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AIR FORCE SCIENTIFIC RESEARCH
BIBLIOGRAPHY
1959

by

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Science and Technology Division
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FOREWORD

The Air Force Office of Scientific Research, a primary research capability of the technology-dependent USAF, looks to the world of science with a view toward helping insure the most timely impact of new discovery on the operating capability of the Air Force. To this objective AFOSR brings to bear its specialized resources to assist the transfer of concepts from basic research to those agencies and individuals equipped to translate these concepts into technology.

One of the most comprehensive efforts of AFOSR in this direction is the Air Force Scientific Research Bibliography, a project designed and monitored by the AFOSR Directorate of Information Sciences. This series provides ready access to both the published literature and unpublished technical reports resulting from the extramural support of basic research by the Air Force.

Four years ago AFOSR published volume one covering research published from 1950 to 1956. Volume two, published in 1964, covers 1957 and 1958. This volume spans research published in 1959. Subsequent volumes now in preparation will make the bibliography effectively current.

The bibliography of this research stands as a unique publication among Federally sponsored research agencies, inasmuch as it sets forth a comprehensive listing of research results in one series. A large share of credit for the inclusiveness of the bibliography goes to the principal investigators through whose conscientious efforts the body of this literature has been collected.

This series is prepared through the cooperation of the Special Bibliographies Section of the Science and Technology Division, Library of Congress, which also prepared the scientific abstracts.

William J. Price

William J. Price
Executive Director

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PREFACE

Scope

This is the third volume of a continuing bibliographic series. The first volume,
issued in 1961, covered the period 1950 through 1956. The second volume, issued in
1964, covered the period 1957 and 1958.

This volume of the bibliography includes, within the limitations of the law of
diminishing returns, abstracts of all technical reports, journal articles, books, sympo-
sium proceedings, and monographs produced and published by scientists supported in whole
or in part by the Air Force Office of Scientific Research during the calendar year 1959.

The Air Force Office of Scientific Research supports fundamental research in the
five major scientific disciplines: physics, chemistry, engineering sciences (subsuming
mechanics and propulsion), life sciences (both biological and behavioral, but not medical),
and mathematics (including during the period of this bibliography, the information sci-
ences). Thus, these abstracts are multi-disciplinary, their common link being their
support by AFOSR.

Sources Searched

References, reports, and clues to the existence of reports were found by searching
the indexes and report collection of the Air Force Office of Scientific Research Technical
Library, and the collection of the Defense Documentation Center. Detailed searches were
made of each contract file in the several AFOSR Directorates. In addition cover-to-cover
searches were made of over 200 scientific journals issued mostly in the time period
1959-1962.

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(1) Remark attributed to William Henry, Duke of Gloucester, upon presentation of
the third volume of the "Decline and Fall of the Roman Empire."

(2) Study Number IV. "Documentation and Dissemination of Research and Develop-
ment Results" Report of the Select Committee on Government Research of the House of
Representatives. Eighty-eighth Congress, Second Session. 20 November, 1964. Page 91

(3) Gray, Dwight E. Science, v. 137: 266, July 27, 1962.

Form of Entry and Arrangement

Inherent in the organization of this book is the concept of the reports within a contract as an unanalyzed monographic series. Reports are posted chronologically and/or alphabetically under contracts, these in turn under laboratories, and these under contractors. This does, in fact, provide a rough subject grouping, with the detailed subject index leading into clusters of like reports.

The abstracts are identified by item numbers and are listed under these numbers in the indexes. The three letter mnemonic code, used in Volumes I and II, has been discontinued in this volume. The form of entry is, in general, that being used for DDC catalog cards, i.e.; source of the document; title; personal author, if any; date; pagination; report number; contract number; and accession number. The chief exception is that the primary entry is by the parent organization followed by the name of the specific laboratory or important subdivision, if necessary, e.g. Princeton U. Frick Chemical Lab., rather than Frick Chemical Lab., Princeton U.

Availability of Reports

The principal accession or control numbers, which indicate the locations of reports in collections are:

AD ASTIA Document, or Accessioned Document: available at DDC (Defense Documentation Center), Cameron Station, Alexandria, Virginia 22314

PB Publication Board: for sale by the Clearinghouse for Federal Scientific and Technical Information (CFSTI), Sills Building, 5285 Port Royal Road, Springfield, Virginia 22151

The fact that a report is abstracted in this book means that a copy of this report existed at the time the abstract was written; it should not be construed to imply that AFOSR or the Library of Congress necessarily has a copy available for distribution. Those seeking reports should do so from the cited agencies, not from AFOSR.

Indices

A detailed subject index, arranged alphabetically, and special subject classification for mathematics, have been provided. In addition, there are a contract index, an AFOSR control number index, and a personal author index.

Acknowledgements

Many people have shared in the production of this volume. The work has been fostered and encouraged by the previous Commanders and Executive Director of the Air Force Office of Scientific Research: Brigadier Generals H. F. Gregory and B. G. Holzman, Colonels A. P. Gagge and Jack L. Deets, Dr. Knox Millsaps and the present Executive Director, Dr. William Price. Invaluable assistance has been given by Mrs. Eleanor Capps, AFOSR's documentation librarian, whose accurate records have helped to make this book possible. Alex Nagy, chief designer, and staff artist of the Office of Aerospace Research drew the chapter end plates (with the usual disclaimer about resemblances to persons living or dead being purely coincidental). Perhaps, most important of all, has been the cheerful and willing cooperation of the scientific staff of AFOSR in assisting the bibliographers in locating reports and helping with subject analysis.

The bibliographic team has worked under the guidance and leadership of Dr. Clement R. Brown, Head of the Special Bibliographies Section, Science and Technology Division, Library of Congress. The chief bibliographers have been G. Vernon Hooker, Aaron S. Dann, Doris C. Yates and Harvey D. Brookins. A special note of gratitude is due to those who have aided in abstracting and subject indexing, especially Thomas C. Goodwin, Mrs. Joan Halpin, Abbott W. Martin, Jr., and Bruce Blankenhorn. Recognition is also due for the invaluable work in the preparation of this manuscript done by Mrs. Marion S. Carr and Mrs. Phyllis M. Martin.

Harold Wooster

Washington, D. C.
August 1965

Harold Wooster
Director
Information Sciences

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Aarhus U. [Mathematical Inst.] (Denmark).

ON THE DISTRIBUTION OF THE RANDOM VARIA-
BLE H_n, by E. S. Andersen. Feb. 27, 1959 [15]p. incl.
diagr. (Technical scientific note no. 1) (AFOSR-TN-
59-671) (AF 61(052)42) AD 218383   Unclassified

Treatment is made of the distribution of the random
variable H_n. Given a sequence X_1, X_2, ... of random
variables we define $S_k = X_1 + ... + X_k$ and the new
sequence $T_0^{(n)}$, $T_1^{(n)}$,..., $T_n^{(n)}$ as the largest convex
minorant sequence to the sequence $S_0 = 0$, S_1, ..., S_n.
The random variable H_n we define as the number of
values $k(k = 1, ...,n)$ for which $T_k^{(n)} = S_k$. It is assumed
that the random variables X_1, X_2, ... are independent
and identically distributed. In the case, where the com-
mon distribution function $F(x)$ of the random variables
X_n is continuous the distribution of H_n is known. The
condition that $F(x)$ be continuous is omitted. The main
result is a formula for the double-generating function

$$H(s,t) = \sum_{n=0}^{\infty} \sum_{m=0}^{n} P(H_n = m)s^n t^m.$$

(Contractor's abstract)

2

Aarhus U. [Mathematical Inst.] (Denmark).

ON THE DISTRIBUTION OF THE RANDOM VARIABLE
H_n, by E. S. Andersen. Technical summary rept. Feb.
27, 1959 [4]p. (AFOSR-TN-59-672) (AF 61(052)42)
AD 218384   Unclassified

Definition of the random variable H_n is presented.
Given a sequence of random variables X_1, X_2, ...,
$S_k = X_1 + ... + X_k$ and a new sequence
$T_0^{(n)}$, $T_1^{(n)}$, ..., $T_n^{(n)}$ is defined as the largest convex
minorant sequence to the sequence $S_0 = 0$, S_1, ..., S_n.
The random variable H_n is defined as the number of
values k ($k = 1,...,n$) for which $T_k^{(n)} = S_k$. The distri-
bution of H_n was investigated under the assumption
that the random variables X_1, X_2, ... are independent
and identically distributed. If the common distribution
function $F(x)$ of the random variables X_k is continuous,
then the distribution of H_n is known. In the investiga-
tions reported the condition that $F(x)$ be continuous was

dropped. The main result is a formula for the double-
generating function

$$H(s,t) = \sum_{n=0}^{\infty} \sum_{m=0}^{n} P(H_n = m)s^n t^m.$$

(Contractor's abstract)

3

AeroChem Research Labs., Inc., Princeton, N. J.

SIMILITUDE TREATMENT OF HYPERSONIC STAGNA-
TION HEAT TRANSFER, by D. E. Rosner. [1959] [2]p.
[Rept. no. TP-10] (AFOSR-TN-59-288) (AF 49(638)-
300) AD 212920   Unclassified

Also published in ARS Jour., v. 29: 215-216, Mar. 1959.

Using the similarity between heat and mass transport
an expression for the convective heat transfer rate at
the nose of a blunt body is developed for dissociated
but chemically frozen laminar flow with arbitrary sur-
face catalytic activity. The result is shown to be identi-
cal in structure with recent solutions to the boundary
layer equations.

4

AeroChem Research Labs., Inc., Princeton, N. J.

REACTION RATE DISTRIBUTIONS ON CATALYTIC
SURFACES, by D. E. Rosner. Dec. 26, 1958 (7]p. incl.
diagrs. (Rept. no. TM-12) (AFOSR-TN-59-432)
(AF 49(638)300) AD 214794; PB 140809 Unclassified

Ambrok's (Soviet Phys. Technical Phys., v. 2: 1979-
1986, Sept. 1957) nonsimilarity correction to the
Nusselt number is applied to the diffusion boundary
layer with catalytic surface reaction. For the laminar
boundary layer on a catalytic flat plate closed form re-
sults are obtained for the steady state reactant concen-
tration along the surface and hence the reaction rate
distribution, for arbitrary values of the reaction order.
(Contractor's abstract)

5

AeroChem Research Labs., Inc., Princeton, N. J.

ON THE EFFECTS OF DIFFUSION AND CHEMICAL
REACTION IN CONVECTIVE HEAT TRANSFER, by D.
E. Rosner. (Rept. no. TM-13) (AFOSR-TN-59-920)
(Sponsored jointly by Air Force Office of Scientific
Research under AF 49(638)300 and Wright Air Develop-
ment Center under AF 33(616)6216)   Unclassified

Also published in ARS Jour., v. 30: 114-115, Jan. 1960.

The notion of an "effective" thermal conductivity for
reacting gaseous mixtures is applied to the prediction

of convective heat transfer rates when dissociation, diffusion and atom recombination take place within a laminar boundary layer in quasi-equilibrium. The result for the forward stagnation region of a cool blunt nosed body is compared to recent solutions of the boundary layer equations with particular regard to the explicit dependence on the Lewis number. (Contractor's abstract)

6

AeroChem Research Labs., Inc., Princeton, N. J.

CHEMICALLY FROZEN BOUNDARY LAYERS WITH CATALYTIC SURFACE REACTION, by D. E. Rosner. [1959] [6]p. incl. diagrs. refs. (AF 49(638)300)
Unclassified

Published in Jour. Aero/Space Sci., v. 26: 281-286, May 1959.

When a fluid boundary layer containing a single reactant develops along a solid surface which acts chemically as a sink distribution for this species, its steady-state concentration along the surface, and, hence, the reaction rate distribution depends both upon the true surface chemical kinetics and a combination of convective and diffusive mass transport through the fluid. A simple approx method for studying this streamwise distribution of reaction rate in terms of the shear and temperature distributions along the surface. The method is based upon a treatment of the concentration integral equation which initially parallels Liepmann's recent treatment of the energy integral equation but which ultimately leads to a differential equation for the concentration distribution of reactant along the surface. This approach to "mass transfer" problems is compared with the techniques of Chambré and Acrivos. The reactant concentration is considered to be so small that constant diffusion coefficient, D, viscosity coefficient, μ, Prandtl Number for diffusion (Schmidt Number), $Pr_D = \mu/(pD)$, can be assumed, and the fluid is taken to be incompressible, with catalyzed reaction taking place only at the wall. Thus, the hydrodynamic field is unaltered by the surface reaction, and only the effect of small surface temperature differences on the kinetics of the wall reaction — i.e., the effective "sink" strength — are taken into account. Extension to the case of several reactants is discussed, and an interpretation of the governing catalytic parameter as a ratio of characteristics times is given. (Contractor's abstract, modified)

7

AeroChem Research Labs., Inc., Princeton, N. J.

LOW TEMPERATURE PLASMA JET AS A FREE RADICAL SOURCE (Abstract), by D. E. Rosner, H. Burwasser, and H. F. Calcote. [1959] [1]p. (Bound

with its AFOSR-TN-59-770; AD 241053) (AF 49(638)-300)
Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

Nitrogen at pressures between 30-100 nm Hg has been partially dissociated in a dc discharge and expanded through a split brass/lava nozzle-shaped cathode into a low pressure (1-10 mm) test section. Power balance and discharge characteristics have been obtained over a current range from 0.25-0.50 amp at fixed electrode separation. In addition to an over-all power balance technique, 2 methods are described for determining the atom concentration in the emerging supersonic jet of active nitrogen. The 1st is a differential thermoelectric catalytic probe technique relying on the difference in the catalytic activity of 2 small cylinders in cross flow to the exothermic surface recombination of atoms. The theory of such probes in low density supersonic flows is discussed with regard to corrections for arbitrary catalytic activity, diffusion and radiation. In practice, platinized quartz and bare quartz have been used as the catalytic and "noncatalytic" members, with both elements operating in the slip flow regime. The 2nd method consists of a chemical titration in which propylene is used as the titrant, and the amount of hydrogen cyanide produced by the reaction with nitrogen atoms is determined by means of mass spectrometric analysis. Based on the measurements made to date, the over-all energy efficiency for the production of atoms by the device described compares favorably with high intensity arc plasma jets operating at stagnation temperatures in excess of 6000°K.

8

Aerojet-General Corp., Azusa, Calif.

KINETICS OF THE SURFACE DEGRADATION OF POLYMETHYLMETHACRYLATE, by R. F. Chaiken, W. H. Andersen and others. Aug. 1959 [15]p. incl. diagrs. tables, refs. (Rept. no. TN-29) (AFOSR-TN-59-610) (AF 18(603)74) AD 217397   Unclassified

Also published in Jour. Chem. Phys., v. 32: 141-146, Jan. 1960.

The surface degradation of both linear and crosslinked polymethylmethacrylate (PMM) has been studied over the surface temperature range from 550 to 910°K by means of a hot-plate pyrolysis technique. It was demonstrated that surface gasification due to the high heat flux at the decomposing PMM surface involves a depolymerization process and surface desorption of methylmethacrylate monomer. The apparent activation energy for the linear rate of regression of the solid PMM surface (linear pyrolysis rate) was found to decrease with increasing surface temperature, approaching a limiting constant value of 11.2 ± 0.6 kcal/mol at ~ 650°K

for linear PMM, and at ~ 770°K for crosslinked PMM.
The mechanism for the surface degradation is depicted
as (1) formation of monomer in the surface substrate,
(2) diffusion of monomer to the surface, and (3) desorp-
tion of monomer from the surface. The linear-pyro-
lysis-rate data is correlated by means of an absolute-
rate-theory treatment of surface decomposition. The
experimental results are in good agreement with the
theory. (Contractor's abstract)

9

Aerojet-General Corp., Azusa, Calif.

STUDY OF THE KINETICS OF SOLID PHASE REAC-
TIONS, by R. F. Chaiken. Nov. 1959, 6p. incl. refs.
(Rept. no. 1706) (AFOSR-TR-59-180) (AF 18(603)74)
AD 229120   Unclassified

A theoretical concept of the mechanism of the thermal
decomposition of solids proposed by Schultz and Dekker
was tested on various pure compounds. Mechanisms
are postulated for the degradation of polymethylmetha-
crylate and the decomposition of ammonium nitrate.
Important differences were found between bulk and sur-
face decomposition data which could be explained on
the basis of the processes involved. An improved
linear pyrolysis apparatus was constructed which per-
mitted the re-evaluation of kinetic data. A careful study
of the data revealed the limitations of the instrument,
and resulted in the use of supplementary methods for
obtaining kinetic decomposition data. (Contractor's
abstract)

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Aerojet-General Corp., Azusa, Calif.

A MODEL DESCRIBING COMBUSTION OF SOLID
COMPOSITE PROPELLANTS CONTAINING AMMONI-
UM NITRATE, by W. H. Andersen, K. W. Bills and
others. [1959] [17]p. incl. diagrs. tables. (AF 18(603)-
74)   Unclassified

Published in Combustion and Flame, v. 3: 301-317,
Sept. 1959.

A 'two-temperature' model describing the burning of
ammonium nitrate, AN, composite propellants is pre-
sented. This theory postulates that in an AN propel-
lant, the oxidizer gasifies first at about 300° to 350°C
by a highly endothermic surface process to give pre-
mixed ammonia and nitric acid. The oxidation-reduc-
tion reactions of these 2 gases establish a flame with a
maximum temperature of about 1000°C. Burning cata-
lysts influence burning characteristics of AN propellants
mainly through a heterogeneous catalysis of these gas-
phase reactions. Particles of binder protrude from the
burning oxidizer surface and pyrolyse in this hot flame-
zone. Since the pyrolysis of solid oxidizer and of solid
binder are independent processes it is possible with this
theory to estimate average surface temperatures of both

the oxidizer and binder in the burning propellant by
means of linear pyrolysis-rate data. Unique experi-
ments demonstrate that the binder-oxidizer gas reac-
tions often take place at a relatively large distance from
the surface in a region of relatively high temperature.
The heat produced by these exothermic binder-oxidizer
gas reactions (diffusion flame) must therefore contribute
very little to the determination of the effective temper-
ature at the surface with many typical AN propellants.
The theory predicts a lower limit of about 0.04 cm/sec
to the burning rate of AN propellants. (Contractor's
abstract)

11

Aerojet-General Corp., Azusa, Calif.

A THERMAL LAYER MECHANISM OF COMBUSTION
OF SOLID COMPOSITE PROPELLANTS: APPLICA-
TION TO AMMONIUM NITRATE PROPELLANTS, by
R. F. Chaiken. [1959] [16]p. incl. diagrs. refs. [AF 18-
(603)74]   Unclassified

Published in Combustion and Flame, v. 3: 285-300,
Sept. 1959.

A mechanism for the combustion of ammonium nitrate
solid composite propellants is present, utilizing the
recent 'two-temperature' theory of propellant burning.
According to the theory, the rate-controlling reactions
associated with the gasification (pyrolysis) of the solid
oxidizer and of the solid binder in a composite propel-
lant are essentially independent of each other. A model
of steady-state combustion is set up which considers
the pyrolysis of oxidizer separately from the binder. It
is assumed that the surface pyrolysis is the result of
the transfer of heat from a flame zone surrounding the
oxidizer particle, and that this flame zone is the result
of the gas-phase redox reactions between the oxidizer
pyrolysis products. It is assumed that a thermal layer
exists about an oxidizer particle; the thickness of this
layer (distance between the oxidizer surface and the
flame zone) is related to the velocity at which gas ex-
pands away from the surface, and the rate of the gas-
phase reaction. From heat transfer considerations, an
analytical expression for the thickness of the thermal
layer is obtained in terms of the pressure, oxidizer
particle size, and the kinetics of the solid and gas-phase
reactions. The agreement between the theory and the
available data on ammonium nitrate propellants is
reasonable. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

A THERMOCOUPLE JUNCTION FOR A HOT-PLATE
LINEAR PYROLYSIS APPARATUS, by R. F. Chaiken
and D. K. Van de Mark. [1959] [4]p. incl. diagr.
(AF 18(603)74)   Unclassified

Published in Rev. Scient. Instr., v. 30: 375-376, May 1960.

As a supplement to a previous report (AER.06:001, Vol. II) it is pointed out that the surface temperature measurements given could be in error, particularly at high heat flux. The finite thickness of the thermocouple junction is believed to be the cause of the error. At lower temperatures the temperature drop across the plate is small and negligible, but at higher temperatures the drop is quite noticeable. Surface temperature measurements which are in error by as much as 30°C have been found.

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Aerojet-General Corp., Azusa, Calif.

FREE RADICAL FUELS - A TOUGH PROBLEM, by J. M. Flournoy. Sept. 1959 [6]p. incl. illus. diagr. (Rept. no. TN-32) (AFOSR-TN-59-821) (AF 18(603)-110) AD 226541   Unclassified

Also published in Astronautics, v. 4: 44, 106, 1959.

The problems involved in the use of stabilized energetic free radicals for propulsion purposes are summarized and discussed briefly in terms of 4 problem areas: selection of systems, production, storage, and combustion. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

CHEMICAL FRAGMENTS AS ULTRA-ENERGY PROPELLANTS, by D. L. Wulff, I. H. Baum, and J. M. Flournoy. Nov. 1959, 56p. incl. refs. (Abstracts Bull. no. 4; rept. no. TN-33) (AFOSR-TN-59-1249) (AF 18(603)110) AD 230736; PB 145649

Unclassified

The 4th in a series of Abstracts Bulletins continuing the work of the 1st 3 (AER.08·001, 002, 004, Vol. II) surveys the time period from 1956 through part of 1958. This bulletin is expected to terminate the service since wide-spread interest in this field has been generated. The investigations cover certain high-energy chemical systems as potential propellants for rocket propulsion which has necessitated an extensive review of the literature concerned with chemical fragments, products, identification, stabilization, and determination of properties.

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Aerojet-General Corp., Azusa, Calif.

RESEARCH ON ULTRA ENERGY FUELS FOR ROCKET PROPULSION, by J. M. Flournoy, L. H.

Baum and others. Oct. 1959, 1v. incl. illus. diagrs. tables, refs. (Rept. no. 1690) (AFOSR-TR-59-169) (AF 18(603)110) AD 229132   Unclassified

The results of 3 yr of research on the stabilization of energetic free radicals are summarized. Hydrogen atoms, hydroxyl radicals, and other normally unstable chemical species, produced by ionizing radiation and by electric discharges, were stabilized at low temperatures. The rate of disappearance of some of these radicals were studied over a range of temperatures, using electron-paramagnetic-resonance techniques. The heat released by the recombination of hydroxyl radicals in ice near 100°K was measured. The adsorption of hydrogen atoms on glassy materials at normal temperatures was investigated and found to involve a variety of different adsorption sites. The general problems involved in the production, storage, and utilization of high concentrations of free radicals are briefly summarized in the light of the results of research in the field over the last several years. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

RESEARCH ON FREE RADICALS AS ROCKET PROPELLANTS, by G. Moe and D. L. Armstrong. [1959] [14]p. incl. diagrs. tables, refs. [AF 18(603)110]

Unclassified

Published in Proc. Symposium on Advanced Propulsion Systems, Los Angeles, Calif. (Dec. 11-13, 1957), New York, Pergamon Press, v. 2: 213-226, 1959.

One of the problems encountered in the development of airborne vehicles capable of traveling longer distances and of attaining increased altitudes is the need for fuels of higher specific impulse than is currently attainable with conventional chemical fuels. Calculations have been made to indicate that significant increases in the performance of rocket propellants are possible if certain types of free radicals and atoms can be utilized. The radicals and/or atoms might be introduced into a suitable working fluid, such as hydrogen. The reaction of the radicals would heat the working fluid to the desired operating temperature. Whereas the maximum specific impulse that can be expected from ordinary chemical propellant systems is in the range from 350 to 400 lb-sec/lb, the utilization of the heat of reaction of free radicals, such as NH, CH, or of atomic H could result in specific impulses in excess of 400 lb-sec/lb. The method of calculation of the performance characteristics of free radical propellant systems is discussed in detail. The results of an experimental study on the production and stabilization of the imine radical, NH indicate that the blue material which is condensed at -196°C when hydrazoic acid, HN_3, is passed through a furnace at 1000°C or an electric discharge is a form of undissociated nydrazoic acid. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

EPR STUDIES OF ELECTRON IRRADIATED ICE AND
SOLID HYDROGEN, by J. M. Flournoy, L. H. Piette
and others. [1959] [2]p. incl. diagrs. [AF 49(638)110]
Unclassified

Published in Jour. Chem. Phys., v. 30: 1623-1624, June
1959.

The results are given of a group of electron irradiation
experiments employing the Stanford U. mark II 40-mev
linear accelerator and a V-4500 EPR spectrometer
with liquid helium accessory. Irradiations were carried
out on ice and on solid hydrogen. Resonance values
were obtained at 4.2°K at different dosages and re-
ported. It is felt that increased concentration of the
hydrogen atom could be achieved through improved
thermal contact of the sample to the helium bath and
through the use of considerably lower irradiation rates.

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Aerojet-General Corp., Azusa, Calif.

UTILIZATION OF UPPER-ATMOSPHERE ATOMIC-
OXYGEN RECOMBINATION FOR PROPULSION, by A.
Zukerman and C. B. Kretschmer. Apr. 10, 1959, 1v.
incl. diagrs. tables, refs. (Rept. no. TN-28) (AFOSR-
TN-59-517) (AF 49(638)111) AD 216292; PB 152055
Unclassified

The report presents a preliminary investigation of
several methods for the utilization of the upper-atmos-
phere atomic-oxygen recombination energy for propul-
sion purposes. The following systems were studied:
(1) the fuelless ramjet, (2) a ramjet with fuel addition,
and (3) a catalytic ram rocket (a power plant of the
ramjet type in which the chemical reaction takes
place primarily on the catalytic surfaces of the reac-
tion chamber). The fuelless ramjet cycle was previ-
ously investigated using ideal conditions (AER.11:004,
Vol. II). In this investigation, losses were taken into
account and the latest available values for the reac-
tion-rate constant were used. This investigation shows
that the fuelless ramjet cannot provide enough thrust
to sustain a satellite in the atomic-oxygen layer. The
investigation of the ramjet with mass addition shows
that with fuels similar to NO_2 (in molecular weight

and heat release) enough thrust can be derived to
overcome the external drag, but not the total drag.
Certain configurations of the catalytic ram rocket
show promise for sustaining a satellite for a consider-
able length of time at a high expense of coolant fluid.
(Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

A STUDY OF THE FEASIBILITY OF AN ATOMIC
OXYGEN RAMJET, by A. Zukerman and C. B.
Kretschmer. [1959] [17]p. incl. diagrs. tables. [AFOSR-
TN-59-820] [AF 49(638)111] Unclassified

Presented at Fourth AFBMD/STL Symposium on Ad-
vances in Ballistic Missile and Space Technology, Los
Angeles, Calif., Aug. 24-27, 1959.

Also published in Planetary and Space Sci., v. 4: 60-76,
Jan. 1961.

The utilization of the upper-atmosphere, atomic-oxygen-
recombination energy for propulsion purposes through
the use of different ramjet types of engine was investi-
gated. The fuelless ramjet, the ramjet with fuel addition,
and a catalytic-ramjet-rocket (ram-rocket) were inves-
tigated as possible satellite sustainers in the atomic-
oxygen layer. Optimum configurations of the different
types were determined, and the performance was com-
pared with satellite sustaining requirements. (Con-
tractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

INVESTIGATION OF ATOMIC-OXYGEN RECOMBINA-
TION RATES, by C. B. Kretschmer. Final rept. May
1959 [35]p. incl. diagrs. table, refs. (Rept. no. 1611)
(AFOSR-TR-59-62) (AF 49(638)111) AD 217008
Unclassified

The following values of rate constants were determined
at 350°K:

$O + O + M \rightarrow O_2 + M$; $k_1 = (2.5 \pm 1.0) \times 10^{15}$ cm^6/mol^2 sec

$O + O_2 + M \rightarrow O_3 + M$; $k_2 = 1.1 \times 10^{14}$ cm^6/mol^2 sec

$O + OH + M \rightarrow HO_2 + M$; $k_{28} = 1.2 \times 10^{17}$ cm^6/mol^2 sec

These values are for $M = O_2$ or A. When $M \rightarrow O$, k_1 is
4 to 20 times as large as the value stated. A comparison
of the value of k_1 found here with values obtained from
shock-tube experiments gives the following equation for
the temperature dependence of k_1: $k_1 =$
10^{14} $(T/4500)^{-(1.22 \pm 0.16)} \pm 5 \times 10^{13}$ cm^6/mol^2 sec.
An investigation of the feasibility of the atomic-oxygen
ramjet led to the conclusion that flight at orbital velocity
is impossible because of diffuser losses. Flight at M =
2 is marginally feasible, but at any velocity less than
orbital, the payload capacity is essentially zero.

21

Aerojet-General Corp., Azusa, Calif.

POSITIVE-ION EMISSION FROM SURFACES (Abstract), by R. J. Sunderland. [1958] [1]p. (Bound with its AFOSR-TR-58-125; AD 162274; also bound with its AFOSR-TN-59-770, AD 241053) (AF 49(638)214)
Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

At the present time there does not exist a source capable of producing a copious quantity of ions on a surface and which also has the feature of continuously replenishing the ionizing material. The research being conducted under this contract is directed toward the investigation of several systems which show promise of providing the desired emissions. These include: (1) the ionization of gases on diffusion through heated metal foils, (2) the electrolysis of alkali metal ions through glass membranes, and (3) the diffusion of alkali metal vapor through porous tantalum or tungsten metals at elevated temperatures. The sodium through glass experiment is the most advanced, and there is some indication of an emission from the vacuum side of a glass membrane whose outer surface is immersed in a molten sodium nitrate bath. The emitted material is collected on a water cooled surface maintained at a high negative potential with respect to the molten salt. Apparatus for the detection and identification of the ions emitted from a heated palladium foil through which hydrogen is diffusing has been designed and is being assembled, and a device to study the transmission of cesium vapor through a porous tungsten sheet maintained at 1200-1400°K is being fabricated.

22

Aerojet-General Corp., Azusa, Calif.

THEORETICAL AND EXPERIMENTAL STUDIES OF GAS DYNAMICS, by K. Sato. Final rept. June 1959 [26]p. incl. illus. diagrs. (Rept. no. 1604) (AFOSR-TR-59-65) (AF 49(638)252) AD 264247 Unclassified

The primary objective of the program was to determine the conditions necessary to obtain a rapid chemical reaction in the immediate vicinity of a shock wave. The initial shock wave, generated in the gaseous oxidizer, was allowed to disperse the injected fuel droplets and to raise the temperature and pressure of the fuel-oxidizer mixture. It was then reflected from the end of the shock tube and allowed to pass through the dispersed fuel droplets and oxidizer. The course of the reflected shock wave was followed photographically to determine the degree of chemical reaction of the

fuel-oxidizer mixture. Results showed that the chemical reaction between the fuel and oxidizer was observed only after the passage of the reflected shock wave. (Contractor's abstract)

23

Aerojet-General Corp., Azusa, Calif.

THE ROLE OF BINDER IN COMPOSITE PROPELLANT COMBUSTION, by R. F. Chaiken and W. H. Andersen. July 1959 [24]p. incl. diagrs. tables, refs. (Rept. no. TN-30) (AFOSR-TN-59-540) (AF 49(638)-566) AD 216557; PB 149772 Unclassified

Presented at meeting of the Paint, Plastics, and Printing Ink Chem. Div. of the Amer. Chem. Soc., Atlantic City, N. J., Sept. 13-18, 1959, p. 15-Q.

Abstract published in 136th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1959, p. 15-Q.

Also published in Prog. in Astronaut. and Rocketry, v. 1: 227-249, 1960.

The interrelation of binder (fuel) and oxidizer during burning of conventional types of solid composite propellants is discussed in terms of the mechanism of the combustion process. A major feature of most contemporary theories of composite propellant combustion is that diffusion processes are involved in the chemical reactions between the gaseous pyrolysis products of the oxidizer and binder. However, the importance of these diffusion processes in affecting the propellant-burning characteristics depends upon the relative rates of reaction between the oxidizer-binder pyrolysis products and the oxidizer pyrolysis products alone. Utilizing the recently developed "Two-Temperature" and "Thermal Layer" theories of combustion, it is possible to delineate the various effects of these gaseous reactions on the propellant burning rate. These theories have been extended semi-quantitatively to include the effects of dilution, diffusion, and fast chemical reaction of the gasified binder. The combustion of ammonium nitrate and ammonium perchlorate propellants is discussed in terms of the described concepts, and compared with experimental data where possible. Evidence is presented which suggests that the "order-of-magnitude" burning rates of most ammonium-nitrate-based propellants should be determined largely by the chemical decomposition behavior of the oxidizer, with the binder decomposition playing a secondary role. It is not clear that the same situation holds for ammonium-perchlorate-based propellants. The physical influence of the binder on the combustion process is also discussed briefly. (Contractor's abstract)

24

Aerojet-General Corp., Azusa, Calif.

THE COLLOID ROCKET: PROGRESS TOWARD A

CHARGED-LIQUID-COLLOID PROPULSION SYSTEM, by R. D. Schultz and L. K. Branson. [1959] [31]p incl. illus. diagrs. tables, refs. (AFOSR-TN-59-1334) (AF 49(638)656) AD 241055   Unclassified

Also published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass., (Oct. 7-8, 1959), Boston, v. 1: 53-72, 1959. (AFOSR-637)

Theoretical and experimental research is described leading toward a space propulsion system in which microscopic oil droplets are produced with a high positive charge and accelerated electrostatically to exhaust velocities of over 50,000 mph with a specific impulse of over 2200 sec. This type of rocket system may prove to be of considerable value for controlling the orbit of an earth satellite, for earth-moon missions, and possibly for deep-space exploration such as a Mars or Venus probe. (Contractor's abstract)

25

Aerojet-General Corp., Azusa, Calif.

INVESTIGATION OF A CHARGED-COLLOID PROPULSION SYSTEM (Abstract), by R. D. Schultz. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)656)   Unclassified

Presented at Second AFOSR Contrac rs meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

Preliminary measurements have been made of the initial charge-to-mass-ratio of liquid colloidal droplets produced by electrical dispersion from sharp needle tips maintained at high positive potentials. The needle tip is continuously wetted with liquid. Liquids tested include octoil, didecyl adipate, and polyalkylene glycol derivative ("flexol" plasticizer B-400, Union Carbide Chemicals Co.). Initial charge-to-mass-ratio for colloidal droplets of each liquid was approx 5×10^8 esu/g. Apparatus has been designed and a system is being constructed in which charge-to-mass-ratio of colloidal droplets and the momentum beam of charged colloids can be measured in high vacuum. Pressures as low as 5×10^{-7} mm Hg have been obtained and accelerating voltages, as high as 200 kv.

26

Aeronautical Research Inst. of Sweden, Stockholm.

A THEORETICAL INVESTIGATION OF SECOND-ORDER SUPERSONIC INTERFERENCE EFFECTS, by B. '. Beane and M. T. Landahl. Apr. 1959 [17]p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-59-962) (AF 61(052)75) AD 216957; PB 144305   Unclassified

An approximate solution, valid for high Mach numbers,

for the 2nd-order supersonic flow problem of 2 interfering flow fields is given. The approximate solution requires that the spanwise curvature of the body flow field is small. A further approximation is made which leads to a very simple formula for the interference pressure. This formula is found to give relatively small errors in the cases investigated. It is found that 2nd-order interference effects may be large at Mach numbers above 3. It is demonstrated that large gains in control surface efficiency may be obtained by placing the control surface in a region of high pressure from the body. (Contractor's abstract)

27

Aeronutronic, Newport Beach, Calif.

ENHANCEMENT OF GAS PHASE CHEMICAL REACTION RATE DUE TO SIMULTANEOUS PERIODIC TEMPERATURE AND VOLUME PERTURBATIONS, by H. M. Wight. Apr. 1959, 27p. incl. diagrs. tables. (Technical note no. U-489) (AFOSR-TN-59-513) (AF 49(638)311) AD 264246   Unclassified

A research study was made of the effect of simultaneous temperature and volume variations on gas phase chemical systems having well established kinetics. The specific systems selected for study were: (1) the decomposition of Hl; and (2) the direct synthesis of HBr. A theoretical analysis was made which predicts reaction rate enhancements should occur for systems subjected to periodic perturbations in volume and temperature. The enhancement arises essentially from the non-linear temperature dependence of the rate constants. For a chain reaction such as HBr synthesis, the predicted rate enhancement falls off mildly with an increase in the perturbation frequency. (Contractor's abstract)

28

Aeronutronic [Newport Beach, Calif.].

ON STUDY OF METHODS OF PRODUCING HIGH-SPEED PARTICLES, by T. Bergstralh, D. Krucoff and others. Nov. 1959, 65p. incl. illus. diagrs. tables, refs. (Rept. no. U-698) (AFOSR-TR-59-181) (AF 49(638)366) AD 229718; PB 144731   Unclassified

Methods were investigated for accelerating, measuring the size and velocity, and effects of impacts, of small particles with diameters in the range of 1 to 1000u to velocities of 5 to 10 km/sec. The primary interest in meteoritic impact effect is on missiles, satellites, and space vehicles. The experimental efforts were limited to electromagnetic and light gas gun techniques since the particles involved in meteoritic impact have diameters greater than 1 micron. Two methods of electromagnetic acceleration were studied: (1) the single coil, repulsion solenoid, employing a thin disc as the sabot;

and (2) a variant of the exploding wire technique. An adaptation of the single-chamber, directly heated, light gas was undertaken. (ASTIA abstract)

29

Aeronutronic, Newport Beach, Calif.

MAGNETOHYDRODYNAMIC WAVES (Abstract), by T. A. Bergstralh. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)670)
Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

Aeronutronic is undertaking an experimental study of magnetically driven shock waves in ionized media. It is intended to drive shocks through an already ionized medium of sufficient conductivity to insure that the magnetic flux remains with the plasma. The diffusion of the magnetic flux with respect to the plasma will be measured. The motion in these magnetohydrodynamic waves will be studied by means of voltage induced in wire loops and by optical methods. The program is intended to experimentally determine the equation of state of the shocked gas and the instabilities at the interface between the plasma and the propelling magnetic field. Th e program is just being started. The planned experiments are outlined.

30

Aeronutronic Systems, Inc., Glendale, Calif.

PROJECT FARSIDE (Unclassified title), by R. G. Taylor (Thiokol Chemical Corp., Elkton, Md.). [1959] 1v. incl. illus. diagrs. tables. (Thiokol Chemical Corp. Elkton Div. rept. no. E 60-57) (AFOSR-TR-59-18) (AF 49(638)55) AD 314403L   Confidential

31

Air Force Office of Scientific Research, Washington, D. C.

PERFORMANCE OF CLOSED-LOOP FLIP-FLOP CONTROL SYSTEM IN MISSILES AND ROCKETS, by M. Rogers and G. Shapiro. [Apr. 15, 1959] 1v. incl. diagrs. (AFOSR-TN-59-349) (In cooperation with Westinghouse Electric Corp., Baltimore, Md.) AD 213677; PB 143593
Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 841-853, Nov. 1960.

The basic concepts underlying the synthesis and analysis of closed-loop, flip-flop control systems of the electromechanical type are developed. Generalized design and analysis charts are presented to aid the engineer in

quickly gaining an understanding of the relative importance of various elements in the system to the system's performance and stability. The importance of considering not only control-system dynamics, but also the damping provided by the airframe in developing practical flip-flop control systems is forcefully demonstrated to the engineer and scientist. Analog computer data, obtained as part of the present study, are used to substantiate analytic approaches and to advance the understanding of such systems. (Contractor's abstract)

32

Air Force Office of Scientific Research, Washington, D. C.

POSSIBLE EFFECTS OF CURRENT RESEARCH IN AUTOMATIC INFORMATION HANDLING ON TECHNICAL WRITING AND PUBLISHING, by H. Wooster. [1959] 18p. incl. refs. (AFOSR-TN-59-484) (Sponsored jointly by Air Force Cambridge Research Center, Air Force Office of Scientific Research, Council on Library Resources, Office of Naval Research, Rome Air Development Center, and National Science Foundation)
Unclassified

Presented at meeting of the Tech. Publishing Soc., San Diego, Calif., May 22, 1959.

The possible effects of current research and development in fields of mechanical translation, character reading, automatic abstracting, information storage, retrieval, and pattern recognition are reported. A brief explanation of each of these is given. Some of the problems of information distribution are discussed including the dissemination problem. The role of automatic information handling within the context of these problems is examined. It is concluded that there are many things in this field that machines can do as well as people; applications may save the efforts of people for things that machines cannot do.

33

Air Force Office of Scientific Research, Washington, D. C.

VISTAS IN ASTRONAUTICS, VOLUME II. PROCEEDINGS OF THE SECOND ANNUAL AIR FORCE OFFICE OF SCIENTIFIC RESEARCH ASTRONAUTICS SYMPOSIUM, Denver Colo., Apr. 28-30, 1958, ed. by M. Alperin and H. F. Gregory. New York, Pergamon Press, 1959, 318p. incl. illus. diagrs. tables, refs. (Internat'l. Series of Monographs on Aeronaut. Sci. and Space Flight) (AFOSR-TR-59-94) (Sponsored jointly by Air Force Office of Scientific Research and Institute of Aeronautical Sciences)   Unclassified

At the 2nd Astronautics Symposium, papers were presented dealing with space environment and vacuum research, control and propulsion of vehicles outside the atmosphere, departure and space navigation and reentry problems, and the earth's moon. It was noted that unmanned vehicles could achieve better scientific

information in some instances, but that man would eventually venture out into space. Before that time, however, much more information must be acquired.

34

Air Force Office of S.ientific Research, Washington, D. C.

PROCEEDINGS OF A SYMPOSIUM ON ADVANCED PROPULSION SYSTEMS, Los Angeles, Calif., Dec. 11-13, 1959, ed. by M. Alperin and G. P. Sutton. New York, Pergamon Press, 1959, 237p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-166) (Sponsored jointly by Air Force Office of Scientific Research and North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif.)
Unclassified

This symposium was aimed at bringing together American scientists and engineers engaged in the establishment of the fundamental principles of propulsion for space vehicles. It was realized that the conventional rocket propulsion based solely on chemical propellants had limitations that were fast being approached and that a new type propulsion system was needed. The symposium included reports on all phases of rocket propulsion plus a test firing of the power plant for the Atlas missile. Its publication was delayed because of the classified status of the reports, but a slackening of security and requests for publication led to the volume.

35

Alabama U., University.

CONDUCTANCE OF THE HEXAFLUOCOMPLEXES OF THE FOURTH GROUP, by E. L. Grove and R. Schmitt. July 25, 1959, 54p. incl. diagrs. tables, refs. (AFOSR-TN-59-616) (AF 18(600)1567) AD 230706; PB 145639
Unclassified

An investigation was made of the variation of equivalent conductance with concentration for 18 alkali-hexafluocomplex solutions. The electrolytes included the K, Rb, and Cs hexafluocomplexes formed with Si, Ge, Sn, Ti, Zr, and Hf. Plots of the equivalent conductance vs the square root of the concentration of the compounds yielded typically weak electrolyte curves. Cryoscopic determinations carried out with 0.03, 0.02, and 0.01 molar solutions indicated that 3 ions are formed for each molecule of salt. The pH of all solutions was almost constant for concentrations ranging from 10^{-1} to 10^{-4} equivalents per liter. It was suggested that these properties are caused by the following 3 reactions which occur when a hexafluocomplex is dissolved: (1) the salt ionizes by the mechanisms $K_2MF_6 \rightarrow 2K^+ + MF_6^{--}$, where M is a Group IV element; (2) the hydroxyl ions compete with the fluoride ions as substituents in the coordination sphere of the hexafluocomplex ion as shown by $MF_6^{--} + 2nH_2O \rightarrow$

$MF_{6-n}(OH)_n^{--} + nF^- + nH_3O+$, where n has no exact

value but is usually zero; and (3) the equilibrium $FH \rightarrow F^- + H^+$. The constancy of the pH is thought to be explained by the presence of the buffer, alkali fluoride, and hydrofluoric acid. A sharp increase in equivalent conductance at low concentrations was attributed to the contribution of the fast moving hydronium ion. (ASTIA abstract)

36

Alabama U., University.

A STUDY OF THE GALLIC ACID COMPLEXES OF NIOBIUM, TANTALUM, TITANIUM, AND IRON, by E. L. Grove, L. Maddox, and W. S. Jeffrey. July 26, 1960, 11p. incl. diagrs. table. (AFOSR-TN-59-1183) (AF 18(600)1567) AD 248631
Unclassified

Presented at Chem. Sect. of the Thirty-fifth annual meeting of the Alabama Acad. Sci., Howard College, Birmingham, Ala., Mar. 31-Apr. 2, 1958.

Abstract published in Jour. Alabama Acad. Sci., v. 30: 13, Oct. 1958.

The use of gallic acid as a spectrophotometric procedure for both tantalum, and niobium was investigated. The optical properties of several other metal chelates were also explored. The pH effects on the absorption of niobium, tantalum, and vanadium-gallate chelates is summarized. It is pointed out that it should be possible to develop a colorimetric procedure for tantanium and rhenium without prior separation.

37

Alfred U. New York State U. Coll. of Ceramics, N. Y.

DIFFUSION IN ALKALI HALIDES AT LOW TEMPERATURES, by T. J. Gray and P. G. Harrison. [1959] [11]p. incl. illus. diagrs. (AF 18(600)1448)
Unclassified

Published in Faraday Soc. Discussions, No. 28: 81-85, 1959.

The results of diffusion studies made on alkali halide crystals grown from solution are presented and contrasted with those grown from the melt. Confirmation is made that the predominant feature is the initial distribution of impurities achieved during growth from solution. However, heating the crystals to a temperature corresponding to the "knee" in the classic diffusion relationship reveals that the relationship is contiguous with the classical curve for high temperatures. From this and other evidence, it seems certain that the low-temperature process is definitely associated with the aggregation of impurities and vacancies at dislocations. It is also pointed out that the solution-grown crystals contain 2 orders of magnitude less hydroxyl ion than do typical melt-grown crystals. In addition, no dielectric relaxation phenomena have been observed in any

solution-grown crystals until after heating to above the "knee" temperature; and after heat treatment has occasioned aggregation, the rate of F-center formation increases by 30 to 50%. It is believed that this evidence precludes the acceptance of any oversimplified theoretical treatment which ignores the complexity introduced by aggregation at dislocations.

38

Alfred U. New York State U. Coll. of Ceramics, N. Y.

THE KINETICS OF F-CENTER FORMATION IN ALKALI HALIDES AS A FUNCTION OF PRECIPITATION AT DISLOCATIONS (Abstract), by T. J. Gray and P. G. Harrison. [1959] [3]p. (AF 18(600)1448)
Unclassified

Published in Proc. 1959 Internat'l. Symposium on Color Centers, Oregon State Coll., Corvallis (Sept. 8-11, 1959) [Salem] Oregon State Board of Higher Education, 1959, p. 25-26.

A report on a technique by which the phenomena of F-center development can be studied is presented. An apparatus was designed by which specimens are automatically irradiated for constant periods of time and then moved by linear actuator to a position where they are illuminated at extremely low light intensity from a monochromator and the optical adsorption measured automatically. The time of exposure is substantially less than 1 sec after which the crystal is returned to the x-ray beam. By suitable coupling to a recorder, an intermittent trace is obtained by giving direct display of the development of the adsorption due to F-centers against time for the selected temperature. From these curves, the kinetic relationships for the process can be developed and comparison for several temperatures enables the activation energy for the process to be determined directly.

39

Allied Research Associates, Inc., Boston, Mass.

STAGNATION POINT MELTING AND ABLATION, by T. R. Goodman and C. Chin. Mar. 30, 1959, 18p. incl. diagrs. (AFOSR-TN-59-390) (AF 49(638)347) AD 213894; PB 140523   Unclassified

An investigation of melting and aerodynamic ablation in the vicinity of the stagnation point of blunt bodies is presented. Numerical results for an axially symmetric aluminum body are included. The results show that the quasi-steady solution is in excellent agreement with the complete solution except at the start of the ablation process. A numerical comparison has been made between ablation at the stagnation point of a blunt body and ablation of a flat plate (from an analysis given in an earlier report) both in the same environment and having comparable dimensions. This shows that unsteady effects may persist an order of magnitude

longer for a complete body than they do near the stagnation point. Consequently, it may be necessary to account for these unsteady effects in re-entry vehicles even though an analysis based on behavior near the stagnation point indicates that they can be ignored. (Contractor's abstract)

40

American Mathematical Soc., Providence, R. I.

MATHEMATICS ADVISORY AND EVALUATION SERVICES. Jan. 1959-Dec. 1959. (AF 49(638)204)
Unclassified

This contract provides for an evaluation service to the Mathematics and Applied Mathematics Divisions of the Mathematical Sciences Directorate. Upon request, distinguished mathematicians review and evaluate proposed new directions for mathematical research, new mathematical ideas, and the importance of contemporary mathematical results. The contract also provides for an AFOSR Mathematics Advisory Committee which weighs the general direction of mathematical research, in particular of research supported by the Mathematics and Applied Mathematics Divisions of the Mathematical Sciences Directorate.

41

American Mathematical Soc., Providence, R. I.

CURRENT MATHEMATICAL DEVELOPMENTS. Feb. 1958-Dec. 1959. (AF 49(638)291)   Unclassified

This contract provides for the preparation of a series of reports or books on selected topics in modern mathematics. These reports are prepared by experts in their prospective fields and are written in an expository style. The exposition is pitched at a level accessible to 1st or 2nd year graduate students of science and engineering, and the authors are encouraged to emphasize point of contact with other areas of science. Thus the books should be both interesting and intelligible to professionals in other areas of science and engineering. It is planned that each book be systematic and as far as possible self-contained so that a qualified reader could hope not only to begin the reading of such a book, but to work through it and in doing so to acquaint himself with the principal methods and results in the area covered by the book. One of the main features of these books is the emphasis placed on recent developments and their relationship to other areas of mathematics and science.

42

American Soc. of Mechanical Engineers, New York.

APPLIED MECHANICS REVIEWS, ed. by M. Goland. 1959. (MIPR-680-59-11 and Nonr-275700)
Unclassified

This project is for the production of a monthly journal, reviewing current literature in the field of theoretical and applied mechanics.

43

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

THE PHYSICAL CHEMISTRY OF WATER SOLUTIONS AT HIGH TEMPERATURES AND PRESSURES. Final rept. July 1, 1955-June 30, 1959, 1v. incl. diagrs. tables, refs. (AFOSR-TR-59-74) (AF 18(600)1490) AD 220103   Unclassified

The work of this project has been divided into 2 main sections: (1) the investigation of chemical reactions that take place in water solutions at high temperatures and pressures, and (2) the measurement of the conductivity of salt solutions under supercritical conditions. The chemical reactions investigated include the silicon dioxide water system, the germanium dioxide water system, the aluminum dioxide water system, and the effect of fluoride ion on the equilibrium involved in the silicon dioxide and aluminum oxide system. The occurrence of a conductivity difference between the top and bottom of a platinum lined spark plug autoclave containing NaCl and KCl has been confirmed and measured. The conductivity varies with concentration and solution density in the same manner as that reported in the literature for homogeneous systems. The following reports and publications are appended to this report: item nos. ANT.03:001, 009-011, Vol. II, and item nos. 44-49, this volume.

44

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

TETRASODIUM ENNEAGERMANATE, $Na_4Ge_9O_{20}$, TETRAGONAL FORM, by J. F. White E. R. Shaw and others. [1959] [2]p. incl. illus. table. (In cooperation with California U., Berkeley, Calif.) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1490 and Signal Corps under DA 36-039-sc-73211)   Unclassified

Published in Anal. Chem., v. 31: 315-316, Feb. 1959.

Euhedral crystals of previously undescribed $Na_4Ge_9O_{20}$ were prepared hydrothermally by the reaction of germanium dioxide-sodium hydroxide mixtures and water at 200°C and 12 atm. Crystallographic data are given.

45

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

THE EFFECT OF pH ON THE FORMATION OF

DIASPORE AND CORUNDUM, by R. G. Yalman, E. R. Shaw, and J. F. Corwin. [1959] [17]p. incl. diagr. tables. (Bound with its AFOSR-TR-59-74; AD 220103) [AF 18(600)1490]   Unclassified

Presented at meeting of the Inorg. Chem. Div. of the Amer. Chem. Soc., Boston, Mass., Apr. 5-10, 1959.

Abstract published in 135th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1959, p. 36-M - 37-M. (Title varies)

The conversion of gibbsite to boehmite and diaspore was investigated in 30-day runs at 350° and 5000 psi in aluminum sulfate and sodium aluminate solutions. No diaspore was observed in the absence of a seed nor in acid solutions. In alkaline solutions the rate of diaspore formation increased with increasing sodium aluminate concentration. A similar study at 400° and 6200 psi showed that the conversion of gibbsite to boehmite and corundum was also pH-dependent, and that the conversion of gibbsite to corundum in situ occurs more readily in the presence of a sapphire seed. No corundum was formed in acid solutions. The transfer of alumina from gibbsite to a sapphire seed occurs in potassium fluoride solutions, the rate of transfer increasing with increasing potassium fluoride concentrations. At the same time potassium cryolite, K_3AlF_6, is formed. In concentrated solutions crystals of potassium cryolite will grow at the expense of the sapphire seed. The effect of fluoride upon the hydrothermal growth of quartz crystals in the presence of aluminum and the equilibrium between tetracoordinated and hexacoordinated aluminate ions is discussed.

46

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

HYDROTHERMAL REACTIONS IN THE $Na_2O-GeO_2-H_2O$ SYSTEM. II. INFRARED STUDIES OF GERMANIUM DIOXIDE, by E. R. Shaw, J. F. Corwin, and H. V. Knorr. [1959] [9]p. incl. diagr. table, refs. (Bound with its AFOSR-TR-59-74; AD 220103) (AF 18(600)-1490)   Unclassified

Also published in Jour. Phys. Chem., v. 64: 174-175, Jan. 1960.

The infrared patterns of the 3 forms of germanium dioxide obtained by various methods have been prepared and the principle bands in the 2-15 μ region are reported at: amorphous - 11.25 μ; hexagonal - 10.43 μ, 11.45 μ; tetragonal - 12.90 μ, 13.90 μ. It is shown that the appearance of the broad strong band of the "hydrolysed" form at 11.35 μ is a result of incomplete inversion and is thus due to the presence of minute centers of the amorphous form. (Contractor's abstract)

47

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

HYDROTHERMAL REACTIONS IN THE Na_2O-GeO_2-H_2O SYSTEM. III. INFRARED STUDIES OF THE AL-KALI GERMANATES, by E. R. Shaw, J. F. Corwin, and H. V. Knorr. [1959] [16]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TR-59-74; AD 220103) (AF 18-(600)1490)　　　　　　Unclassified

Infrared spectroscopic studies were made of the alkali germanates, including lithium, sodium, potassium, rubidium, and cesium. The method of preparation of the crystals was the same as that used previously (see item no. ANT.03:009, Vol. II), but with varying reaction temperatures. The preparation temperatures and observed indices of refraction are given. It was found that considerable variation in spectra results from change in crystalline form, while slight variations, found with change in crystalline habit, disappear with proper grinding. As the crystals which separated as single phases were sometimes homogeneous in size and habit it was also possible to show the effects on the infrared patterns of using whole crystals of near the $5\,\mu$ particle size reported as the maximum in the literature for inorganic infrared spectroscopy.

48

[Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio]

STUDY OF THE EFFECT OF pH AND FLUORIDE ION ON HYDROTHERMAL REACTIONS OF SILICA AND ALUMINA, by R. [G.] Yalman. [1959] 21p. incl. tables, refs. (Bound with its AFOSR-TR-59-74; AD 220103; [AF 18(600)1490]　　　　　　Unclassified

A study of the hydrothermal reactions of silica and alumina in the presence of fluorides is presented by reviewing the 3 major parts of this research. The 1st (ANT.03:011, Vol. II) dealing with the effect of fluoride on the hydrothermal formation of quartz, shows that the "mineralizing" action of fluoride ion is due to the hydrolysis of the fluoride ion, and that the concentration of the hydroxide ion formed determines the kind of crystalline silicon dioxide produced. The 2nd, concerned with the effect of fluoride on the hydrothermal formation of corundum, shows that potassium cryolite, K_3AlF_3,

forms increasingly with the length of run and increasing potassium fluoride concentration. A correlation was attempted for the aluminum system to ascertain the relationship between corundum formation rate and basicity of the solution. The results show that corundum is formed only in very weakly acid solutions and that growth occurs in alkaline solutions. Similar results were obtained for the formation of diaspore. The 3rd part, formation constants of fluoro complexes, arrives at its results by utilizing the fact that the thiocyanate complexes of ferric ion have a very large molar extinction coefficient at 460 mμ, while the fluoro com-

plexes of iron do not absorb light in the visible or near ultra-violet region. The results are presented in table form with their respective molar coefficients and are of the order of 138 at 26.1°C, varying slightly with temperature. Formation constants of the iron complexes formed with aluminum, boron, silicon and molybdenum are also given.

49

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

THE CONDUCTIVITY OF DILUTE SODIUM CHLORIDE SOLUTIONS UNDER SUPERCRITICAL CONDITIONS, by J. F. Corwin and R. G. Bayless. [1959] [26]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TR-59-74; AD 220103) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1490 and Signal Corps under DA 36-039-sc-64605)　　　Unclassified

Also published in Jour. Phys. Chem., v. 64: 641-646, May 1960.

The conductivity of aqueous sodium chloride solutions above the critical temperature for the solution differs by a considerable amount when the electrode system is located at the top of the container from that when the electrodes are at the bottom. The difference is a function of the degree of filling (steam density) and is minimized by increasing the amount of solution in the container. A concentration gradient in the solution is proposed to explain the difference and comparisons are made with existing data which were made under conditions where homogeneity was artificially maintained or ignored by equipment design. (Contractor's abstract)

50

Arkansas U. [Dept. of Physics] Fayetteville.

ISOTOPE SHIFTS IN THE RuI SPECTRUM (Abstract), by R. H. Hughes. [1959] [1]p. [AF 18(603)26]　　　　　　　　　　　　Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 262, Apr. 30, 1959.

The hollow cathode spectra from isotopically enriched samples of ruthenium (Z = 44) have been studied with the use of a Fabry-Perot interferometer. The following shifts in mK were measured for the $\lambda 4449$-A line. The minus sign indicates a shift in the field effect direction.

98 -96	100 -98	102 -100	104 -102
~-36.2	~-15.2	-22.7	-25.1

99 -98	101 -100	104 -96
~+1.6	-4.3	-99.5

The uncertainty in the shifts relative to Ru-98 is brought about only by the isotopic impurity of the 98 sample. The estimated limit error of the other measurements is about ± 1.6 mK. Although the minimum in the shifts between neutron numbers 56-54 might possibly be exaggerated a small amount (say 4 mK), there is little doubt that it exists. A similar minimum has been found in molybdenum at these neutron numbers. The comparison of the 99-98 shift with a strong even-odd staggering effect found in molybdenum which produces a change in the sign of the shifts between neutron numbers 55-54 might support a contention that the Ru-98 position has not been chosen to exaggerate the 100-98 minimum. The presence of this minimum was predicted from nuclear deformation data as measured by Coulomb excitation experiments.

Armour Research Foundation, Chicago, Ill. see Illinois Inst. of Tech. Armour Research Foundation, Chicago.

51

Athens U. Dept. of Physics (Greece).

THE CHARACTERISTIC TEMPERATURE OF SILVER FROM X-RAY REFLECTIONS, by J. Boskovits, M. Roilos and others. [1959] [3]p. incl. diagr. tables. (AFOSR-TN-59-294) (AF 61(514)1248) AD 213034
Unclassified

Also published in Acta Cryst., v. 11: 845-847, Dec. 1958.

The present paper describes experiments carried out in order to determine the characteristic temperature θ of silver. The method consists in scattering a pencil of x-rays on a silver wire and measuring the intensity of the diffracted rays at different temperatures. The changes of intensity then give the value of θ according to the usual Debye theory. In the light of modern theory of solids, the characteristic temperature is not a constant but can show a considerable change with temperature. The integrated intensity of diffraction lines (111) and (422) was measured at 6 different temperatures between 81°K and 774°K. The scattering sample was heated above room temperature by blowing a vertical stream of hot air onto the wire. The cooling below room temperature was obtained with a suitable vacuum cryostat. The temperature of each measurement was determined from the angular shift of diffraction line (422). By applying the formula of the usual Debye theory to each neighboring pair of temperatures, a value of θ was obtained. Each value of θ corresponds to a temperature which lies at the middle of the temperature interval. The following results were obtained:

Temperature °K	138	243	405	592	726
Characteristic temperature	203	233	200	178	121

The error in each value of θ was of the order of 3 to

20°. The results give a fall of θ with increasing temperature. The results at temperature above room temperature do not coincide with the results found by Andriesen. His measurement gave a constant value of θ = 218 up to temperature of 670°K. A discussion of the possible reasons for such a disagreement does not lead to any explanation. Neither extinction nor oxidation would give such low values as found in the present measurements. (Contractor's abstract)

52

Atlantic Research Corp., Alexandria, Va.

THE MECHANISM OF DEFLAGRATION OF PURE AMMONIUM PERCHLORATE, by R. Friedman, J. B. Levy, and K. E. Rumbel. Feb. 5, 1959 [34]p. incl. diagrs. tables, refs. (AFOSR-TN-59-173) (AF 18(600)-1502) AD 211313; PB 139991 Unclassified

Results of new deflagration experiments with ammonium perchlorate, both pure and crystalyzed are presented. These include studies of rates of deflagration, pressure limits of deflagration, surface temperature, and effects of incident radiation on deflagration. These and previous results are interpreted in terms of a tentative qualitative model of the deflagration process.

53

Atlantic Research Corp., Alexandria, Va.

RESEARCH ON SOLID-PROPELLANT COMBUSTION, by R. Friedman, J. B. Levy, and K. E. Rumbel. Final technical rept. July 1955-Oct. 1959. Nov. 30, 1959, 13p. incl. diagrs. tables, refs. (AFOSR-TR-59-192) (AF 18(600)1502) AD 230724; PB 145634
Unclassified

The results and progress of this program have been described in 3 technical notes (see item nos. ATL.01:001, 002, Vol. II, and item no. 52, this volume). Two other lines of investigation which have not been previously reported because of incomplete results, are described. The Chemical Nature of the Products of Deflagration of Ammonium Perchlorate: Measurements were made on pressed strands of ammonium perchlorate at pressures ranging from atmospheric to 2000 psi, both in the presence and absence of copper chromite catalyst. At high pressures and atm pressure the gaseous products formed were nitrogen, nitrous oxide and oxygen. The nitrogen in the products was present as molecular nitrogen, nitrous oxide, and nitrate ion. The effect of the catalyst was to bring about a very sharp decrease in nitrous oxide yield. Both the effect of strand cross-sectional area and the effect of the catalyst suggest that nitric oxide is the primary product and that it can react further to give nitrous oxide or nitrogen. The reaction of nitric oxide appeared to be favored by higher pressures; the nitrous oxide yield was independent of pressure up to 1000 psi. Studies of the Kinetics and

Mechanism of the Thermal Decomposition of Anhydrous Perchloric Acid: Preliminary experiments were carried out on measured amounts of anhydrous perchloric acid, which were sealed in ampules, heated for various lengths of time in a constant-temperature bath, and the contents then analyzed. The reaction products were chlorine, water and oxygen. The results indicated that the reaction is at least partly heterogeneous below 400°C and that the half-life of anhydrous perchloric acid vapor at 400°C is of the order of 1 min.

54

Atlantic Research Corp., Alexandria, Va.

HIGH PRESSURE PLASMA PRODUCTION TECHNIQUE (Abstract), by R. Friedman and L. W. Fagg. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) [AF 49-(638)651] Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

This program was initiated to study the feasibility of a novel and potentially convenient means for producing a concentrated high-pressure plasma and to explore the properties of such a plasma. The basic idea is that a powdered oxidizer such as cesium perchlorate or cesium nitrate might be mixed with a metal having a high heat of combustion (aluminum, beryllium, zirconium) and pressed together to form a brittle stick, or strand, which would burn like a propellant when suitably ignited, particularly at high ambient pressure. The combustion products would be sufficiently hot (about 4000°K) so that very high concentrations of Cs^+ and free electrons will be present, thus providing a convenient high-pressure plasma source for experimental purposes. Cesium perchlorate has been synthesized, and it has been found that a stoichiometric mixture with aluminum can be formed into strong strands with less than 1% voids by pressing at 100,000 psi, and these strands will burn smoothly under nitrogen pressures in the range 400-2000 psi, and presumably higher pressures, with a burning rate of the order of 5 cm/sec. Thermodynamic calculations for this and other systems are being programmed, and experiments for measuring electron concentrations from the Q-factor of a high-frequency resonant circuit whose coil surrounds the plasma are being considered.

55

Avco Corp. Avco-Everett Research Lab., Everett, Mass.

AN ELECTROMAGNETIC ROCKET SYSTEM OF HIGH SPECIFIC THRUST, by R. J. Rosa. Apr. 1958, 10p. incl. diagrs. (Research rept. no. 103) (AFOSR-461) (AF 49(638)61) AD 256792 Unclassified

A nuclear-electric propulsion system is described which avoids the necessity for a low temperature heat sink. The system is an open thermodynamic cycle which in effect re-uses the working fluid several times without recirculating it. Although a very large specific impulse cannot be produced in this manner it does seem possible to get a substantial improvement in the impulse obtainable for a given nuclear pile temperature. In addition, the elimination of the heat sink increases the possibility of making nuclear-electric systems having a high thrust to weight ratio and an ability to function within the atmosphere. (Contractor's abstract)

56

Avco Corp. [Avco-Everett Research Lab.] Everett, Mass.

TABLES OF RADIATION FROM HIGH TEMPERATURE AIR, by B. Kivel and K. Bailey. Dec. 1957, 29p. incl. diagrs. tables, refs. (Research rept. no. 21) (AFOSR-TN-59-289) (Sponsored jointly by Air Force Ballistic Missile Div. under AF 04(645)18 and Air Force Office of Scientific Research under AF 49(638)61) AD 212921 Unclassified

Tables of radiative emissivity of hot air in the range of temperature from 1000°K to 18,000°K and density from 10 to 10^{-6} of a normal atmosphere are presented. The radiative intensities are presented in graphical form.

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Avco Corp. [Avco-Everett Research Lab] Everett, Mass.

SUPERSONIC TWO-DIMENSIONAL MAGNETOHYDRO-DYNAMIC FLOW, by F. Fishman, J. W. Lothrop and others. Feb. 1959, 49p. incl. illus. diagrs. (Research rept. no. 39) (AFOSR-TN-59-290) (Sponsored jointly by Air Force Ballistic Missile Div. under AF 04(647)278 and Air Force Office of Scientific Research under AF 49-(638)61) AD 212922; AD 211723; PB 147199 Unclassified

Also published in Proc. Third Symposium on Magneto-hydrodynamics, Lockheed Research Lab., Palo Alto, Calif. (Nov. 21-22, 1958), Stanford, Stanford U. Press, 1959, p. 90-119.

A perturbation theory was applied to the supersonic flow of a conducting fluid through the magnetic field of a circular solenoid. Calibrated view camera pictures of the light emitted by the gas are in agreement with predictions based on the perturbation theory. Experimental verification of the prediction that lift forces can be achieved with geometrically symmetric bodies by utilizing the Hall effect has been given. Estimates of the experimental lift forces indicate a lift coefficient of about 0.4 and a lift-drag ratio of approximately unity. For very strong magnetic fields the experimental flow pattern becomes similar to the flow pattern around a solid

cylinder. The possibility of using magnetohydrodynamic forces in flight depends upon the fact that the gas behind a normal shock at hypersonic velocities is heated sufficiently to become a good conductor. Such a normal shock could be supported by magnetic field. In order to achieve MHD forces in flight the interaction parameter based on conditions behind the shock wave must be large enough to support the shock. This occurs for drag coefficients near unity. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

PLASMA PROPULSION DEVICES FOR SPACE FLIGHT, by M. Camac, A. Kantrowitz, and H. E. Petschek. Feb. 1959, 40p. incl. diagrs. table. (Research rept. no. 45) (AFOSR-TN-59-385) (AF 49(638)61) AD 213885
                                                            Unclassified

Also published in I.R.E. Trans. on Military Electronics, v. MIL-3: 34-41, Apr. 1959.

An analysis was made of the more immediate space missions to specify whether a large increase in payload can be achieved when electrical propulsion is used instead of chemical propulsion. For military missions such as the stationary communication satellite and moon missions, the desirable specific impulse range is from 1500 to 5000 sec. For these missions electrical propulsion can effect a reduction in initial ground level launch weight requirements by a factor of 2 or 3. Conversely, for the same ground rockets, a 2 or 3 times larger payload can be delivered to the final orbit when electrical propulsion is used. Electrical propulsion with neutral plasma devices operate well in this specific impulse range (1500 to 5000 sec) as well as at higher specific impulses. Three different chambers are described as examples of devices using neutral plasmas. Some of the factors which limit the range of efficient operation of such devices are discussed. In the section entitled "Supplementary Information on Lunar and 24-Hour Orbit Missions," the following topics are discussed: (1) propulsion requirements for placing a 24-hr communication satellite in orbit starting from a 150 min altitude orbit, (2) thrust requirements for rotation of the orbit plane and the application to 24-hr orbit transfer mission, (3) thrust requirements to maintain a 24-hr communication satellite satellite at a given position for 10 yr., and (4) propulsion requirements for round trip moon missions from a 150 mi altitude orbit above the earth to a low altitude circular orbit above the moon.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

A FURTHER NOTE ON HYPERSONIC STAGNATION POINT FLOW WITH A MAGNETIC FIELD, by N. H. Kemp. Apr. 1959, 15p. incl. diagrs. (Research rept.

no. 53) (AFOSR-TN-59-445) (AF 49(638)61) AD 214807; PB 142152   Unclassified

Several notations are made related to a former paper (AVC.01:001, Vol. II) by the author. Included are corrections of numerical solutions of the inviscid vorticity equation, solutions of viscous boundary layer problems for an axisymmetric stagnation point with magnetic field, and some implications of these solutions for reducing the stagnation point heat transfer rate and shear stress.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

HIGH SPEED SHOCK WAVES IN A MAGNETIC ANNULAR SHOCK TUBE, by R. M. Patrick. July 1959, 36p. incl. illus. diagrs. refs. (Research rept. no. 59) (AFOSR-TN-59-845) (AF 49(638)61) AD 225292; PB 143155   Unclassified

Also published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass., (Oct. 7-8, 1959), Boston, v. 1: 151-168, 1959. (AFOSR-637)

Also published in Phys. Fluids, v. 2: 589-598, Nov.-Dec. 1959.

A magnetic annular shock tube was used to produce magnetically driven shock waves with very high velocities. Experiments were carried out with this device with 2 magnetic field configurations ahead of the shock front. The first configuration had a magnetic field ahead of the shock front in the direction of motion of the shock. In the second configuration the magnetic field ahead of the shock had its principal component in the plane of the shock front and a small component in the direction of motion of the shock. The continuum radiation emitted by the shock-heated plasma was measured with photomultipliers. The use of probes to measure the change in the local magnetic field in the shock front was investigated. With the second configuration shock velocities in excess of 4×10^7 cm/sec were measured in hydrogen. For these high speed shock waves, a shock thickness was obtained from measured rise times of the emitted visible radiation. These shock thicknesses are thinner than the mean free path in the shock-heated plasma, an observation which agrees with a theoretical prediction. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

THEORY OF THE FLOW IN THE MAGNETIC ANNULAR SHOCK TUBE, by N. H. Kemp and H. E. Petschek. July 1959, 35p. incl. diagrs. (Research rept. no. 60) (AFOSR-TN-59-846) (AF 49(638)61) AD 225774; PB 143521   Unclassified

Also published in Phys. Fluids, v. 2: 599-608, Nov.-Dec. 1959.

A theoretical description is given of the properties of the gas flow in the magnetic annular shock tube. This shock tube uses a magnetic field to drive a shock wave through an annular region, producing a very high temperature plasma. It is shown that this particular configuration allows a fairly precise calculation of the flow parameters. Numerical calculations of the significant flow properties for a complete range of the initial field strength and orientation have been made and are presented graphically.

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Avco Corp. [Avco-Everett Research Lab.] Everett, Mass.

FLIGHT MAGNETOHYDRODYNAMICS, by A. R. Kantrowitz. Mar. 1959, 18p. incl. illus. diagrs. (Research rept. no. 51) (AFOSR-TN-59-882) (Sponsored jointly by Air Force Ballistic Missile Div. under AF 04(067)278 and Air Force Office of Scientific Research under AF 49(638)61) AD 230023; PB 144785
Unclassified

A brief discussion is given of the possible flight applications of magnetohydrodynamics and the conditions under which they might be practical. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

NUMERICAL CALCULATION OF ABSOLUTE BREMS-STRAHLUNG INTENSITY FOR A FULLY IONIZED FULLY DISSOCIATED HYDROGENIC GAS, by G. S. Janes and H. F. Koritz. Sept. 1959, 13p. incl. diagrs. table. (Research rept. no. 70) (AFOSR-TN-59-1076) (AF 49(638)61) AD 228740; PB 144345   Unclassified

Also published in Jour. Appl. Phys., v. 31: 525-529, Mar. 1960.

Using the approximate relationships of Kirkpatrick and Weidmann (Phys. Rev., v. 67: 321, 1945) for brems-strahlung intensities numerical calculations were made on the IBM 650 for a fully ionized, fully dissociated hydrogenic gas. The intensities are given in terms of a quantity having the units ergs/sec/unit frequency interval/steradian/cc as a function of $h\nu$, (from 0.5 to 4.0 electron v) and kT (from 4 to 200 electron v). A calibration method was devised for measurement of absolute bremsstrahlung intensities, which continually compensates for the errors present in most calibration procedures. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

COLLISION FREE MAGNETOHYDRODYNAMIC SHOCK WAVE, by A. Kantrowitz, R. M. Patrick, and H. E. Petschek. Aug. 1959, 12p. incl. diagrs. (Research rept. no. 63) (AFOSR-TN-59-1190) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-(638)61 and Office of Naval Research under Nonr-252400) AD 228384; PB 148187   Unclassified

Also published in Fourth Internat'l. Conf. on Ionization Phenomena in Gases, Uppsala, Sweden (Aug. 17-21, 1959), Amsterdam, North-Holland Publishing Co., 1960, p. 1086-1091.

It is assumed that the dissipation in a collision free shock produces a random distribution of magnetohydrodynamic waves. These waves are then treated as the fundamental particles of the plasma. A rough kinetic theory is developed which estimates the heat conduction coefficient due to the waves. Using this heat conduction coefficient, the shock thickness is estimated to be about 4 times the characteristic ion Larmour radius. This prediction is in rough agreement with experimental results obtained in a MAST device. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

ON THE FLOW OF A VISCOUS ELECTRICALLY CONDUCTING FLUID, by H. P. Greenspan. Oct. 1959, 32p. incl. diagrs. (Research rept. no. 73) (AFOSR-TN-59-1221) (AF 49(638)61) AD 231877; PB 145772
Unclassified

Also published in Quart. Appl. Math., v. 18: 408-411, 1960/1961.

The magnetohydrodynamic flow of a viscous incompressible fluid of constant properties past a flat plate is considered. The applied magnetic field is parallel to the free stream direction and the plate is at zero angle of attack. A number of explicit solutions of the linearized theory are presented for the flow past a semi-infinite plate which is either sucking or injecting a conducting fluid into the main stream. Unlike the case of super-Alfvén flow (where the free stream velocity is greater than the Alfvén wave speed) no solution exists in the problem of sub-Alfvén flow past a semi-infinite flat plate which is either impermeable or injecting fluid. Special solutions do exist for certain values of the suction velocity. The sub-Alfvén flow past a long finite impermeable plate is studied in some detail and the magnitude of the viscous wake is compared to the similar type upstream disturbance produced by the forward propagation of Alfvén waves. In the case of infinite conductivity, it is found that the upstream disturbance is approximately 1 plate length long measured

from the leading edge. The inadequacies and failures
of the linearized theory of the super-Alfvén are dis-
cussed. (Contractor's abstract)

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[Avco Corp.] Avco-Everett Research Lab., Everett, Mass.

PRODUCTION OF VERY HIGH SPEED SHOCK WAV. ;
(Abstract), by R. M. Patrick. [1959] [1]p. [AF 49-
(638)61] Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
283, Apr. 30, 1959.

A magnetically driven coaxial shock tube has been
used to produce shock waves with very high velocities.
In this device there is a magnetic field anead of the
shock front with its principal component in the plane of
the shock front. The continuum radiation emitted by
the shock-heated gas has been measured with photomul-
tipliers. The use of probes to measure the change in
the local magnetic field at the shock front has been in-
vestigated. Time integrated spectra have been taken
of the light emitted from the shock tube. Shock veloci-
ties in excess of 3×10^7 cm/sec have been measured
in hydrogen. For these high-speed shock waves, the
shock thickness has been obtained from the measured
rise times of the emitted visible radiation. These
shock thicknesses are thinner than a mean free path
for the conditions in the shock-heated gas, which agrees
with a theoretical prediction.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

BASIC STUDIES IN MAGNETOHYDRODYNAMICS
(Abstract). [1959] [1]p. (Bound with its AFOSR-TN-
59-770; AD 241053) (AF 49(638)61) Unclassified

Presented at Second AFOSR Contractors meeting on
Ion and Plasma Propulsion, North American Aviation,
Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9,
1959.

A shock wave propagating in a plasma where the cyclo-
tron radius is much smaller than the mean free path
provides a good opportunity to study the dissipative
mechanisms associated with magnetohydrodynamic
turbulence. Experiments have been performed using an
electromagnetically driven shock wave which propagates
in the annulus between 2 coaxial cylinders with an azi-
muthal magnetic field in the shock plane. The shock
velocity and plasma density have been obtained by meas-
uring the bremsstrahlung intensity. Shock velocities
have been produced up to 4.5×10^7 cm/sec. The kinetic

energy corresponds to a temperature behind the shock
of 1.2×10^6 °K, density 5×10^{15} ions/cc, mean free
path 20 cm, and an ion cyciotron radius of .2 cm. Shock
thickness obtained by measuring the time required for
the continuum radiation to reach a steady value behind
the shock was 2 cm. Shocks thinner than a mean free
path could not be produced without a magnetic field in
the plane of the shock. The observation of "thin" shocks
confirms previous theoretical predictions and provides
a powerful tool for the study of dissipative mechanisms
in collision free plasmas.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

PROCEEDINGS OF THE SECOND SYMPOSIUM ON AD-
VANCED PROPULSION CONCEPTS (Unclassified title).
VOL. I (Unclassified), VOL. II (Confidential), VOL. III
(Secret-Restricted Data), Boston, Mass., Oct. 7-8,
1959, Washington, Government Printing Office, 1960, 3v.
incl. illus. diagrs. tables, refs. (AFOSR-637)
[AF 49(638)61] AD 255830

The Second Symposium on Advanced Propulsion Con-
cepts was held at the Statler Hilton hotel, Boston, Mass.,
Oct. 7-8, 1959. Co-sponsors were the Air Force Office
of Scientific Research and the Avco Corp., Avco-
Everett Research Lab. The program was made up of 7
technical sessions which included a wide range of sub-
jects related to advanced propulsion systems, and an
8th session devoted to a panel discussion of "Progress
in Propulsion."

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

MAGNETOHYDRODYNAMIC ACCELERATION OF
SLIGHTLY IONIZED, VISCOUSLY CONTAINED GASES,
by G. S. Janes and J. A. Fay. [1959] 18p. incl. diagrs.
(AFOSR-TN-59-1333) (AF 49(638)659) AD 241054
Unclassified

Also published in Proc. Second Symposium on Ad-
vanced Propulsion Concepts, Boston, Mass., (Oct. 7-8,
1959), Boston, v. 1: 19-32, 1959. (AFOSR-637)

The various physical and aerodynamic factors affecting
the design of a steady flow MHD accelerator having
viscous containment and crossed electric and magnetic
fields are considered for the case of a slightly ionized
gas. These include the effects of tensor electrical
conductivity, ion slip, current diffusion, frozen flow and
leaving losses, magnetic field and electrode losses, and
viscous boundary layer losses. Some of these effects
are also applicable to the case of a completely ionized
gas. This may be the more interesting case, but it is
not considered in detail. A particular example portray-
ing most of these effects is presented for the case of a
slightly ionized gas. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

PLASMA PROPULSION (Abstract). [1959] [1]p. (Bound
with its AFOSR-TN-59-770; AD 241053) (AF 49(638)-
659)   Unclassified

Presented at Second AFOSR Contractors meeting on
Ion and Plasma Propulsion, North American Aviaticn,
Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9,
1959.

Using the arc jet as a source of partially ionized plasma
at approx 3,000°K, an isothermal accelerator has been
designed which utilizes MHD forces to accelerate the
gas. Currents are made to flow through the gas between
electrodes placed at the top and bottom of a duct. A
magnetic field perpendicular to these currents produces
forces which accelerate the gas. Preliminary experi-
ments on a scale model MHD generator are in accord-
ance with expectations based upon estimates of gas con-
ductivity. The MHD shock tube operates on a pulsed

basis and heats the propellant to relatively high temper-
atures. The basic accelerating mechanism of the MHD
shock tube is that which exists in a conventional electro-
magnetic rail source. However, the geometry is coaxial
and the acceleration takes place in the annular region
containing an axial magnetic field which is used to con-
tain the gas away from the walls. An experimental model
of this apparatus has been in operation on a single pulsed
basis in the specific impulse range from 10,000 to 20,000
sec. Efficient operation requires that the back voltage
developed by the motion of the gas in the presence of the
driving magnetic field be large compared to the arc elec-
trode voltage drops. Experiments are currently under
way to determine the electrode voltage characteristics
of this device. The basic geometry of this device,
coupled with a choice of particle velocities, determines
the characteristic impedance and therefore a minimum
instantaneous power level for efficient operation. In the
MHD shock tube, frozen flow losses amount to approx
30%, since half the energy goes to heat and ionization.
Investigations are also being carried out on alternative
devices which avoid these limitations, including the
MHD rotor.

Bartol Research Foundation, Swarthmore, Pa.
  see Franklin Inst. Bartol Research Foundation,
  Swarthmore, Pa.

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Battelle Memorial Inst., Columbus, Ohio.

FINE STRUCTURE IN THE HALL COEFFICIENT, by
A. C. Beer. [1959] [5]p. incl. diagrs. [AF 49(638)222]
Unclassified

Presented at 1958 Internat'l. Conf. on Semiconductors,
Rochester U., N. Y., Aug. 18-22, 1958.

Published in Jour. Phys. and Chem. Solids, v. 9: 507-
511, Jan. 1959.

Measurements of the Hall coefficient as a function of
magnetic field in the extrinsic region of semiconduc-
tors such as p-type germanium, silicon, diamond, and
AlSb are presented confirming a fine structure consist-
ing of maxima and minima. Data is given at several
temperatures on a specimen containing 1×10^{13} extrin-
sic holes/cm^3. It is pointed out that the minima is de-
pendent upon the temperature. It is also shown that
the relative prominence of the structure depends quali-
tatively on β (a measure of the degree of impurity scat-
tering) in the manner predicted by theory.

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Battelle Memorial Inst., Columbus, Ohio.

HIGH-PURITY SINGLE CRYSTALS OF INDIUM AN-
TIMONIDE (Abstract), by R. C. Baurke, S. E. Miller,
and W. P. Allred. [1959] [1]p. [AF 49(638)222]
Unclassified

Presented at [Seventh annual Spring Symposium on
Semiconductors] Philadelphia, Pa., May 3-7, 1959.

A combination zone-refining and crystal-pulling tech-
nique was developed. The indium antimonide were
purified by multiple zone passes and crystals were then
pulled from the high-purity sections of the ingot. The
same hydrogen atmosphere is used for both the zone-
refining and the pulling operations. Large, high-purity,
single crystals of indium antimonide with electron mo-
bilities over 450,000 cm^2/volt-sec at 80°K can be
pulled consistently. The crystals have extremely low
dislocation densities as shown by etch-pit studies.

73

Baylor U. Coll. of Medicine, Houston, Tex.

SOME MEMBRANE PROPERTIES OF THE EFFECTOR

IN THE GALVANIC SKIN RESPONSE, by R. Edelberg,
T. Greiner, and N. R. Burch. [1959] [6]p. (AFOSR-TN-
59-887) [AF 18(603)79] AD 613318   Unclassified

Also published in Jour. Appl. Physiol., v. 15: 691-696,
July 1960.

Several membrane-like properties of the effector in the
galvanic skin response (GSR) were measured in humans
by comparison of activity at a control site with that of a
site subjected to changes of external chemical environ-
ment or changes in direction or density of imposed cur-
rent. Comparison of inorganic chlorides shows that

small cations, e.g., K^+, may reversibly reduce GSR

amplitude and R by 40%; larger cations, e.g., Ca^{++}, in-
crease GSR by several hundred per cent while at the
same time reducing basal resistance (R). GSR and R
are reduced by acids and alkalies and by detergents.
The effector is a poor rectifier, but there is a pro-
nounced effect of polarity of current on the amplitude
of the GSR in the case of large cations or anions com-
bined with smaller ions of opposite charge. Current

densities beyond 11 $\mu amp/cm^2$ produce an "injury"
effect manifested in GSR and apparent resistance.
These results have been interpreted in terms of an ac-
tive superficial membrane having a relatively low
charge. (Contractor's abstract)

74

Baylor U. Coll. of Medicine, Houston, Tex.

SIMPLIFIED REFERENCE CHARTS OF THE ADULT
RAT BRAIN IN STEREOTAXIC COORDINATES (Ab-
stract), by J. de Groot. [1959] [1]p. (AFOSR-TN-59-
536) (AF 49(638)384) AD 216553   Unclassified

Presented at Seventy-second annual meeting of the Amer.
Assoc. of Anatomists, Washington U., Seattle, Apr. 1-3,
1959.

Also published in Anat. Rec., v. 133: 446, Feb. 1959.

It is pointed out that an increasing number of investiga-
tions in the rat concerning the relationship of hypo-
thalamic, rhinencephalic and midbrain structures to
endocrine function has involved the use of stereotaxic
techniques. It is shown that in the absence of a standard
set of coordinates and a large scale atlas, the series of
reference charts (mapped from 50 μ thick, frozen and
parasagittal sections, stained with various techniques)
may facilitate the accurate placement of electrodes and
the evaluation of results.

75

Baylor U. Coll. of Medicine, Houston, Tex.

THE RAT FOREBRAIN IN STEREOTAXIC COORDI-
NATES, by J. de Groot. 1959, 40p. incl. diagrs. refs.

(AFOSR-TN-59-537) (AF 49(638)384) AD 216554
Unclassified

Also published in Verhandel. Koninkl. Nederl. Akad.
Wetensch., . 52: 1-40, 1959.

A presentation is made of a series of semi-diagrammatic reference charts of subcortical prosencephalic structures to facilitate the placement of stimulating, recording or lesion-inducing electrodes in the rat forebrain. Detailed descriptions are given concerning orientation, reference points and identifying structures.

76

Baylor U. Coll. of Medicine, Houston, Tex.

THE RAT HYPOTHALAMUS IN STEREOTAXIC COORDINATES, by J. de Groot. [1959] [12]p. incl. diagrs. refs. (AFOSR-TN-59-906) (AF 49(638)384) AD 234037 Unclassified

Also published in Jour. Compar. Neurol., v. 113: 389-400, Dec. 1959.

Sixteen semi-diagrammatic reference charts in stereotaxic coordinates through the hypothalamus of the adult rat are presented and briefly discussed. It is hoped that these charts of basal diencephalic structures may facilitate the accurate placement of stimulating, recording or lesion-inducing electrodes and the precise evaluation of results.

77

Bell Aircraft Corp., Buffalo, N. Y.

A STUDY OF VELOCITY-FREQUENCY-DAMPING RELATIONSHIPS FOR WING AND PANEL BINARY SYSTEMS IN HIGH SUPERSONIC FLOW, by M. B. Zisfein and F. J. Frueh. Oct. 1959, 55p. incl. illus. diagrs. table, refs. (Rept. no. 9015-19-001) (AFOSR-TN-59-969) (AF 49(638)365) AD 228774; PB 145978
Unclassified

Initial results are presented of a program to obtain and study analytical relations between flutter and dynamic response. Piston theory aerodynamics was used to study 2 kinds of binary systems, pitch-plunge wings and 2-degree-of-freedom simply supported panels. A major portion of the effort was focused on the effects of viscous and structural damping on the flutter and dynamic response characteristics and the relations between them. The characteristic equations of the binary systems were derived from Lagrangean mechanics and solved for the velocity-frequency-damping relationships of these systems. From these closed-form solutions, by means of gross simplifications, several new concepts (base curve and high damping and decay asymptotes) were postulated. By comparison with exact solutions these concepts and their interrelation are shown to convey the essence of the dynamic aeroelastic stability

problem. Also from the closed-form solutions a new simple relation between flutter damping and dynamic response was derived. These new tools were then used to explain the hitherto unexplained phenomenon of loopbacks in the cruves of velocity vs required damping.

78

Bell Aircraft Corp., Buffalo, N. Y.

CHEMICAL NON-EQUILIBRIUM EFFECTS IN THE LAMINAR HYPERSONIC BOUNDARY LAYER, by G. R. Inger. Mar. 30, 1959, 132p. incl. refs. (Rept. no. 7010-6) (AFOSR-TN-59-237) (AF 49(638)380) AD 212007; PB 143588 Unclassified

New theoretical representations of a dissociating air mixture and a new method of non-equilibrium boundary layer solution are presented. The general governing conservation equations and attendant boundary conditions are given and discussed. The associated laminar boundary layer equations are presented, along with a consideration of the proper definition of a characteristic parameter with which the chemical non-equilibrium in the layer can be classified. Three main new features of the problem area are considered: (1) an evaluation of the comparative merits of various types of schemes approximating a dissociated air mixture is given and a more accurate and general method is proposed and developed. This new scheme is applicable to a 4-specie air mixture which is in a general state of chemical non-equilibrium; (2) the boundary layer non-equilibrium stagnation point similarity solution is reformulated in more accurate fashion according to this more accurate air mixture representation, and errors incurred by use of a lumped air atom-air molecule binary approximation of air are discussed; and (3) a new method of solving the non-equilibrium boundary layer problem is discussed, based on a chemical perturbation analysis from either frozen or thermostatic equilibrium extremes. The method permits evaluation of non-equilibrium effects over a much wider set of local conditions than is permitted by a similarity-type solution. (Contractor's abstract)

79

Bell Aircraft Corp. Niagara Frontier Div., Buffalo, N. Y.

A HIGH-SPEED AND HIGH-RESOLUTION PHOTO-GRAPHIC TECHNIQUE FOR THE OBSERVATION OF PROPELLANTS INJECTED INTO A FIRING COMBUS-TION CHAMBER. PARTS I AND II, by T. G. Rossmann. May 18, 1959, 2v. incl. illus. diagrs. refs. (Rept. no. 8007-981-008, pts. 1 and 2) (AFOSR-TN-59-8) (AF 49-(638)260) AD 208304; AD 221063; PB 143902, PB 143915 Unclassified

The objective of this investigation is to "conduct research in the general field of Observation of Burning Propellants in Rocket Engines", for the purpose of obtaining design criteria for liquid propellant rockets which

will permit a more rational approach to design of rocket engines. The investigation shall make both theoretical and empirical approaches. For this purpose, an experimental method has been developed employing high-speed and magnifying photographic techniques in the following way. The light of a high intensity source, flashing at rates up to 10,000/sec, is directed through 2 windows in opposite walls of a rocket combustion chamber. It produces, by means of a photographic objective, a series of up to 10 consecutive magnified shadow pictures of the liquid core of the evaporating or burning propellant droplets and ligaments on a photographic film. Evaluation of these films enables one to follow the time history of the physical phenomena mentioned before which occur in a firing rocket combustion chamber. (Contractor's abstract)

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Bell Aircraft Corp. [Niagara Frontier Div.] Buffalo, N. Y.

OBSERVATION OF PROPELLANTS INJECTED INTO A FIRING ROCKET COMBUSTION CHAMBER, by T. [G.] Rossmann. [1959] [37]p. incl. illus. diagrs. refs. (AFOSR-TN-59-867) (AF 49(638)260)   Unclassified

Presented at First meeting of the Joint Army-Navy-Air Force Liquid Propellant Group, New Orleans, La., Nov. 3-5, 1959.

An experimental method has been developed to gain a realistic insight into the injection and combustion processes in rocket engines by observing directly the formation and subsequent physical behavior of propellant jets and droplets during the consecutive phases of injection, impingement, atomization, evaporation, recirculation, and combustion under actual operating conditions. The method employs high speed and magnifying photographic techniques in the following way. The light of a high intensity light source, flashing at rates up to 10,000/sec, is directed through 2 windows in opposite walls of a rocket combustion chamber. It produces, by means of a photographic objective, a series of up to 10 consecutive magnified shadow pictures of the liquid core of the evaporating or burning propellant droplets and ligaments on a photographic film. Evaluation of these films enables one to follow the time history of the physical phenomena mentioned before which occur in a firing rocket combustion chamber. (Contractor's abstract)

81

Birmingham U. Dept. of Experimental Psychiatry (Gt. Brit.).

EFFECT OF DRUGS ON CONDITIONING AND HABITUATION TO AROUSAL STIMULI IN ANIMALS, by B. J. Key and P. B. Bradley. [1959] [4]p. incl. diagrs. (AFOSR-TN-59-542) (AF 61(514)1184)   Unclassified

Also published in Nature, v. 182: 1517-1519. Nov. 29, 1958.

Confirmation and extension is made of previous studies concerning differential effects of certain drugs on the thresholds for arousal from sleep produced by auditory stimulation. Conscious, chronic cat preparations carrying permanently implanted cortical recording electrodes were used. Chlorpromazine, at doses of 5-10 mg/kg, produces a rise in the thresholds of both conditioned and unconditioned auditory responses, and at doses of 15-20 mg/kg, it blocked both responses. Reserpine, at a single dose of 200-250 μg/kg, produced, after a 1 - 1 1/2 hr interval, a rise in threshold for unconditioned response and later completely blocked the response, but the drug failed to significantly affect the conditioned response. Lysergic acid diethylamide caused the threshold for the unconditioned response to fall sharply but failed to affect the conditioned response threshold. Possible explanations of the data are given.

82

Birmingham U. Dept. of Industrial Metallurgy (Gt. Brit.).

RESEARCH ON STRAIN-AGEING, HARDENING AND SOFTENING OF METALS BY FATIGUE. [PART I.] THE FATIGUE OF ALUMINUM-MAGNESIUM ALLOYS, by G. W. J. Waldron. [PART II.] FATIGUE OF Zn SINGLE CRYSTALS, by J. M. Summerton. Technical summary rept. Sept. 1957-Feb. 1959, 120p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-774) (AF 61(514)1182) AD 219917; PB 143959   Unclassified

Part I. Room-temperature fatigue experiments were conducted to study the conditions under which true fatigue limits occur in as-extruded Al-Mg alloys. Metallographic observations showed that increasing the Mg content reduces the width of the slip marks which occur during fatigue; the amount of surface cracking is also reduced. Subsequent to fatiguing at -196°C, tensile experiments at -196°C with intermediate resting between -80° and 20°C showed hardening and softening effects. A study of the effect of temperature on fatigue life for a given stress in Al-3% Mg indicated an increase in fatigue corresponding to the hardening effects in the fatigue-tensile experiments. Part II. A technique is outlined for growing large seeded single crystals of any desired orientation; a method is described for acid machining gage lengths in these crystals. Zn crystals of 5 different orientations were fatigued to fracture at room temperature in push-pull tests at a frequency of 100 cps. S/N curves were determined for each orientation. When the curves are replotted in terms of resolved shear stress, they superimpose, indicating that the fatigue life of a crystal is determined by the shear component of the applied stress. A few crystals which were fatigued at 50 cps showed that failure is dependent on the time of testing rather than on the number of cycles. A method was developed for measuring hysteresis loops during fatigue. The amount of plastic strain/cycle decreases with the increasing number of reversals for the first 10% of life and then remains constant for the remainder.

83

Birmingham U. Dept. of Physical Metallurgy (Gt. Brit.).

THE BEHAVIOUR OF GRAIN BOUNDARIES IN METALS
IN A TEMPERATURE GRADIENT, by R. W. Cahn and
R. W. Lucas. Final technical summary rept. Oct. 1956-
Oct. 1959, 1v. incl. illus. diagrs. refs. (AFOSR-TR-59-
126) (AF 61(514)1020) AD 230161; PB 145664
Unclassified

The results of a series of investigations on grain bound-
ary migration induced by a temperature are reported.
Briefly summarized the following conclusions are
reached. Grain boundary motion induced by a tempera-
ture gradient does not take place in a metal of high
purity. Grain boundary motion, when it occurs at all,
does so only at temperatures within a few degrees of
the melting point of the solvent metal. A gradient of
1 to 2°C/cm suffices to produce movement under these
conditions. Grain boundary motion can occur when ap-
propriate solutes are concentrated at the grain boundary.
This has been observed both in zinc and aluminum. The
factors determining the nature and initial concentration
of the solute are not known. The "driving force" for
migration is always small, and surface tension forces
tending to contract a curved boundary readily mask the
effect in zinc. The surface area scanned by a moving
boundary in zinc oxidizes faster than the body of each
grain. (Contractor's abstract, modified)

84

Boston U. Dept. of Biology, Mass.

THE INNERVATION AS A FACTOR IN CONTROL OF
THE MICROCIRCULATION, by G. P. Fulton, B. R. Lutz,
and A. B. Callahan. [1959] [15]p. incl. illus. refs.
(Sponsored jointly by Air Force Office of Scientific Re-
search under AF 49(638)44 and National Institutes of
Health)   Unclassified

Presented at Symposium on Central Nervous System
Control of Circulation, Washington, D. C., Nov. 1-3,
1959.

Also published in Physiol. Rev., Suppl. 4, v. 40: 57-64,
Apr. 1960.

Some aspects of the problem concerned with the com-
parative significance of direct humoral action on smooth
muscle versus the role of the innervation are presented.
Reference is made to investigations of the neuromotor
mechanism which are concerned with the control of the
microcirculation in the retrolingual membrane of the
frog and the cheek pouch of the hamster. Areas where
new investigations are needed in order to confirm and
disprove existing assumptions are pointed out. It is be-
lieved that the innervation, at least at the peripheral
level is a relatively important factor in the regulation
of the microcirculation.

85

Boston U. Dept. of Biology, Mass.

VASOMOTOR ADJUSTMENTS IN THE MICROCIRCULA-
TION DURING CHANGES IN BLOOD DISTRIBUTION, by
G. P. Fulton and R. F. Slechta. Final rept. Jan. 1957-
July 1959, 27p. incl. illus. diagrs. tables, refs. (AFOSR-
TR-59-191) (AF 49(638)44) AD 229503; PB 144789
Unclassified

Vascular responses to changes in body orientation were
studied by making an investigation on the carotid sinus
in golden hamsters. Using the cheek pouch preparation,
it was possible to investigate by direct observation pe-
ripheral vascular responses to such blood-redistributing
conditions as body orientation changes, corticosteroids
and other substances produced during stress, tempera-
ture changes, hemorrhage, anoxia, etc. Pressor effects
were observed after occlusion of the common carotid
arteries. In body tilting experiments a carotid-sinus-
like response to baroreceptor stimulation appeared to
be present in the hamster. Tilting, irrespective of di-
rection, resulted in a decreased rate of blood flow in
both arterioles and venules, suggesting that the mecha-
nisms involved are not entirely passive. Criteria were
presented for the study of microcirculatory responses
to environmental stresses. Studies of the relation be-
tween level of anesthesia and blood velocity were con-
ducted to ascertain the pattern of change in velocity
occuring over relatively long intervals during the period
of anesthesia. Pilot experiments were performed to
determine quantitatively and qualitatively by direct bio-
chemical micro-methods the hormone production in
vitro and in vivo of hamster adrenocortical tissue.

86

Boston U. Dept. of Chemistry, Mass.

AN INEXPENSIVE INTEGRATING PHOTOMETER FOR
MEASURING X-RAY FILM INTENSITIES, by E. L.
McGandy, J. Degelman, and K. Eriks. [1959] [4]p. incl.
illus. diagr. (AFOSR-TN-59-615) (AF 49(638)65)
AD 221895   Unclassified

In photography it is customary to measure the blacken-
ing of photographic film quantitatively with a densitome-
ter. In x-ray structural investigations, where precise
determination of scattered radiation must be made,
blackening of x-ray film is used as a measure of x-ray
intensity. This may be determined by densitometry
which measures the darkest part of the spot, visual com-
parison of the spots with a standard series, or the use
of an elaborate mechanism on the x-ray camera to spread
out the spot in a way that facilitates its measurement.
These have both theoretical and economic drawbacks.
An inexpensive integrating photometer for measuring
x-ray film intensities accurately has been developed,
which avoids the difficulties inherent in older methods.
The photometric measurement consists of the difference
between the light transmitted by an area of the film in-
cluding the spot, and the light transmitted by an

equivalent area without the spot. This difference is the so-called "integrated intensity" of the x-ray beam. The max expected error of a single integrated intensity measurement using the Integrating Photometer has been shown to be ± 5%. The total cost of the components is approx $ 75.00.

87

Boston U. [Dept. of Physics] Mass.

MODIFICATION OF THE FOKKER-PLANCK EQUA-TION FOR NON-LINEAR FRICTION (Abstract), by A. Siegel. [1959] [1]p. (AFOSR-TN-59-257) [AF 18(603)-29] AD 212325   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 20-May 2, 1959.

Also published in Bull. Amer. Phys. Soc., Series II, v. 4: 277, Apr. 30, 1959.

Moyal's expansion of the collision operator of the linear Boltzmann equation gives the exact basis of the Fokker-Planck equation. This expansion was studied relative to a simple model, involving 1-dimensional motion of particles of mass M in a dilute gas of molecules of mass m (M >> m), in internal equilibrium ("Rayleigh model"). The Fokker-Planck equation (= Brownian motion approximation) for the distribution of particle velocities V is obtained by breaking off the Moyal expansion after the 2nd term, and taking the 2 retained "derivate moments" only to lowest order in V; this means taking the Döppler friction (1st derivate moment) to $O(V)$. The equilibrium solution is, as is known, the Maxwell-Boltzmann distribution. If friction is taken to higher terms, say $O(V^n)$ (n odd), it can be found in this model the equation that must replace the Fokker-Planck. In order that the equilibrium distribution have the Maxwell-Boltzmann form, the Moyal expansion must be broken off after the $(n + 1)$st term, and each retained derivate moment α_k taken to $O(V^{n+1-k})$.

88

Boston U. [Dept. of Physics] Mass.

[THEORETICAL STUDIES IN STATISTICAL AND QUANTUM MECHANICS] by A. Siegel. Final rept. Nov. 1959 [7]p. (AFOSR-TR-59-177) (AF 18(603)29) AD 246339   Unclassified

A brief review of the results reported under this contract is presented. Two published papers (BOS.03:001, Vol. 1; BOS.03:006, Vol. II) deal with the subject of theory of fluctuations in systems with linear dissipation. A technical status report (BOS.03:005, Vol. II) was issued on the subject of quantum effects in Brownian motion. An answer to the questions concerned with a sequence of approx to the linear Boltzmann operator was also reported (item no. 87, Vol. III). Work concerned with the differential-space theory of quantum

systems has not been reported as yet, but has resulted in 2 accomplishments: (a) a new algorithm for the construction of a classical probabilistic form of quantum mechanics was developed; (b) a method was outlined for studying the temporal relaxation of ensembles whose distributions of observables differ initially from the usual quantum-mechanical form. In the area of statistical description of turbulence, a preliminary abstract has been reported (item no. 89, Vol. III). Work is continuing under contract AF 49(638)675.

89

Boston U. [Dept. of Physics] Mass.

EXPANSION OF THE TURBULENT VELOCITY FIELD IN IDEAL RANDOM FUNCTIONS, II (Abstract), by W. C. Meecham and A. Siegel. [1959] [1]p. (In cooperation with Michigan U., Ann Arbor) [AF 18(603)29]
                        Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 197, Mar. 30, 1959.

The pressure term in the Navier-Stokes equations for incompressible flow is 1st eliminated. The velocity field for a member of the ensemble is then written in terms of a "power" series of ideal random functions. The necessary restrictions for the determination of the ordinary functions, K, in the expansion are obtained either by constructing correlation tensors following the method of von Karman-Howarth or from the Navier-Stokes equations directly. When only the lowest order non-vanishing terms are retained, one finds Chandrasekhar's equation (obtained by him using a different method). This result is to be expected since the velocity field to lowest order obeys a joint-normal distribution. The present method gives a systematic technique for the correction of the Chandrasekhar result. It is interesting to note that the first term also gives the first hypothesis used by Kraichnan in his work on the theory of turbulence.

90

Boulet, Georges, Toulouse (France).

DESIGN, CONSTRUCTION AND TEST OF TWO CON-STANT VOLUME COMBUSTION CHAMBERS, by G. Boulet. Technical final rept. June 30, 1959, 1v. incl. diagrs. tables. (AFOSR-TR-59-164) (AF 61(514)1162) AD 232200; PB 155570   Unclassified

The problems, methods, and results of testing 2 constant volume combustion chambers are reported. Detailed diagrams of turbines are presented along with complete calculations for determining the gain on pay load these turbines would provide. The advantages of a constant volume combustion chamber and justification for

continuing the research in this area are pointed out. The results have convinced the investigator to start the 2nd stage of development, building a smaller combustion chamber suitable for use in automobiles and light aviation.

91

Brandeis U. [Dept. of Physics] Waltham, Mass.

ANALYTICAL METHODS IN THE THEORY OF ELECTRON LATTICE INTERACTIONS, I, by E. P. Gross. Nov. 1958, ?1p. (Technical note no. 6) (AFOSR-TN-59-101) (AF 49(638)27) AD 221897
Unclassified

Also published in Ann. Phys., v. 8: 78-99, Sept. 1959.

A study is made of the low-lying levels of an electron interacting with a quantized lattice vibration field. To treat the case of arbitrary coupling strength, a canonical transformation is performed. The new lattice variables describe motions carried out partly relative to the instantaneous electron position and partly relative to the average electron state. The wave functions are assumed to be a product of electron and lattice functions in the new variables. By taking the partial expectation value with respect to electron coordinates, an effective Hamiltonian acting on the lattice variables is obtained. This Hamiltonian is brought to normal form. Corrections are obtained to intermediate coupling theory and to earlier theories of the transition between weak and strong coupling. The wave functions used are readily made the basis of a systematic perturbation theory. The relations to other methods are described and a number of generalizations noted. The approach can be directly generalized to treat more complicated Hamiltonians which involve a periodic potential, a magnetic field, or many electrons. (Contractor's abstract)

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Brandeis U. [Dept. of Physics] Waltham, Mass.

DYNAMICS OF ELECTRON BEAMS AND PLASMAS, by E. P. Gross. [1959] [26]p. incl. refs. (Technical note no. 5) (AFOSR-TN-59-102) (AF 49(638)27) AD 253127
Unclassified

Also published in Proc. Symposium on Electic Waveguides, Polytechnic Inst. of Brooklyn, (Apr. 8-10, 1958), New York, Interscience Publish,)58, p. 43-61.

Many features of these systems have been treated by using one-particle velocity distribution functions. The forces acting on a particle are of 2 types: (1) a self-consistent force arising from the average effect of other particles and (2) a short-range collision force. From the results of the investigation, a clear understanding is gained of the transition from the low-pressure Knudsen gas to the hydrodynamic limit, including

the role of boundary conditions. For ionized gases there are low-pressure plasma electron and ion oscillations. At high pressures the system behaves as a single component fluid propagating acoustic waves. As the pressure is lowered there is decoupling of the charge components and finally heavy damping. A new collective method is described in which the ionized gas is treated in terms of density fluctuations, using a completely Hamiltonian theory. Distribution functions of the Fourier components of the density and their canonical conjugates are used.

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Brandeis U. [Dept. of Physics] Waltham, Mass.

COLLECTIVE ROTATIONS OF NUCLEI, by E. P. Gross [1959] [9]p. incl. refs. (AFOSR-TN-59-1065) [AF 49(638)27]
Unclassified

Also published in Nuclear Phys., v. 14: 389-397, Jan. 1960.

An analysis is made of descriptions of collective motions of nuclei which involve the application of projection operators to a localized nuclear wave function ψ. This procedure leads to an incorrect description of center mass motion. The proposed remedy is to consider functions of the form $\psi e^{iS/\hbar}$, and to vary the functional form of the velocity potential S, subject to the constraint that the expectation value of the constant of motion has a given value for the state of collective motion. For translational motion this localized function already leads to the correct effective mass. The subsequent application of a projection operator mainly improves the zero momentum wave function. For rotational motion the velocity potential is expressed in terms of the excited states of a potential defined by ψ. The resulting moment of inertia is that of Inglis. The knowledge of the correct velocity potential for a given ψ suggests approx trial functions S which express the moments of inertia solely in terms of properties of the ground ψ.

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Brandeis U. [Dept. of Physics] Waltham, Mass.

SYSTEMATIC APPROXIMATION OF THE LINEAR BOLTZMANN EQUATION (Abstract), by E. P. Gross and E. A. Jackson. [1959] [1]p. [AF 49(638)27]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 198, Mar. 30, 1959.

A systematic procedure is proposed for approximating the linear Boltzmann equation. The Nth approximation

replaces the symmetric portion of the collision kernal, $K(c,c_1)$, by a bilinear series of orthonormal velocity

polynomials of order N or less. In low-order approximation the present method provides a justification of the linearized form of the equation Bhatnagar, Gross, and Krook used to approximate the Boltzmann equation. This equation has been extended by Krook and Fishman, and applied to a number of problems by them and Gross, Jackson, and Ziering. Jackson showed, using this equation, that the distribution function for the Couette flow problem is a nonanalytic function of the velocity at low densities, and as a result, the flow velocity is a nonanalytic function of the mean free path λ [being of the form $(x/\lambda) \log (x/\lambda)$]. This result is not obtained by the standard method of approximating the distribution function by a polynomial expansion, as in the Chapman-Enskog or Grad schemes. The present method will likewise make it possible to treat much more accurately low-density gas dynamics, high-frequency sound propagation, and boundary value problems.

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Brandeis U. [Dept. of Physics] Waltham, Mass.

KINETIC MODELS AND THE LINEARIZED BOLTZ-MANN EQUATION, by E. P. Gross and F. A. Jackson. [1959] [10]p. incl. refs. (AFOSR-4155) [AF 49(638)27] Unclassified

Published in Phys. Fluids, v. 2: 432-441, July-Aug. 1959.

Attention is directed to some unsatisfactory features of kinetic theory treatments of problems for which the linearized Boltzmann equation is applicable. The main defects are in the region where nearly free molecular flow conditions prevail. They can be overcome when the problems are treated by simplified kinetic models. In this paper relations between the linearized Boltzmann equation and some models are established. The method is based on a comparison of the eigenvalue spectra of the respective collision operators. Particular attention is paid to inverse fifth molecules. This allows evaluation of the limitations of a given model and shows how more accurate models can be constructed. It is shown how one may overcome the chief shortcomings of approx solutions of the linearized Boltzmann equation.

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Brandeis U. [Dept. of Physics] Waltham, Mass.

HEAT FLOW BETWEEN PARALLEL PLATES, by E. P. Gross and S. Ziering. [1959] [12]p. incl. diagrs. (AFOSR-4156) [AF 49(638)27] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys Soc., Series II, v. 4: 221, Apr. 30, 1959. (Title varies)

Also published in Phys. Fluids, v. 2: 701-712, Nov.-Dec. 1959.

A study is made of the flow of heat between parallel plates of slightly different temperatures. The problem is described by the linearized Boltzmann equation which is subject to microscopic boundary conditions. We approximate the distribution function by half-range polynomials in velocity space and determine the space-dependent coefficients by forming half-range moment equations. An approximation involving four pairs of space functions suffices to give an accurate treatment of the heat flow and of the density and temperature profiles for the entire range of conditions from free molecule to hydrodynamic. Detailed numerical results for the temperature slip and molecular boundary structure are obtained for hard-sphere molecules. The accuracy of cruder half-range approximations and other methods of fixing the coefficients is established. (Contractor's abstract)

97

Brigham Young U. Dept. of Chemistry, Provo, Utah.

RHENIUM TRIOXIDE, RHENIUM HEPTOXIDE AND RHENIUM TRICHLORIDE AS HYDROGENATION CATALYSTS, by W. J. Bartley. Aug. 1958 [96]p. incl. diagrs. tables, refs. (AFOSR-TN-59-76) (AF 18(600)-1164) AD 210136; PB 142192 Unclassified

Rhenium trioxide was prepared by 3 methods, the 1st 2 involving formation of a complex between rhenium heptoxide and anhydrous dioxane and the last method, employing tetrahydropyran as a complexing agent. Reductions were carried out in a high-pressure hydrogenation vessel. The reduction products were analyzed in a gas chromatograph, by refractive indices, distillation, and/or chemical extraction, and the activities of the catalysts were determined. Results indicated that the heptoxide- and trioxide-derived catalysts were similar in their catalytic activities. The trichloride was slightly lower in its activity than the oxides. The reduction of cyclohexanone was catalyzed at 123°C with rhenium trioxide, while the heptoxide and trichloride required temperatures of about 150°C. The olefinic compounds such as 1-hexene were reduced at 95° to 100°C while styrene required slightly higher conditions due to its conjugation with the benzene ring. Nitro compounds and benzenoid compounds were the most difficult to reduce with the trioxide- and trichloride-derived catalysts. Nitrobenzene yielded aniline only below temperatures of 226° to 275°C, depending on the catalyst used. Benzene yielded slight reduction with the trichloride catalyst at 200°C. The trioxide, heptoxide, and trichloride catalysts were outstanding in their ability to reduce the carboxylic acids. In most cases, reduction was effected at 150° to 160°C. Most rhenium catalysts exhibited high activity toward the carboxyl group to some extent. The oxide catalysts

showed an extremely high activity toward the hydro-
genation of amides and anilides.

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[British Columbia U. Dept. of Mathematics, Vancouver
(Canada).]

EIGENVALUE INEQUALITIES FOR FINITE MATRICES,
by B. N. Moyls. Final status rept. June 1, 1956-Apr.
30, 1959. May 8, 1959, 4p. (AFOSR-TR-59-52)
(AF 18(603)83) AD 215869   Unclassified

The results reported in this final report include an
investigation of the maximum and minimum values of
certain real valued functions where the arguments
range over all sets of k orthonormal vectors in unitary
n-space. A Hermitian matrix type function was ex-
amined, and extreme values of ψ were obtained when σ
is a real non-negative number and when $\sigma = 1$. Several
types of functions reportedly have been examined and
presented in tabular form. The problem of determining
the structure of any linear transformation T of M_n

having 1 or more of several properties was also ana-
lyzed.

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Brown U., Providence, R. I.

PROCEEDINGS OF THE THIRD U. S. NATIONAL CON-
GRESS OF APPLIED MECHANICS, Brown U.,
Providence, R. I. (June 11-14, 1958), ed. by R. M.
Haythornthwaite. New York, American Society of Me-
chanical Engineers, 1958, 864p. incl. illus. diagrs.
tables, refs. (AFOSR-TR-59-16) (Sponsored jointly by
Air Force Office of Scientific Research under [MIPR-
€80-58-4], National Committee on Theoretical and Ap-
plied Mechanics, Office of Naval Research under [Nonr-
245700], Office of Ordnance Research and others)
                                              Unclassified

This volume contains the complete texts of 4 invited
general lectures and 97 technical papers presented at
the congress. The papers are grouped by subject into
4 broad categories and arranged alphabetically, by
author, within each category. Sponsors of this congress
include 7 professional societies and 31 universities,
institutes, federal agencies, and industrial corporations.
The aim is to help maintain a high level of domestic
interest in applied mechanics during the intervals be-
tween the international congresses.

100

Brown U. Dept. of Physics, Providence, R. I.

A PROGRAM FOR CALCULATING ATOMIC WAVE
FUNCTIONS ON THE I.B.M. 704 COMPUTER, by

M. N. Lewis. Interim rept. Oct. 14, 1958, 1v. incl.
diagrs. tables. (AFOSR-TR-59-175) (AF 18(600)1554)
                                              Unclassified

A program is described for calculating self-consistent
field atom. wave functions for both the original ground
states and the ionized states of atoms. The methods
and nomenclature used in the program follow closely
those of D. R. Hartree, The Calculation of Atomic
Structures, New York, Wiley and Sons, 1957. The time
required by the program to compute the wave functions
for an atom is estimated to be of the order of 15-20 min
instead of the yr or so required by hand computing tech-
niques. Modifications in the form of the program control
and input data are necessary for the program to become
generally useful.

101

Brown U. Dept. of Physics, Providence, R. I.

SONICALLY INDUCED MICROSTREAMING APPLIED
TO A SURFACE REACTION, by W. L. Nyborg, R. K.
Gould and others. [1959] [6]p. incl. illus. diagrs.
(AFOSR-TN-59-253) (Sponsored jointly by Air Force
Office of Scientific Research under AF 18(603)54 and
National Institutes of Health under Grant RG-4431)
AD 238441   Unclassified

Also published in Jour. Acoust. Soc. Amer., v. 31: 706-
711, June 1959.

Special arrangements are used to produce small-scale
eddying near surfaces at which reactions are taking
place. Experiments in which the reaction involves a
photographic emulsion acted upon by developer show that
the development process is considerably accelerated in
small areas where the near-surface flow is concen-
trated. Resonant gas bubbles appear to be by far the
most efficient sources of sonically induced microeddy-
ing. When such a bubble rests on an emulsion surface,
the development reaction in its neighborhood is signifi-
cantly affected, evidently because of the local "micro-
stirring," at ambient pressure amplitudes much less
than are typically used in sonic and ultrasonic applica-
tions. Sonic microstreaming, especially as induced near
resonant bubbles at boundaries, appears to be an impor-
tant mechanism in accounting for certain well-known
effects of ultrasound. Continued development may lead
to means for applying microstreaming to surface proc-
esses in a controlled and specifiable manner. (Contrac-
tor's abstract)

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Brown U. [Dept. of Physics] Providence, R. I.

SONICALLY INDUCED MICROSTREAMING AND ITS
EFFECTS ON SURFACE PHENOMENA (Abstract), by
W. L. Nyborg, F. J. Jackson, and E. C. Tanner. [1959]
[1]p. (Sponsored jointly by Air Force Office of Scien-
tific Research under [AF 18(603)54] and National Insti-
tutes of Health)   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 20, Jan. 28, 1959.

A consequence of non-linearity in the hydrodynamical equations is that flow fields generated in sinusoidally vibrating boundaries exhibit time-independent circulation superposed on the oscillatory flow. Of special interest here is the steady flow induced in the immediate vicinity of boundaries. Typical speeds in this near-boundary flow tends to have their greatest values at points where there exist steep gradients of the near-surface irrotational velocity amplitude. Arrangements will be described in which vibratory sources (10 to 40 kc) are used to generate highly localized eddying near points of interest on a plane surface. Application of this small-scale eddying, or microstreaming, to surfaces at which reactions, transport activity, etc., occur shows promise as a technique for studying flow effects on such surface processes. Preliminary results have been obtained on such diverse phenomena as (1) photographic development, (2) metal etching, and (3) electrode processes.

103

Brown U. [Dept. of Physics] Providence, R. I.

CAVITATION MICROSTREAMING, by S. A. Elder. [1959] [11]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)54] and Office of Naval Research)
Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 54-64, Jan. 1959.

In the research reported here an attempt has been made to discover by experiment what physical assumptions and approximations are appropriate in the theory of cavitation microstreaming, especially for cavitation bubbles, located near solid boundaries. A systematic investigation of the phenomenon has been made and its dependence on certain parameters (e.g., amplitude of sound) has been determined. The investigation has disclosed that as the sound amplitude is varied, other conditions remaining the same, the streaming changes discontinuously through several stable regimes. It appears that in order to account for the generation of vorticity one needs to assume different conditions at the boundaries for each regime. For at least 1 regime, a theoretical model due to Nyborg seems to be applicable; comparison is made with experimentally determined streaming velocities. (Contractor's abstract)

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Brown U. Dept. of Physics, Providence, R. I.

SMALL SCALE ACOUSTIC STREAMING NEAR A VI-

BRATING PISTON OPPOSITE A RIGID BOUNDARY (Abstract), by F. J. Jackson and W. L. Nyborg. [1959] [1]p. (AF 18(603)54)
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 846, June 1959.

In studying effects of acoustic streaming on surface processes it is important to specify the flow as well as possible. One arrangement for generating localized streaming consists, in essence, of a piston of circular cross section placed in liquid a short distance above a rigid boundary. When the piston oscillates along its axis of symmetry (perpendicular to the boundary) eddying motions are observed near the tip periphery—where sharp velocity gradients exist. To permit detailed observation of the flow a large-scale low-frequency model which operates at 2 kc has been constructed. Using dark field illumination and small indicator particles, it is possible to record photographically sonically generated eddying in this case and thus determine velocity distributions. Photographs of the motion for various values of such parameters as viscosity, vibration amplitude, and piston-boundary separation will be shown. Relevant theory will be discussed.

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Brown U. Dept. of Physics, Providence, R. I.

MAGNETIC OSCILLATIONS OF ULTRASONIC ATTENUATION IN A COPPER CRYSTAL AT LOW TEMPERATURES, by R. W. Morse and J. D. Gaverda. [1959] [3]p. incl. diagrs. [AF 49(638)6]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Phys. Rev. Ltrs., v. 2: 250-252, Mar. 15, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 167, Mar. 30, 1959. (Title varies)

The magnetic field dependence of ultrasonic attenuation has been measured in a single crystal of copper where the condition $kl > 1$ is amply satisfied at liquid helium temperatures (k being the ultrasonic propagation constant and l the electron mean free path). At frequencies around 70 mc/sec several distinct maxima and minima in attenuation are found, the oscillations being in H^{-1}. With a longitudinal wave propagated along the (001) direction and H directed perpendicularly, pronounced anisotropic effects are found as H is rotated about the (001) direction. These presumably reflect anisotropy of the Fermi surface. When H is along (100) or (010) well-defined oscillations are found, which however, are largely suppressed for H along a 45° direction such as (110). This suppression is probably a result of the

Fermi surface touching the zone boundaries in the (111) direction as suggested by Pippard. The period of the oscillations should be related directly to the Fermi momentum and reasonable values are found using a simple model. Shear waves show a pronounced phase change of the oscillations as H is rotated with respect to the direction of polarization, the effect being similar to that previously observed in a polycrystal.

106

Brown U. [Dept. of Physics] Providence, R. I.

MAGNETIC DEPENDENCE OF ULTRASONIC ATTEN-UATION IN TIN (Abstract), by T. Olsen and R. W. Morse. [1959] [1]p. [AF 49(638)6]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 167-168, Mar. 30, 1959.

The ultrasonic attenuation due to electron interaction has been measured as a function of magnetic field in single crystals of tin where the electron mean free path is much longer than the wavelength at liquid helium temperatures. Frequencies around 50 mc/sec give pronounced oscillations from which several

periods (periodic in H^{-1}) can be distinguished. These oscillations are highly anisotropic and should be related directly to the Fermi momentum. Another aniso-tropic effect occurs at fields of several kgauss. For some cases we find a general decrease in the attenua-tion with increasing field as would be expected from a simple theoretical model. However, for several orienta-tions of the field the attenuation increases rapidly and levels off at a value higher than the 1 at zero field. It is felt that this anomalous increase with H may be re-lated to the occurrence of open orbits for certain direc-tions, i.e., the Fermi surface touches the zone bound-aries in such a way that increasing H does not lead to localization of these electrons. An attempt will be made to deduce features of the Fermi surface of tin from these results.

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Brown U. Dept. of Physics, Providence, R. 1.

EVIDENCE FOR ANISOTROPY OF THE SUPERCON-DUCTING ENERGY GAP FROM ULTRASONIC AT-TENUATION, by R. W. Morse, T. Olsen, and J. D. Gavenda. [1959] [2]p. incl. diagrs. [AF 49(638)6]
Unclassified

Published in Phys. Rev. Ltrs., v. 3: 15-16, July 1, 1959.

The results given are of ultrasonic absorption measure-ments on single crystals of pure tin in the temperature range $1.00°K - 3.73°K$. Longitudinal waves of frequen-cies up to 80 mc/sec were used, and different directions

of propagation were studied. It is pointed out that dif-ferences in the results for different directions may be interpreted in part as due to variations over the Fermi surface of the energy gap now associated with the super-conducting state. Limiting energy gaps for various propagation directions are deduced to be: $[001]$, $(3.5 \pm 0.1)kT_c$, $[100]$, $(4.3 \pm 0.2)kT_c$; and $[110]$, $(3.8 \pm 0.1)kT_c$.

The relevant portion of the Fermi surface is a cross-section at right angles to the propagation direction, and it is suggested that more than 1 energy gap may be in-volved.

108

Brown U. Dept. of Physics, Providence, R. I.

SOME ULTRASONIC MEASUREMENTS IN NORMAL AND SUPERCONDUCTING ALUMINUM, by R. W. Morse and H. V. Bohm. [1959] [4]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Re-search under [AF 4t(638)6] and Office of Naval Re-search)   Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1523-1526, Nov. 1959.

Ultrasonic attenuation measurements in an aluminum single crystal near the superconducting transition tem-perature are described. These include both longitudi-nal and shear wave attenuations at frequencies of be-tween 11 and 58 mc/sec and at temperatures between 1.0 and $4.2°K$, as well as attenuation as a function of magnetic field in the normal state. It is found that the attenuation of shear waves at the transition temperature shows a discontinuity of about 25% of the total attenua-tion, this fraction being relatively independent of fre-quency. The longitudinal wave attenuation shows a sharp but continuous drop at the transition temperature. It is shown that the electron mean free path 1 can be estimat-ed from the magnetic field dependence of the attenuation and the condition $kl < 1$ ($k = 2\pi/\lambda$, λ being the ultrasonic wavelength) holds for the measurements. The possible significance of the shear wave discontinuity is dis-cussed. (Contractor's abstract)

109

Brown U. [Dept. of Physics] Providence, R. 1.

FERMI SURFACE INFORMATION IN COPPER FROM ULTRASONIC ATTENUATION (Abstract), by J. D. Gavenda and R. W. Morse. [1959] [1]p. [AF 49(638)6]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Pasadena, Calif., Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 463, Dec. 28, 1959.

For electron mean free paths longer than the ultrasonic

wavelength (λ) there is an oscillatory variation of ultrasonic attenuation with magnetic field (H). These oscillations, which are periodic in H^{-1}, have been previously reported in a copper crystal at 4.2°K. For H perpendicular to the propagation vector q the period of the oscillations should be determined by the external electron momentum mutually perpendicular to H and q. Thus, measurements of the periods as H is rotated about q in a single crystal should map out the Fermi surface in a plane perpendicular to q. Such measurements have been made at frequencies between 80 and 115 kc/sec and q along the [100], [110], and [111] directions. Results suggest that the surface touches the zone boundaries in [111] directions, as in Pippard's model. A long period found when H is along [111] is consistent with orbits where electrons circle around the necks of the touching regions. These indicate that touching extends over about a 20° region.

110

Brown U. [Dept. of Physics] Providence, R. I.

ELECTRON RESONANCE WITH ULTRASONIC WAVES, by R. W. Morse. [1959] [1]p. [AF 49(638)6]
Unclassified

Published in Internat'l. Conf. on Electronic Properties of Metals at Low Temperatures, Geneva, N. Y. (Aug. 25-29, 1958), 1959, p. 39.

Attenuation measurements at values of $ql < 1$ (q = wavenumber of sound wave, 1 = electron free path) give useful information about the electron distribution. Thus in a magnetic field, H, the relative attenuation is α

$(H)/\alpha$ (O) $= 1/[1 + (2\,\omega_c\,\tau)^2]$ where $\omega_c = eH/m^*c$ is the cyclotron frequency of free particles of mass m*, and

is the relaxation time. Hence for Cu, τ is estimated in a particular specimen from attenuation measurements as 3.8×10^{-11} sec, and, using the Fermi velocity for free electrons, gives $1 = 7 \times 10^{-3}$ cm. From the general dependence of α on ql, using Pippard's free electron theory without an H field, the region of $ql = 1$ can be identified where the curve changes character. Hence 1 can be deduced from the frequency (10 mc) giving $1 = 6 \times 10^{-3}$ cm for the specimen Cu. At large ql, in an H field, oscillatory attenuation is found. The oscillation periods are simply related to electronic properties and offer a more promising way of obtaining information about the Fermi surface, than the above procedures. The results are now independent of 1, and give information about R/λ where R is the cyclotron radius, $P_\perp C/eH(P_\perp$ = momentum of electron transverse to H), and λ the sound wave length. The basic rule for the oscillation periods proposed by Pippard is that the diameter of the orbit changes λ in one period; hence an average $P_\perp$ can be evaluated for a particular direction in the crystal. Anisotropy in $P_\perp$ can then be studied.

Measurements have been carried out on Cu and Sn, leading to reasonable estimates of P_F (the Fermi momentum).

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Brown U. [Dept. of Physics] Providence, R. I.

ULTRASONIC ATTENUATION OF SHEAR WAVES IN SUPERCONDUCTORS, by R. W. Morse and H. V. Bohm. [1959] [2]p. [AF 49(638)6]   Unclassified

Published in Internat'l. Conf. on Electronic Properties of Metals at Low Temperatures, Hobart Coll., Geneva, N. Y. (Aug. 25-29, 1958), 1959, p. 20-21.

The observed rapid decrease of attenuation of ultrasonic longitudinal waves, on going into the superconducting state, has previously been shown to agree with a prediction of the BCS (J. Bardeen, L. Cooper and J. Schrieffer, Phys. Rev., v. 108: 1175, 1957) theory. The simple result of calculating the energy lost by the sound wave through scattering electrons between stages of the superconductor, is $\alpha_s/\alpha_n = 2/\exp(E_0/kT) + 1$ where $2\,E_0$ is the temperature-dependent energy gap in the one-particle spectrum, and α_s, α_n are attenuations in the superconducting and normal states. Thus the attenuation drops sharply but continuously below T_c because of the increasing energy gap. Measurements on Sn single crystals with 51 mc/sec longitudinal waves along [001] agree strikingly well with this formula. Shear waves, however, show a remarkable new feature in their attenuation, namely, a discontinuous drop at T_c, and then a continuous fall with decreasing T. Thus a polycrystal of Sn with 27.5 mc/sec shear waves shows a 55% drop at T_c in an interval less than 0.01 K°, whereas in the next 0.02 K° the attenuation falls only 4%. The gradually decreasing part then agrees with the BCS formula above. Similar results are shown in measurements with In and Al.

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Brown U. Dept. of Physics, Providence, R. I.

ULTRASONIC ATTENUATION IN METALS AT LOW TEMPERATURES, by R. W. Morse. [1959] [39]p. illus. diagrs. tables, refs. [AF 49(638)6]   Unclassified

Published in Progress in Cryogenics, v. 1: 221-259, 1959.

Recent low-temperature observations of ultrasonic attenuation have shown that it is possible to observe directly the interaction of a plane harmonic lattice wave with the conduction electrons in metal. This paper reviews the current status of this method, and discusses in some detail the experimental techniques used. The theory of attenuation by conduction electrons is

considered, including phonon-electron scattering, relaxation and viscosity approximations, the attenuation for an arbitrary mean free path, and attenuation in the superconducting state. The experimental results deal with attenuation in the normal and superconducting states, and with the magnetic-field dependence of attenuation.

113

Brown U. Div. of Applied Mathematics, Providence, R. L

CALCULATION OF SUPERSONIC FLOW PAST A FLAT-HEAD CYLINDER BY BELOTSERKOVSKII'S METHOD, by R. Gold and M. Holt. Mar. 1959, 21p. incl. diagrs. tables. (AFOSR-TN-59-199) (AF 49-(638)232) AD 211525; PB 139947   Unclassified

Belotserkovskii's method of calculating the supersonic flow past a circular cylinder is applied to the case of a flat headed cylinder. The surface pressure distribution and associated flow field (including the shape of the detached shock wave) are determined for a prescribed incident Mach number. Only the 1st approximation of Belotserkovskii is considered. Selected physical variables are assumed to vary linearly between the body and the shock, thereby reducing the original problem to 1 of solving 3 ordinary differential equations. The boundary conditions are obtained from symmetry conditions on the axis of symmetry, the oblique shock equations and the condition that sonic speed is attained at the sharp shoulder. (Contractor's abstract)

114

Brown U. Div. of Applied Mathematics, Providence, R. I.

SUPERSONIC PANEL FLUTTER OF A CYLINDRICAL SHELL OF FINITE LENGTH, by S. L. Strack and M. Holt. May 1959, 56p. incl. diagrs. refs. (AFOSR-TN-59-547) (AF 49(638)232) AD 216693; PB 142404   Unclassified

Also published in Jour. Aero/Space Sci., v. 28: 197-208, Mar. 1961.

Panel flutter characteristics of cylindrical shells of finite length in a uniform supersonic stream are determined. The aerodynamic term is found for a finite cylinder, and the corresponding shell equation is an integro differential equation of 4th or 8th order. This is very difficult to solve as it stands but can be reduced to a differential equation by means of a plausible assumption about the behavior of the aerodynamic term. This simplified equation is solved, and the results are compared with those of earlier calculations. In general, it is found that the use of a more realistic aerodynamic term leads to higher estimates of critical flutter Mach numbers. (Contractor's abstract)

115

Brown U. Div. of Engineering, Providence, R. I.

AN APPROXIMATE SOLUTION FOR TRANSONIC FLOW IN CASCADES, by A. D. Wood and J. H. Clarke. [1959] [1]p. (AF 18(600)664)   Unclassified

Published in Jour. Aero/Space Sci., v. 26: 318:319, May 1959.

Treatment is made of the steady, isentropic, isoenergetic, transonic flow equation through an unstaggered, nonlifting, 2-dimensional cascade of slender airfoils. The equation assumes a form affinely related to Poisson's equation which treats the problem as a 1-dimensional flow through the cascade. The final formula for the coefficient of pressure is easily obtained, and comparison of theoretical and experimental results is particularly good.

116

Brown U. [Div. of Engineering] Providence, R. I.

THE EFFECT OF PRESSURE ON THE VISCOSITY OF N_2-CO_2 MIXTURES, by J. Kestin and W. Leidenfrost. [1959] [12]p. incl. diagrs. tables. (AFOSR-TN-59-393) (AF 18(600)891) AD 214513   Unclassified

Also published in Physica, v. 25: 525-536, July 1959.

Precise measurements of the viscosity of the binary mixture N_2-CO_2 at 20°C over a range of pressures from 1 to 21 atm are given. The viscosity was measured with the aid of an oscillating-disk viscometer developed by the authors. The measurement was an absolute one with an estimated accuracy of 0.05%. The composition of the mixtures was determined from the measured pressures during filling with the aid of the Benedict-Webb-Rubin equation. It is believed that the molar fractions were determined with an uncertainty of 1%. This is by far the largest uncertainty of the measurements. The pressure effect on the viscosity of the pure components at 20°C was determined in the same instrument leading to internally consistent data. A comparison is made with Wilkes' equation for the viscosity of binary mixtures but the deviations from proportionality predicted by it are opposite to those measured. No comparison with the results of calculations based on inter-molecular potentials were possible. (Contractor's abstract)

117

Brown U. [Div. of Engineering] Providence, R. I.

THE VISCOSITY OF HELIUM, by J. Kestin and W. Leidenfrost. [1959] [19]p. incl. diagrs. tables, refs. (AFOSR-TN-59-394) [AF 18(600)891] AD 214514   Unclassified

Also published in Physica, v. 25: 537-555, July 1959.

Measurements of the viscosity of helium are investigated in the range of pressures of 1-137 atm and in the range of temperatures of 25-237°C with an accuracy of from 0.2% at lower temperatures to 0.5% at higher temperatures. The method used was that of a disk oscillating between 2 plates with moderate gaps, and the measurements were relative to nitrogen. The results show no significant pressure effect. The temperature effect has been correlated empirically by the use of Keesom's and Keyes formulas as well as by the use of the methods of statistical mechanics, i.e. with the aid of the Lennard-Jones, 6-12, and the modified Buckingham, exp-6, potentials. It appears that the best fit is obtained with the aid of the exp-6 potential. If an accuracy of 1% only is required, then there is little to choose between the various schemes up to 800°C. Keesom's formula spans the widest range of temperatures. (Contractor's abstract)

118

Brown U. [Div. of Engineering] Providence, R. I.

REVIEW OF AVAILABLE EXPERIMENTAL DATA
ON THE VISCOSITY OF STEAM, by J. Kestin and J. R.
Moszynski. [1959] [8]p. incl. diagrs. table, refs.
[AF 18(600)891]   Unclassified

Presented at Symposium on Thermophysical Properties, Purdue U., Lafayette, Ind., Feb. 23-26, 1959.

Also published in Thermodynamic and Transport Properties of Gases, Liquids and Solids, ed. by Y. S. Touloukian, New York, Amer. Soc. Mech. Engineers; McGraw-Hill, 1959, p. 70-77.

A critical review of existing experimental data on the viscosity of steam and compressed water is presented. At low pressures, i.e., up to about 1 atm, the existing data correlate with an estimated accuracy of $\pm 1.5\%$ with the aid of the equations

$$\mu = \frac{25.64 \ \sqrt{T}}{1 + \frac{1371}{T} \times 10^{-37.4/T}} \times 10^{-6} \text{ poise for } T < 1100°C$$

and
$$\mu = \frac{14.98 \ \sqrt{T}}{1 + \frac{24.51 \times 10^4}{T^2}} \times 10^{-6} \text{ poise for } T \times 1100°C.$$

It is hoped that the 2nd of these equations may offer a reasonable means for extrapolating to, say, 2000°C. At higher pressures new and more reliable data will be required before any reasonable correlations may be attempted. (Contractor's abstract, in part)

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Brown U. Div. of Engineering, Providence, R. I.

TESTS OF A CONFIGURATION COMPOSED OF A
BODY UNDER A LIFTING WING IN SUPERSONIC
FLOW, by C. F. Chen. Feb. 1960 [10]p. incl. illus.
diagr. (Technical rept. no. WT-31) (AFOSR-TN-59-
1275) (AF 49(638)444) AD 233944; PB 146438
                                        Unclassified

Also published in Jour. Aero/Space Sci., v. 28: 547-562, July 1961. (Title varies)

Tests were made on an arrangement consisting of a Sears-Haack body located under a lifting rectangular diamond profile wing. The Mach number was 1.6 and the Reynolds number was 9.17×10^5 based on the body length. The experiments were suggested by a previous theoretical study of such arrangements. It is found that the measured lift developed on the wing due to the flow field of the body agrees very well with the theoretical value. Downstream of the impinging shock from the wing, flow separation was observed on the exterior side of the body but not on the interior side. The separation is attributed not to the pressure rise across the shock but to the pressure field arising from the reflection from the body of the shock-induced cross flow. Further observations suggest that the separation can be avoided by pitching the body or by kinking the body at the shock wave to accommodate the shock-induced cross flow. (Contractor's abstract)

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Brown U. Div. of Engineering, Providence, R. I.

A STUDY OF CONFIGURATIONS COMPOSED OF A
BODY UNDER A LIFTING WING IN SUPERSONIC
FLOW, by C. F. Chen and J. H. Clarke. Jan. 1960
[62]p. incl. diagrs. table, refs. (AFOSR-TN-59-1276)
(In cooperation with Johns Hopkins U., Silver Spring,
Md.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)444 and Bureau of
Weapons under NOrd-7386) AD 233523; PB 146437
                                        Unclassified

Also published in Jour. Aero/Space Sci., v. 28: 547-562, July 1961. (Title varies)

An investigation is made of supersonic aircraft configurations composed of a cambered body positioned a certain distance beneath an arbitrary lifting wing. The geometry of the wing is regarded as given and the geometry of the body may be given or optimum. Expressions for the drag and lift are obtained from reverse-flow considerations; these greatly implement such a study when interference cross-flows must be cancelled. The drag advantage to be gained when a given body and wing assume a given orientation is studied. Treated more extensively is the variational problem of determining the optimum wing incidence and optimum body

shape, for the given volume and length, to yield the minimum drag for prescribed lift. Numerical results are provided to indicate the significance of the large number of parameters appearing in the problem. Of these the gap between the wing and the body is found to be particularly important. It is found at low gap that moderate body distortions have a significant influence on the drag. Drag reductions of up to 44% relative to the case of no interference have been found at M = 2.24 in a configuration having a gap approximately equal to the maximum diameter of the body, a wing chord of about 3/8 of the length of the body. Comparison is made with the conventional wing-body combination with the effects of skin friction included, and it is concluded that the advantage suggested by the preceeding considerations is not appreciably diminished. Finally, it is shown that the configurations studied lead to bodies of much lower fineness ratics than appropriate in conventional wing-body combinations. (Contractor's abstract)

121

Brown U. Div. of Engineering, Providence, R. I.

ON THE APPLICATION OF THE URSELL-WARD THEOREM TO WINGS WITH EDGE FORCES, by J. H. Clarke. [1959] [2]p. (AF 49(638)444)   Unclassified

Published in Jour. Aero/Space Sci., v. 26: 535-536, Aug. 1959.

The way in which the Ursell-Ward reverse flow theorem must sometimes be modified to account for edge forces on wings is shown and several applications of this modified theory are considered. It is pointed out that the inference made by Yoshihara (Jour. Aero/Space Sci., v. 25: 600, Sept. 1958) that the downwash criterion is invalid when edge forces are present, and deduction based on this conclusion are the result of an incorrect application of the theorem. It is further demonstrated that the downwash criterion does hold for such cases.

122

Brown U. Metals Research Lab., Providence, R. I.

ORIENTATION OF RECRYSTALLIZED GRAINS IN STRAINED ALUMINUM SINGLE CRYSTALS, by H. Yoshida, B. [G.] Liebmann, and K. Lücke. [1959] [6]p. incl. illus. diagrs. table, refs. (AFOSR-4393) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)75 and Office of Naval Research under Nonr-56212)   Unclassified

Published in Acta Metall., v. 7: 51-56, Jan. 1959.

Artificially nucleated crystals were grown in strained aluminum single crystals by cutting them at one end with pliers and then subjecting them to recrystallization heating. An overwhelming majority of the new crystals showed an orientation characterized by a 40° rotation

around the $[1\bar{1}1]$ axis relative to the old matrix. After further heating most of the fine grains disappeared and only one crystal finally occupied the full diameter of the wire. Laue and Debye-Scherrer x-ray photographs indicated that the preferred orientation of the final crystals originates in growth selection. The preference of the $[1\bar{1}1]$ among the other 111 axes may be caused either by the plastic deformation of the old matrix or by the fact that the boundary between the two crystals is a pure tilt boundary if both have a common $[1\bar{1}1]$ axis.

123

Brown U. Metals Research Lab., Providence, R. I.

MULTIPLE SCATTERING OF ELASTIC WAVES INVOLVING MODE CONVERSION, by B. Raphael and R. Truell. May 15, 1959 [54]p. incl. diagrs. tables. (AFOSR-TN-59-399) (AF 49(638)450) AD 214519; PB 142001   Unclassified

The equations of multiple scattering derived by Waterman and Truell [Technical rept. WAL 143/14-49, Oct. 1957] are applied to problems of scattering of elastic waves by a random array of identical spherical obstacles with mode conversion treated explicitly. In the multiple scattering of a plane compressional wave, mode conversion is shown to introduce only negligible corrections to the modified phase velocity and attenuation expressions found by Waterman and Truell. In the multiple scattering of a plane shear wave it is shown that no single overall modified phase velocity or attenuation exists since the wave motion in the scattering medium does not maintain the form of a plane wave. The incident plane shear wave after scattering is found to be resolved into a series of component waves, which are difficult to describe physically, and each of which propagates with its own independent phase velocity and attenuation. Formulas for the propagation parameters of each scattered component wave are developed in terms of constants which may be found from appropriate single-scattering problems, and these constants are evaluated for the case in which the scatterers are elastic spheres. (Contractor's abstract)

124

Brown U. Metals Research Lab., Providence, R. I.

INVESTIGATIONS ON RECRYSTALLIZATION AND RECOVERY OF STRAINED ALUMINUM SINGLE CRYSTALS, by R. Green, Jr., H. Yoshida, and B. [G.] Liebmann. Apr. 30, 1959 [74]p. incl. illus. diagrs. refs. (AFOSR-TN-59-381) (AF 49(638)479) AD 214008; PB 140996   Unclassified

The influence of the state of impurities (dissolved in solid solution or precipitated) on the recrystallization of extended Al single crystal wires was investigated. The crystals contained 99.79% Al, 0.09% Fe, 0.09% Si, and 0.03% Zn; only the Fe was not well within its

solubility limit. No preferred orientations were ob-
tained when the crystals were annealed for several
hours at 620°C prior to deformation. Upon reheating be-
low 500°C, the yield point of the crystals increase
reached a maximum, and finally decreased. Recrystal-
lization produced preferred orientations in samples
which were reheated until the maximum yield point
was reached or exceeded. This result indicates that
Fe in supersaturated solid solution prevented the gen-
eration of preferred orientations while it had no effect
of this kind when precipitated. The initial growth rate
of strain-free nuclei into deformed matrices was also
strongly dependent on the state of Fe; the larger the
Fe precipitates, the faster was the initial growth rate.
Curves of recovery of the growth rate vs reheating
time showed a maximum at the same point as the yield
point curve. These curves indicate that recovery was
greatest when Fe precipitates were at a critical size
and separation; these precipitates produced the maxi-
mum hardness. The growth rate of new crystals in-
creased as the amount of extension of the matrix crys-
tals was increased. (ASTIA abstract)

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Brown U. Metals Research Lab., Providence, R. I.

INFLUENCE OF BOUNDARY ORIENTATION ON
GROWTH RATES IN RECRYSTALLIZATION, by H.
Yoshida, N. Pitula, and B. [G.] Liebmann. Apr. 30,
1959 [10]p. incl. diagrs. table. (AFOSR-TN-59-382)
(Sponsored jointly by Air Force Office of Scientific Re-
search under AF 49(638)479 and Office of Naval Re-
search under Nonr-56212) AD 214009; PB 140995
Unclassified

The influence of the orientation of grain boundaries on
their mobility during recrystallization was investigated.
Thin rods of 1.5 mm x 1.5 mm cross section were cut
from strained aluminum single crystal sheets and arti-
ficially nucleated at one end. Due to the surface tension
of the interfaces the boundaries always took a position
normal to the rod axes. Therefore it was possible to
produce boundaries of various orientations by cutting
the rods in different crystallographic directions. Since
the sheet crystals were extended prior to cutting, the
distribution of dislocations in the rods was independent
of the rod axes. This is an advantage over extended
single crystal wires where the normal to the grain
boundary and the direction of extension always coincide.
Growth rates and preferred orientations after recrys-
tallization were investigated for various boundary ori-
entations. The results provide evidence that the orien-
tation of the boundary may have a strong influence on
its mobility during recrystallization. In the case of
40° <111> orientation relations between new and de-
formed crystals, the rate of boundary migration
changes by a factor of 45 due to variations in the ori-
entation of the boundary. The dependence of the growth
rates of 40° <111> rotated new grains on the orienta-
tion of their grain boundaries contradicts attempts to
explain high growth rates on the basis of common lat-

tice sites and suggests that edge dislocations play an
important role in the structure of boundaries with high
mobility. (Contractor's abstract)

126

Brown U. Metals Research Lab., Providence, R. I.

STATUS REPORT ON RECRYSTALLIZATION TO
MARCH 31, 1959, by B. G. Liebmann. Technical rept.
Apr. 15, 1959, 5p. (AFOSR-TR-59-63) (AF 49(638)-
479) AD 217009; PB 142302   Unclassified

The work performed under this contract is described
in 3 technical notes (see item nos. BRO.14:001, Vol. II,
and item nos. 124 and 125, Vol. III). The present rept.
gives abstracts of these publications in addition to pos-
sible areas for further study.

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Brown U. Metcalf Research Lab., Providence, R I.

STATISTICAL-MECHANICAL THEORY OF TRANS-
PORT IN FLUIDS, by H. Mori. [1958] [14]p. incl. refs.
(AFOSR-TN-59-548) (AF 18(603)87) AD 264299
Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago,
Ill., Mar. 27-29, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II,
v. 3: 104, Mar. 27, 1958.

Also published in Phys. Rev., v. 112: 1829-1842,
Dec. 15, 1958.

A statistical-mechanical theory of transport processes
in fluids of g components is presented on the assump-
tion that the macroscopic state of the system can be
described by 1 velocity, 1 temperature, and g mass-
density fields. The formulation is based on the explicit
recognition of the fact that there are 2 relaxation
processes in fluids: one is the macroscopic process of
attaining spatial uniformity and is represented by the
hydrodynamical equations, whereas the other is the mi-
croscopic process of attaining internal thermal equilib-
rium in small mass elements of macroscopic size and
determines the transport coefficients. For instance, in
dilute gases the microscopic process is the relaxation
process in momentum space. The coupling of the 2
processes is investigated to obtain the dissipative terms
in the transport equations with the aid of the correlation
function method outlined in a previous paper. The hydro-
dynamical equations, the equation of entropy balance,
and the linear relations between the thermodynamic
fluxes and affinities are thus derived with explicit ex-
pressions for the coefficients of viscosity, thermal con-
ductivity, and diffusion, which are valid for liquids as
well as for gases. The classical limits of these

expressions, h ~ 0, are somewhat different from those obtained by Green for classical mechanical systems. (Contractor's abstract)

128

Brown U. Metcalf Research Lab., Providence, R. I.

CORRELATION FUNCTION METHOD FOR TRANS-PORT PHENOMENA, by H. Mori. [1959] [3]p.
[AF 18(6C3)87]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 275, Apr. 30, 1959.

Also published in Phys. Rev., v. 115: 298-300, July 15, 1959.

An expression for the nonequilibrium density matrix is derived in terms of dynamical fluxes, which leads to a rigorous formulation of the correlation function method for transport phenomena with nonuniform thermodynamic quantities.

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Brown U. Metcalf Research Lab., Providence, R. I.

DIELECTRIC RELAXATION OF POLAR LIQUIDS, by S. H. Glarum. [1960] [5]p. incl. refs. [AF 49(638)31]   Unclassified

Published in Jour. Chem. Phys., v. 33: 1371-1375, Nov. 1960.

The statistical theory of the dielectric relaxation of polar liquids is developed using the fluctuation-dissipation approach to linear dissipative phenomena, and an expression is derived relating the complex dielectric constant to a time-dependent microscopic correlation function. It is found that a finite number of microscopic relaxation times leads to an equal number of macroscopic decay times, and, in the case of a single relaxation time τ_0, the decay time is given by $T_0 = [3\epsilon_0/(2\epsilon_0 + \epsilon_\infty)]\tau_0$, ϵ_0 being the static dielectric constant, and ϵ_∞ being the high frequency dielectric constant. Relaxation times are also determined for systems having 2 decay times, and for systems characterized by the circular-arc and skewed-arc distribution functions. (Contractor's abstract)

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Brown U. Metcalf [Research] Lab., Providence, R. I.

THE HIGH TEMPERATURE PYROLYSIS OF

ACETYLENE 1400-2500°K, by C. F. Aten and E. F. Greene. May 1959 [30]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-514) (AF 49(638)167)
AD 253124   Unclassified

Also published in Combus. and Flame, v. 5: 55-64, Mar. 1961.

The pyrolysis of acetylene-argon mixtures has been investigated in the temperature range 1400 to 2500°K by using shock wave heating. Time resolved emission and absorption spectra, measurements of reflected shock velocities, and analysis of the products of the reaction have been used to follow the rate of loss of acetylene. The average activation energy from 600 to 2600°K is approximately 39 kcal/mol and there is evidence that the same mechanism is dominant over the whole range. (Contractor's abstract)

Brussels U. (Belgium) see Free U. of Brussels (Belgium)

131

Burden Neurological Inst. [Physiological Dept.] Bristol (Gt. Brit.).

AN AMBIGUITY OF BIPOLAR RECORDING, by R. Cooper. [1959] [2]p. [AF 61(514)1178]   Unclassified

Published in EEG Clin. Neurolophysiol., v. 11: 819-820, 1959.

Consideration is given to the use of differential (push/pull) amplifiers for phase or time comparison of periodic functions and possible misinterpretation of the results.

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Burden Neurological Inst. [Physiological Dept.] Bristol (Gt. Brit.).

INTRINSIC RHYTHMS OF THE BRAIN, by W. G. Walter. [1959] [20]p. incl. illus. diagrs. refs. [AF 61-(514)1178]   Unclassified

Published in Handbook of Physiol., v. 1: 279-298, 1959.

The main sources of rhythmic activity are illustrated by 2 simple mechanical models and their electric equivalents: (1) a pendulum, illustrating simple harmonic oscillation, and (2) the autosiphon, an elementary example of relaxation oscillation. Alpha rhythms are the most prominent and peculiar features of human brain activity and are considered representative of rhythmic activity under normal conditions. Their appearance in normal people is usually suggestive of intrinsic complexity. It is generally true that the amplitude of spontaneous rhythms in the alpha category is inversely correlated with visual attention. The acceptable frequency range is 8-13 cps. Experiments with a toposcope

display system, used to record the effect of mental activity on alpha frequency and distribution in a normal subject, demonstrated that alpha activity exhibits extreme constancy in frequency under tranquil conditions, but during activity, there is a marked independence of the hemispheres of the brain and of adjacent regions. Discussion is presented on 3 other main classes of rhythm: (1) theta rhythms, with a frequency of 4-7 cps, occupying typically the parietal and temporal regions of the brain, and associated with childhood and emotional stress in some adults; (2) delta rhythms, with frequencies from less than 1 up to 3? cps, associated with deep sleep in normal adults, with infancy, and with organic brain disease; and (3) beta rhythms, with frequencies higher than 14 cps, generally associated with activation and tension.

133

Burden Neurological Inst. [Physiological Dept.] Bristol (Gt. Brit.).

A SIMPLE ELECTRODE SELECTOR SYSTEM. by R. Cooper and W. J. Warren. [1959] [2]p. [AF 61(514)-1178] Unclassified

Published in EEG Clin. Neurophysiol. v. 11: 810-811, 1959.

A description is presented of an electrode selector system which can be used for connecting a selection from 88 electrodes to any of 30 differential amplifiers either bipolar fashion or with respect to the average potential of all electrodes. Provision is also made for connection to and from transducers so that polygraphic recording of autonomic variables can be made.

134

Bureau of Mines, Bartlesville, Okla.

THE PRESSURE-VOLUME-TEMPERATURE PROPER-TIES OF PERFLUOROCYCLOBUTANE. EQUATIONS OF STATE, VIRIAL COEFFICIENTS, AND INTER-MOLECULAR POTENTIAL ENERGY FUNCTIONS, by D. R. Douslin, R. T. Moore, and G. Waddington. May 1959 [30]p. incl. diagrs. tables, refs. (Contribution no. 90) (AFOSR-TN-59-493) (CSO-680-57-4) AD 215846 Unclassified

Also published in Jour. Phys. Chem., v. 63: 1959-1966, Nov. 1959.

Studies of the pressure-volume-temperature properties of perfluorocyclobutane in the ranges, 3-394 atm, 30-350°, yielded values of gas compressibility, critical constants, vapor pressure and orthobaric liquid and vapor densities. The results were correlated by the Beattie-Bridgeman, Benedict-Webb-Rubin, and Martin-Hou equations of state, and by the Stockmayer and the Kihara intermolecular potential energy functions. The merits of the several correlational methods are discussed.

135

Bureau of Mines, Bartlesville, Okla.

PVT AND COMBUSTION STUDIES ON FLUOROCAR-BONS, by D. R. Douslin, W. D. Good and others. Final rept. Dec. 1, 1958-Mar. 1, 1959. Mar. 31, 1959, 22p. incl. tables, refs. (AFOSR-TR-59-42) (CSO-680-57 4) AD 214510 Unclassified

In this report the accomplishments of the project are summarized, and their significance discussed. Also, some of the areas in which future work on the thermodynamic properties of organic fluorine compounds would be most beneficial are outlined.

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Bureau of Mines, Bartlesville, Okla.

COMBUSTION CALORIMETRY. I. ORGANIC FLUOR-INE COMPOUNDS, by W. D. Good and D. W. Scott. Aug. 3, 1959. 34p. incl. diagrs. tables, refs. [CSO-680-59-9] AD 219968; PB 146580 Unclassified

The contents of this technical note are to appear as a chapter in the book "Experimental Thermochemistry, Vol. II," being prepared under auspices of the Sub-Commission on Experimental Thermochemistry of the International Union of Pure and Applied Chemistry. The combustion calorimetry of organic fluorine compounds is discussed, and experimental procedures are recommended. A computation form is given for reducing the experimental results to standard states. Also discussed are factors influencing accuracy, choice of reference substances, and publication of results. (Contractor's abstract)

137

Bureau of Mines, Bartlesville, Okla.

COMBUSTION CALORIMETRY. II. ORGANO-METAL-LIC COMPOUNDS, by W. D. Good and D. W. Scott. Aug. 3, 1959, 30p. incl. tables, refs. (AFOSR-TN-59-699) [CSO-680-59-9] AD 219970; PB 146601 Unclassified

The contents of this technical note are to appear as a chapter in the book "Experimental Thermochemistry, Vol. II," being prepared under auspices of the Sub-Commission on Experimental Thermochemistry of the International Union of Pure and Applied Chemistry. The combustion calorimetry of organometallic compounds and other carbon compounds of metals is discussed. References are given to past work in the field. Limitations of static-bomb methods and advantages of rotating-bomb methods are pointed out. Other topics treated are: Corrections to standard states; comparison experiments; materials for the bomb, fittings and crucible; containers for samples; problem of complete combustion; and publication of results.

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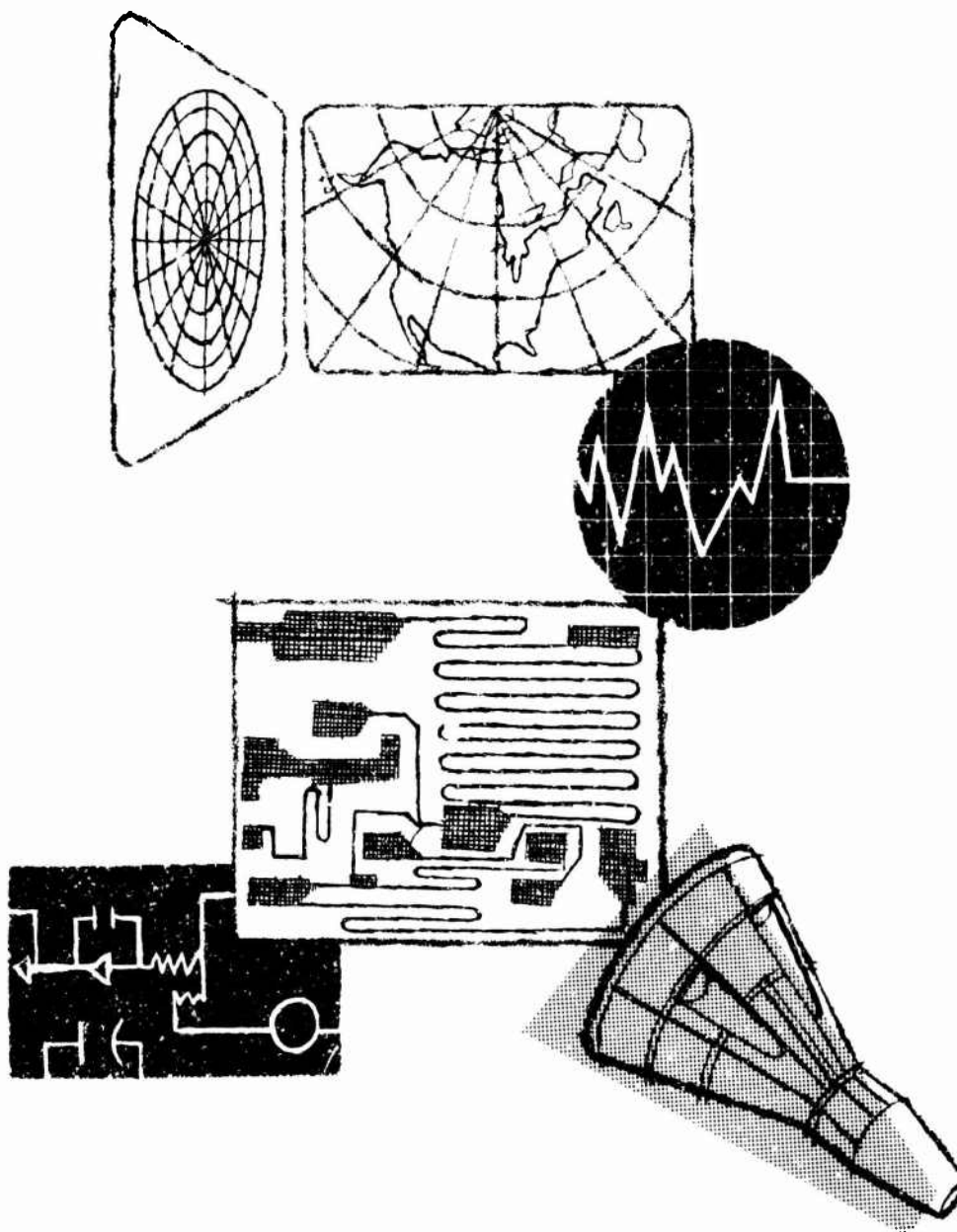
[Bureau of Mines, Pittsburgh, Pa.]

TURBULENT FLAME PROPAGATION BY LARGE-
SCALE WRINKLING OF A LAMINAR FLAME FRONT,
by J. K. Richmond, J. Grumer, and D. S. Burgess.
[1959] [6]p. incl. illus. diagrs. (CSO-680-58-10)
Unclassified

Published in Seventh Symposium (Internat'l.) on Com-

bustion, Oxford U., London (Gt. Brit.) (Aug. 28-Sept.
3, 1958), London, Butterworths Scientific Publications,
1959, p. 615-620.

Photometric and electronic probe studies were made of
wrinkled laminar flames in the wake zone of a 1-1/4 in.
diam burner rim. The salient characteristics of the
flames are summarized, including flame structure, spa-
tial distribution and average levels of flame radiation,
and turbulent burning velocities.

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California Inst. of Tech. [Antenna Lab.] Pasadena.

ELECTROSTATIC ION-OSCILLATIONS OF A HIGH-DENSITY PLASMA, by H. T. Ozaki and C. H. Papas. [1959] 11p. (AFOSR-TN-59-233) [AF 18(600)1113] AD 212003   Unclassified

The positive-ion oscillation of a high-density plasma excited by an injected ion are examined under the assumptions that the plasma ions constitute an electrically charged fluid and that the plasma electrons at each instant have the equilibrium distribution in the electrostatic potential due to the electrical charge of the fluid, the electrons, and the injected ion. A dispersion relation for the electro-acoustic waves is derived, and the spatial rate of decrease of the kinetic energy of an injected ion is calculated. (Contractor's abstract)

140

California Inst. of Tech. Antenna Lab., Pasadena.

ASYMMETRICALLY EXCITED ELECTROMAGNETIC RADIATION FROM CIRCULAR CYLINDERS OF FINITE LENGTH AND PROLATE SPHEROIDS, by H. H. Kuehl. June 1959, 113p. incl. illus. diagrs. refs. (Technical rept. no. 19) (AFOSR-TN-59-595) (AF 18(600)1113) AD 217182   Unclassified

The far zone radiation from 2 types of asymmetrically excited systems is considered. The 1st is a finite cylinder excited by an electric dipole in the radial direction near the cylinder. The 2nd is a prolate spheroid excited by a narrow belt of electric field around the surface of the spheroid. In both cases the body considered is perfectly conducting and the excitation is not necessarily centered at the midplane of the body. In the case of the finite cylinder excited by a radial dipole, an approximate method is used in which the current on the finite cylinder is taken to be identical with the current which would exist on an infinite cylinder under the same excitation. This approximation is shown to be valid analytically and experimentally if the cylinder is not short. The analytic and experimental results are compared for 2 cylinder lengths. The turnstile antenna mounted on a finite cylinder is considered analytically, and the modification of the radiation by the cylinder is exhibited. In the case of the prolate spheroid excited by a narrow belt of electric field, experimental results are compared to analytic expressions. (Contractor's abstract)

141

California Inst. of Tech. Antenna Lab., Pasadena.

SPATIAL DISTRIBUTION OF THERMAL RADIATION AT MICROWAVE FREQUENCIES, by N. George. June 1959, 138p. incl. illus. diagrs. tables, refs. (Technical rept. no. 18) (AFOSR-TN-59-598) (AF 18(600)1113) AD 217179   Unclassified

Theoretical and experimental radiation patterns are given in spectral form for the thermal radiation from thin slots or heated wires having dimensions of the order of the comparison wavelength. Maxwell's equations and noise theory from the basis of the analyses in which 3 independent methods are used to predict a spatial distribution which exhibits interference min and max. In the 1st method, the wave equation is solved for a noise-excited transmission which is suddenly short- and open-circuited at alternate ends. By a study of the trapped noise currents, it is found that radiation pattern has an interference structure which is smoothed as the loss is increased. Secondly, a formula is derived for the radiation pattern of a heated wire by a computation of its absorption in an isothermal enclosure and by an application of the principle of detailed balancing. Finally, the pattern of a long thin slot is computed directly using the Leontovich-Rytov distributed source generalization of Nyquist's noise formula. Fraunhofer pattern measurements are taken for a thin slot excited by a gaseous discharge at $10,100 \pm 200°K$. The pattern measuring apparatus is a Dicke radiometer. (Contractor's abstract)

142

[California Inst. of Tech. Antenna Lab. Pasadena].

TRANSIENTS ON A LINEAR ANTENNA, by G. G. Weill. Aug. 1959 [17]p. incl. diagrs. (Technical rept. no. 20) (AFOSR-TN-59-791) (AF 18(600)1113) AD 225003; PB 143158   Unclassified

Transmission is made on a lossless line of finite length with a wave front propagating with a velocity $\alpha = 1/\sqrt{LC}$ which reflects itself with a change in sign. The transmission line equations are given and the steady state obtained for $t = 21/\alpha$. Diagrams are provided to illustrate directions of the field intensity.

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California Inst. of Tech. Antenna Lab., Pasadena.

RADIATION PATTERNS OF THE NOISE EMISSION FROM A GASEOUS DISCHARGE, by N. George [1959] 29p. incl. diagrs. refs. (Technical rept. no. 22) (AFOSR-TN-59-1101) (AF 18(600)1113) AD 229974; PB 145320   Unclassified

Theoretical and experimental radiation patterns are given in spectral form for the thermal radiation from a cylindrical discharge column which is adjacent to a long thin slot in a metallic plane. A spatial distribution is predicted which exhibits interference minima and maxima when the length of the slot and wavelength of the emission are the same order of magnitude. Fraunhofer pattern measurements are presented in which an Ar source is used to excite the slots of 7.3π and 9.5π radians in length. Data are also presented to show the effects of variations in the pressure and the dc current of the discharge. An interference phenomenon is predicted by the theory and demonstrated by an

experiment, even though the source excitation is spatially distributed and essentially uncorrelated in time and in space. (Contractor's abstract)

144

California Inst. of Tech. Antenna Lab., Pasadena.

A NOTE ON CURRENTS ON A QUADRATIC SURFACE, by G. G. Weill. [1959] 7p. incl. diagr. (Technical rept. no. 21) (AFOSR-TN-59-1102) (AF 18(600)-1113) AD 229970; PB 145319   Unclassified

No explicit general solution is known for the vector integral equation satisfied by the current density vector on a conducting surface. The vector equation is shown to be scalarized in the case of a quadratic conducting surface. (Contractor's abstract)

145

California Inst. of Tech. Antenna Lab., Pasadena.

CURRENT ON AN INFINITELY LONG CYLINDRICAL ANTENNA, by H. H. Kuehl. [1959] [9]p. incl. diagrs. (Technical rept. no. 23) (AFOSR-TN-59-1168) (AF 18-(600)1113) AD 229794; PB 145316   Unclassified

The infinitely long circular cylindrical antenna driven at some cross section by a localized electromotive force, V, circumscribing the cylinder in a peripheral band is considered. The asymptotic expression for the current at large distances from the driving emf is derived using the saddle point method. It is shown that the amplitude of this current is proportional to the reciprocal of the logarithm of axial distance from the driving emf. (Contractor's abstract)

146

California Inst. of Tech. Dept. of Electrical Engineering, Pasadena.

A NEW TRANSMITTING ANTENNA SYSTEM FOR VERY LOW RADIO FREQUENCIES, by W. Van Tuyl Rusch. June 26, 1959, 162p. incl. illus. diagrs. tables, refs. (Technical rept. no. 4) (AFOSR-TN-59-582) (AF 18(600)1552) AD 217029; PB 142988
                                                         Unclassified

A system is presented which employs resonant loading circuits to convert a section of an existing power line into a horizontal very-low-frequency transmitting antenna. The simplicity, low cost, and useful radiation pattern of this horizontal antenna are well suited for many experimental applications. The theoretical antenna problem was solved using a normal mode expansion of the current distribution. A matrix method was developed to compute the current distribution of a thin, linear antenna loaded with lumped-circuit elements, using a digital computer. The series was found to

converge relatively fast. Results were obtained for a full-wave linear antenna symmetrically loaded with real impedances Z_o, one half-wavelength apart. Current distributions, feedpoint impedances, radiation patterns, etc., were presented as functions of Z_o. Results of the idealized problem were applied to the powerline antenna. The matrix method can also be extended to the general linear antenna with any type of loading or feeding. System components, performance, and the 8.4 kc propagation experiments of the Dinkey Creek power-line antenna are described. The problem of interference with nearby audiofrequency communication systems is examined. The series of whistler-mode propagations to probe the exosphere was not completed. However, ionospheric soundings yielded considerable information about the properties of the ionosphere at very low frequency.

147

California Inst. of Tech. Dept. of Electrical Engineering, Pasadena.

EXPERIMENTS IN VERY LOW-FREQUENCY RADIO PROPAGATION, by R. M. Golden. June 26, 1959, 124p. incl. illus. diagrs. refs. (Technical rept. no. 5) (AFOSR-TN-59-583) (AF 18(600)1552) AD 217030; PB 142987   Unclassified

In an effort to extend experimentally determined data on the characteristics of very-low-frequency radio waves, a VLF transmitting station (8.4 kc) was established at Shaver Lake, Calif. This station permitted controlled experiments in long distance propagation, ionospheric vertical sounding measurements, and attempts at the generation of round trip gyroelectric-echoes. The long distance measurements indicated that at VLF, the ground or surface wave radiated by the antenna can be detected at great distances. The ionospheric vertical incidence measurements showed rapid fading of the received signal around localsunrise and sunset. Propagation in the presence of the ionosphere is considered in the theoretical form of propagation in a homogeneous gyroelectric medium. An examination of the natural phenomena of whistlers is presented in order to determine the feasibility of generating gyro-electric-echoes. Reflection and transmission coefficients are presented for vertical incidence in order to ascertain the order of magnitude of such an echo.

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California Inst. of Tech. [Dept. of Electrical Engineering] Pasadena.

A NEW VERY LOW-FREQUENCY CW TRANSMITTER FOR IONOSPHERIC INVESTIGATION-KM2X1X, by R. M. Golden, R. V. Langmuir and others. [1959] [1]p. incl. diagr. (AF 18(600)1552)   Unclassified

Also published in Proc. Inst. Radio Engineers. v 47: 1381, Aug. 1959.

Announcement is made of preliminary results of a recently completed VLF transmitting station at Shaver Lake, Calif. An 8-mile section of a power line makes up the antenna. A strong signal can be detected at a distance of 250 km. Strong fading occurs in the late afternoon until sunset and at approximately sunrise.

149

California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

[EXPANSION PROCEDURE AND SIMILARITY LAWS FOR TRANSONIC FLOW], by J. D. Cole. Final rept. Aug. 11, 1959 [2]p. (AFOSR-TR-59-118) (AF 18(600)-383)   Unclassified

The results of work done under this contract are summarized. The most important of these are: (1) A better understanding of the physical basis of transonic flow, gained by a study of unsteady effects. (2) A reasonable mathematical basis for the derivation of the transonic approximation, achieved by a systematic use of expansion procedures. (3) Fundamental studies which led to a practical method of pressure distribution and drag estimation at $M_\infty = 1$.

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California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

MAGNETOHYDRODYNAMIC WAVES, by J. D. Cole. [1959] [20]p. incl. diagrs. (AF 18(600)383)
Unclassified

Published in Proc. Third Symposium on Magnetohydrodynamics, Lockheed Research Lab., Palo Alto, Calif. (Nov. 21-22, 1958), Stanford, Stanford U. Press, 1959, p. 17-36.

This is a study of some special magnetohydrodynamic waves and their connection with the methods of their production, that is, the boundary conditions. Possible wave motions of a fluid form the underlying structure of the mathematical description. There is some evidence that these waves can be produced in the lab and may occur in nature. These waves occur in an ordinary gas dynamic fluid endowed with a scalar electrical conductivity. In practice, there is a fairly direct application to slightly ionized gases and conducting liquids. However, the general method of approach also applies to fully ionized plasmas described by continuum equations.

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California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

SMALL ASPECT RATIO MEMBRANE FLUTTER, by R. Stearman. Dec. 1958. 46p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-45) (AF 49(638)220) AD 209416   Unclassified

An experimental investigation was undertaken on the flutter of small aspect ratio rectangular membranes in a subsonic flow. The leading and trailing edges of the membrane were restrained from vertical movement while the other two edges were free. Both surfaces of the membrane were exposed to the airstream, and the membrane tension was applied through the trailing edge. The results of the test show that two types of flutter occur. The first to appear as the wind speed was increased from zero, with a fixed tension level in the membrane, was a small amplitude flutter which had a shallow wave like motion traveling in the streamwise direction. At higher wind speeds this motion was damped out. A narrow equilibrium zone or boundary existed which separated the first type of flutter from a second type of motion having a traveling wave of larger amplitude and greater speed. This second type of flutter had no tendency to damp out, but became more violent as the wind speed was increased. The span of the slender membrane is the physical parameter that uniquely determines and controls the first flutter boundary; its mass plays no part here, but does affect the equilibrium zones. Appendix A contains an obvious formulation of the slender membrane flutter problem. (Contractor's abstract)

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California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

MAGNETOHYDRODYNAMIC WAVES, by J. D. Cole. Jan. 1959, 28p. incl. diagrs. (AFOSR-TN-59-13) (AF 49(638)476) AD 208594; PB 140153
Unclassified

Special magnetohydrodynamic waves and the boundary conditions under which they are produced are studied. Possible wave motions of a fluid form the underlying structure of the mathematical description. The magnetohydrodynamic approximation used is the conventional one in that displacement currents are neglected. Shock waves in an infinitely conducting fluid are studied by means of an idealized piston problem. Switch-on waves are shown to be associated with the discharge of a current sheet. The effect of finite conductivity is studied for both ordinary and switch-on waves. Diffusal of current sheets about the wave front are shown. The effects of nonlinearity are discussed qualitatively.

153

California Inst. of Tech. Guggenheim Aeronautical Lab.,
Pasadena.

A SHALLOW-LIQUID THEORY IN MAGNETOHYDRO-
DYNAMICS, by L. E. Fraenkel. June 1959, 74p. incl.
diagrs. refs. (AFOSR-TN-59-563) (AF 49(638)476)
AD 216758; PB 145299   Unclassified

The nonlinear and linear shallow-water theories, which
describe long gravity waves on the free surface of an
inviscid liquid, are extended to the case of an electri-
cally conducting liquid on a horizontal bottom, in the
presence of a vertical magnetic field. The dish holding
the liquid, and the medium outside it, are assumed to
be non-conducting. The approximate equations are based
on a small ratio of depth to wavelength, on the proper-
ties of mercury, and on a moderate magnetic field
strength. These equations have a magneto-hydraulic
character, for in the shallow liquid layer the horizontal
fluid velocity and current density are independent of
the vertical coordinate. Some explicit solutions of the
linear equations are obtained for plane flows and for
axi-symmetric flows in which the velocity vector lies
in a vertical, meridianal plane. (Contractor's
abstract)

154

California Inst. of Tech. Guggenheim Aeronautical Lab.,
Pasadena.

MAGNETOHYDRODYNAMIC SIMPLE WAVES, by J.
D. Cole and Y. M. Lynn. Dec. 1959, 51p. incl. diagrs.
table. (AFOSR-TN-59-1302) (AF 49(638)476)
AD 234739; PB 148688   Unclassified

The simple wave solutions, which in ordinary gas dy-
namics correspond to expansion flows or Prandtl-
Meyer flows are generalized here to ideal magnetohy-
drodynamic flows. The 1-dimensional unsteady (x,t)
case is considered. Due to magnetic effects more than
1 component of field and velocity must be considered.
To carry out the simple wave formalism the equations
of motion (continuity, momentum, induction) are written
in terms of flow velocities (u_1, u_2). Alfvén velocities
(b_1, b_2) and sound speed (a). These velocities are then
functions only of the phase $\xi = x_1 - U(\xi)t$; each phase
line can be thought of as an infinitesimal wave propagat-
ing with a speed $c = U - u_1$ related to the flow. By
elimination of (u_1, u_2) the system of 5 1st-order ordi-
nary differential equations can be reduced to 3 (homogen-
eous) equations. The vanishing of the determinant of
coefficients provides a famous relation for wave speed
c and reduces the problem to integration of 2 1st-order
equations. The further introduction of dimensionless
variables, ratios of wave speeds, reduces the problem
to integration of a single 1st-order equation. By study-
ing the trajectories of this differential equation an

overall view of all possible solutions is obtained; nu-
merical integration is also carried out in the case of
slow waves. (Contractor's abstract)

155

California Inst. of Tech. Guggenheim Aeronautical Lab.,
Pasadena.

MAGNETOHYDRODYNAMIC SIMPLE WAVES (SUPPLE-
MENT), by Y. M. Lynn. [May 1960] [25]p. (AFOSR-
TN-59-1302, suppl.) (AF 49(638)476) PB 148929
                                        Unclassified

As a supplement to a previous report (item no. 154,
Vol. III) an exact analytic solution of the simple wave
problem is presented, as well as some further compu-
tations of integral curves for fast waves. (Contractor's
abstract)

156

California Inst. of Tech. Guggenheim Jet Propulsion
Center, Pasadena.

PART I. EMISSION OF DIFFUSE BANDS OF SODIUM
BEHIND SHOCK FRONTS, by H. Takeyama and A.
Guttman. PART II. MOLECULE FORMATION IN IN-
ERT GASES, by A. Guttman. Aug. 1959, 20p. incl.
illus. diagrs. tables, refs. (Technical rept. no. 10)
(AF 18(603)2) AD 225671; PB 143522   Unclassified

Part I also published in Jour. Chem. Phys., v. 32:
634-635, Feb. 1960.

Part I. A diffuse emission band, centered near the
resonance lines of sodium and attributed to van der
Waals molecules Na_2, has been observed in a shock
tube. A small quantity of finely-ground sodium salt
(e.g., NaCl, NaBr, or Na_2CO_3) was placed at the end
of the low-pressure section of a shock tube containing
an Ar atmosphere. Spectra were recorded photograph-
ically with a 1.5-m grating spectrograph. Part II.
Microwave absorption spectra on inert gases (He, Ne,
Ar, Kr, and Xe) or inert gas mixtures at low tempera-
tures can probably be used to determine the interaction
parameters required for the calculation of transport
properties. This conclusion is reached from a study of
predicted molecular spectra based on a determination
of the Morse interaction potential through a 2nd-order
fit to the known Lennard-Jones potential. (Contractor's
abstract)

157

California Inst. of Tech. Guggenheim Jet Propulsion
Center, Pasadena.

INTERACTION OF ELECTROMAGNETIC WAVES
WITH IONIZED GASES, by R. G. John. Aug. 1959,

44p. incl. diagrs. tables. (Technical rept. no. 9)
(AFOSR-TN-59-911) (AF 18(603)2) AD 226365;
PB 144221   Unclassified

Possibilities are explored with regard to the use of
microwaves as probes to study ionized gas flows. The
case is studied where the propagating waves are dis-
turbed by the gas, rather than the gas being disturbed
by the wave field. The distinction is mainly implicit in
the strength of the impressed signal, and, to a certain
extent, in the free charge and total particle densities.
Waves of small amplitude are considered; therefore,
no component of the gas other than the electrons, both
free and bound, is significantly disturbed. As such, the
treatment is relevant to such problems as the study of
the characteristics of ionized gases by microwave
probes, and the problems of electromagnetic communi-
cation into and through ionized gas layers. Throughout,
the approach is one which starts from the basic field
relations and at every opportunity takes the simplest
alternatives consistent with physical experience, while
attempting to demonstrate the salient features of the in-
teraction with a minimum of mathematical encumbrance.

158

California Inst. of Tech. Guggenheim Jet Propulsion
Center, Pasadena.

THEORY OF THROUGHFLOW IN AXIAL TURBOMA-
CHINES WITH VARIABLE WALL GEOMETRY, by G. C.
Oates. Aug. 1959, 124p. incl. diagrs. refs. (Technical
note no. 1) (AFOSR-TN-59-680) (AF 49(638)497)
                                              Unclassified

The theory of 3-dimensional flow in axial turboma-
chines was extended to include the effects of variable
hub and tip radii such as occur in the entrance stages
of conventional axial flow compressors and, to a larger
extent, in mixed flow compressors. The problem is
simplified by assuming an infinite number of infinitely
thin blades in each blade row, so that axially symmetric
fluid motion results. The effect of variable hub and tip
radii of the annulus walls is investigated when the tan-
gential velocities are small but arbitrary, and when they
are large but of special form. The combined effect of
heavily loaded inlet guide vanes and variable hub radius
is also investigated for the case in which the inlet guide
vanes impart a motion very nearly of the solid-body type.
The boundary conditions for the variable hub radius re-
quire linearization, thus restricting the magnitude of
perturbation to be induced by the wall. Finally, the ef-
fect of a loaded blade row placed behind the inlet guide
vane is determined. The local axial and tangential ve-
locities induced by the variable wall radius were found
to be of the same general magnitude as the velocities
induced by a normal rotor or stator blade row. Al-
though the forms of the solutions are somewhat complex
for routine application in turbomachine design, a suffi-
ciently simple approximate result is obtained for one
case and it is indicated how the method of approximation
may be extended. (Contractor's abstract)

159

California Inst. of Tech. Palomar Observatory, Pasadena.

DIRECT RADIATIVE CAPTURE OF PROTONS BY O^{16}
AND Ne^{20}, by N. Tanner. Dec. 1958 [5]p. incl. diagrs.
table, refs. (AFOSR-TN-59-27) (Sponsored jointly by
Air Force Office of Scientific Research under [AF 49-
(638)21], Atomic Energy Commission, and Office of
Naval Research) AD 208870   Unclassified

Also published in Phys. Rev., v. 114: 1060-1064, May 15,
1959.

A study has been made of the $O^{16}(p,\gamma)Na^{21}$ reactions
by counting the positron activities of F^{17} and Na^{21}
following proton bombardment of oxygen and neon tar-
gets. The $O^{16}(p,\gamma)F^{17}$ cross section was measured at
a proton bombarding energy of 616 kev to be 0.29 ± 0.03
microbarn and the $Ne^{20}(p,\gamma)Na^{21}$ cross section was
measured at 1100 kev to be 1.3 ± 0.7 microbarns. These
cross sections are consistent with the reaction process
in each case being one of direct radiative capture. In
addition, the energy dependence of the $O^{16}(p,\gamma)F^{17}$ cross
section from 275 kev to 616 kev was also consistent with
the direct-capture hypothesis. Both of these reactions
are believed to be important at the thermal energies
effective in stars. For such energies the cross-section
parameter S_0 was estimated to be $S_0 = 5 ± 1$ kev-barns
for $O^{16}(p,\gamma)F^{17}$, and $S_0 \sim 80$ kev-barns for $Ne^{20}(p,\gamma)Na^{21}$.
(Contractor's abstract)

160

California Inst. of Tech. Palomar Observatory, Pasadena.

THE SPECTRUM OF THE IRREGULAR VARIABLE VY
CANIS MAJORIS, by G. Wallerstein. [1959] [6]p. incl.
tables. (AFOSR-TN-59-63) (In cooperation with Mount
Wilson Observatory, Pasadena, Calif.) [AF 49(638)21]
AD 234114   Unclassified

Also published in Astronom. Soc. Pacific, v. 70: 479-
484, Oct. 1958.

VY Canis Majoris is a multiple star immersed in nebu-
losity. From the strength of the TiO bands in recent
spectrog ams the bright close pair is classed as M5.
No emission lines were observed in the blue region, and
Hα was not present either in emission or absorption.
In the yellow and red regions, however, the D lines of
Na, the resonance lines of K at 7665 and 7699A, and the
Ca line at 6573A were present in emission. This is be-
lieved to be the first star repo ed to show emission
lines of K. The relative intensities of these emission
lines indicate that the Na and Ca emissions do not origi-
nate in the same stellar regions. The temperature in the
star atmosphere is estimated to be about 1000°K and the
electron density between 10^9 and 10^{13} electrons/cm^3.

161

California Inst. of Tech. Palomar Observatory, Pasadena.

THE BRIGHTEST MAIN SEQUENCE STAR IN M 67, by
G. Wallerstein. [1959] [4]p. incl. table, refs. (AFOSR-
TN-59-658) (In cooperation with Mount Wilson Observ-
atory, Pasadena, Calif.) (AF 49(638)21) AD 234113
Unclassified

Presented at meeting of the Astronom. Soc. Pacific,
San Francisco, Calif., June 1959.

Also published in Astronom. Soc. Pacific, v. 71: 451-
454, Oct. 1959.

The brightest main sequence star in M 67 is a normal
B8 star showing moderate rotation. Both its observed
rotation, and its effective gravity as inferred from the
equivalent width of Hν, point to the conclusion that the
star has not reached its present position in the color-
magnitude diagram by evolution from the turn-off point
of the unevolved main sequence. Its origin is therefore
completely unexplained. (Contractor's abstract)

162

California Inst. of Tech. Palomar Observatory, Pasadena.

CONTINUUM COLORS OF THE SUN, ξ PEGASI, AND
HD 19445 AS RELATED TO THE POSITION OF THE
METAL-POOR STARS IN THE COLOR-MAGNITUDE
AND TWO-COLOR DIAGRAMS, by E. M. Burbidge,
G. R. Burbidge and others. [1959] [9]p. incl. tables,
refs. (AFOSR-TN-59-860) (In cooperation with Mount
Wilson Observatory, Pasadena, Calif.) (AF 49(638)21)
AD 240633 Unclassified

Also published in Mem. Soc. Roy. Sci. Liege, v. 3: 427-
435, 1960.

The high-velocity, metal-poor, stars in general tend to
lie 1 - 1½ mag below the normal main sequence when
they are plotted in a color-magnitude diagram (M_v vs

B - V). Their spectral types, classified from low-
dispersion spectra, also place them somewhat below
the normal main sequence in the Hertzsprung-Russell
diagram. Thus these stars have commonly been called
"subdwarfs". In the present study, the metal-poor star
HD 19445, ξ Peg, and the sun are compared in order to
ascertain to what extent the ultra-violet excess of HD
19445 can be accounted for by the weakness of its me-
tallic lines. From the results it was concluded that
the name "subdwarfs" for the high-velocity metal-poor
stars is a misnomer unless it is specified that they de-
part from the normal main sequence only in the color-
magnitude plane. In the log T_e-M_{bol} plane and in the

H-R diagram there is no measurable difference be-
tween the positions of these stars and the normal main

sequence. The ultra-violet excess of HD 19445, when
plotted in a 2-color diagram, can be wholly accounted
for by the effect of different line blanketing on the meas-
ured colors.

163

California Inst. of Tech. Palomar Observatory, Pasadena.

THE ABUNDANCE OF LITHIUM IN T TAURI STARS
AND RELATED OBJECTS, by W. K. Bonsack and J. L.
Greenstein. [1959] [16]p. incl. illus. diagrs. tables,
refs. (AFOSR-TN-59-861) (In cooperation with Mount
Wilson Observatory, Pasadena, Calif.) (AF 49(638)21)
AD 240634 Unclassified

Also published in Astrophys. Jour., v. 131: 83-98, Jan.
1960.

Spectrograms of 4 T Tauri stars involved in nebulosity
and 8 stars possibly similar in some respects to T Tauri
stars have been examined for the presence of the reso-
nance doublet of Li I at λ 6708. A very strong feature
at this wave length was found in the spectra of the 4 T
Tauri stars and of SU Aur, which differs from Herbig's
definition of the T Tauri class only in having a somewhat
higher spectroscopic luminosity. Spectrophotometric
analysis showed that the lithium/metals ratio in these
5 stars exceeds the solar ratio by a factor of 100 and
approx equals the terrestrial value. No Li I was de-
tected in the other 7 stars; except for the few hot stars
included, these cannot then have lithium/metals ratios
much in excess of the solar value. These results sug-
gest that young stars have approx 1 lithium atom per

10^9 hydrogen atoms, at least in their atmospheres.
Primary cosmic rays appear to be incapable of con-
taminating the interstellar medium, and then the entire
protostar, with this amount of lithium. However, if a
sufficiently efficient mechanism for the production of
lithium at the surface of a star can be found, this result
can be accomplished without the appearance of a large
fraction of the star's energy as high-energy surface
phenomena. The magnetic energy content of a protostar
is sufficiently large that, if forced to the surface during
the contraction and there dissipated in accelerating pro-
tons, the quantity of lithium required by the observations
can be formed by spallation reactions in the atmosphere.
(Contractor's abstract)

164

California Inst. of Tech. Palomar Observatory, Pasadena.

ASTROPHYSICAL RESEARCH IN SPACE, by J. L.
Greenstein. Sept. 21, 1959, 14p. (Special technical
rept. no. 2) (AFOSR-TN-59-907) (In cooperation with
Mount Wilson Observatory, Pasadena, Calif.) (AF 49-
(638)21) AD 226328 Unclassified

Also published in Fourth Ballistic Missile and Space Tech. Symposium, California U., Los Angeles (Aug. 24-27, 1959), New York, Pergamon Press, v. 1: 27-32, 1961.

Astronomers are seriously hampered in their studies by the atmosphere. Research from earth satellites can be carried on at heights such that most of these difficulties are overcome. A major portion of most astrophysical research can be carried out from large satellites at heights above 500 km. Upper atmosphere geophysics will be supplemented by astrophysics above the atmosphere. The problems of an orbiting telescope are discussed, but there seems little reason to go above 500 km. The earth's magnetic and electric fields, the ionosphere, the density, composition, and temperature of the atmosphere can be studied below this height. Low-resolution cloud mapping, the infrared albedo of the earth and other meteorological studies can be carried out at ordinary satellite heights. Higher altitudes, probably 1000 to 15,000 km, are needed for the study of upper air heating, the Van Allen belts, the cosmic ray albedo and the cosmic ray primaries. A discussion is presented regarding the height at which the earth and its influence are left and interplanetary space is entered.

165

California Inst. of Tech. Palomar Observatory, Pasadena.

THE RADIAL VELOCITY OF SIGMA ORIONIS E, by G. Wallerstein. July 1959, 2p. incl. table. (AFOSR-TN-59-930) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 228276 Unclassified

Also published in Astrophys. Jour., v. 130: 338-339, July 1959.

Observations were made of the star σ Orionis E with a 60-in. Cassegrain spectrograph and a 4-in. camera giving a dispersion of 80 A/mm. Results of these observations are given. It is concluded that σ Orionis E differs from β Canis Majoris stars in 3 respects: (1) Its lines are broadened by rapid rotation; (2) its absolute magnitude is lower; and (3) it has abnormally strong helium lines.

166

California Inst. of Tech. Palomar Observatory, Pasadena.

ON A REVISED TABLE OF ABUNDANCES OF THE ELEMENTS BY A. G. W. Cameron, by G. R. Burbidge. [1959] 5p. (AFOSR-TN-59-1063) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49-(638)21) AD 245962 Unclassified

Also published in Astrophys. Jour., v. 131: 519-521, Mar. 1960.

An argument is presented that A. G. W. Cameron in a recent paper (Astrophys. Jour., v. 129: 676-719, May 1959) assumes that observable results, wher they disagree with theoretical expectations, can be adjusted to agree with the theory. It is pointed out that existing knowlege is, at this time, insufficient for this type of practice. It is indicated that Cameron has a very different model of the supernova process in which the r- and the p-process occur than that given in the fundamental abundance table. He also uses a different neutron source for the s-process. It is further pointed out that the use of theoretical expressions and smoothing of cross-sections is handled in a not usually accepted manner. Finally it is claimed that Cameron neglects the use of all astrophysical arguments in his presentation.

167

California Inst. of Tech. Palomar Observatory, Pasadena.

ABUNDANCES IN SOME POPULATION II K GIANTS, by H. L. Helfer, G. Wallerstein, and J. L. Greenstein. [1959] [21]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-1064) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 228274 Unclassified

Also published in Astrophys. Jour., v. 129: 700-719, May 1959.

Curve-of-growth analyses have been performed for 4 K giant stars, 2 in globular clusters, M13 and M92; a high-velocity star, HDE 232078; and a galactic cluster star (M41). The 3 population II stars show extreme metal deficiencies, the hydrogen/metal ratio being conservatively a factor of 20-100 times greater than in the solar case. The anomaly may be greater by still another factor of 10. The analysis of the galactic cluster star is more uncertain, but, within experimental error, it possesses the solar value of hydrogen/metals. Abundances of various elements relative to iron are derived. In all the stars, these are generally within a factor of 5 of the solar values. An examination of these abundances in the light of the recent compilation of nucleogenesis mechanisms by Burbidge, Burbidge, Fowler, and Hoyle (Rev. Modern Phys., v. 29: 547-650, Oct. 1957) suggests that the e-process probably, and the s-process possibly, may need some modification. (Contractor's abstract)

168

California Inst. of Tech. Palomar Observatory, Pasadena.

THE PERSISTENCE OF SPIRAL STRUCTURE, by K. H. Prendergast and G. R. Burbidge. [1960] [4]p. incl. table, refs. (AFOSR-TN-59-1066) (In cooperation with Yerkes Observatory, Williams Bay, Wis. and Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 240635 Unclassified

Also published in Astrophys. Jour., v. 131: 243-246, Jan. 1960.

The assumption that individual spiral arms are long-lived features in a galaxy is disproved. It is shown that the form of the rotation-curves for spirals will insure that the spiral form will be completely distorted in a time short compared with the age of a galaxy. This is done by proving that 1 or more of the following assumptions cannot hold for certain cases and probably for all similar spiral galaxy cases. The assumptions are: (1) that material which is originally in a spiral arm remains in that arm, (2) that only circular velocities are present, and (3) that the circular velocity is independent of time.

169

California Inst. of Tech. Palomar Observatory, Pasadena.

A REPLY TO G. R. BURBIDGE, by A. G. W. Cameron. [1959] 5p. (AFOSR-TN-59-1079) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49-(638)21) AD 245962   Unclassified

Also published in Astrophys. Jour., v. 131: 521-523, Mar. 1960.

In a reply to Burbidge's criticism (item no. 166, Vol. III) it is pointed out that the nuclear physical evidence on which the author places much weight is not inferior to "observational" evidence. It is explained that astronomical spectroscopy has not been as helpful as was hoped in telling the relative abundances of the elements. Thus, attention has been directed at bodies in which fractionation has obviously taken place, and the most useful of these is the chondrites although some elements have been lost or enriched in these materials. Under these circumstances, it is explained, the "observed" abundances in the chondrites need not be definitive numbers to which nuclear physics must be made to conform. The author's position on why he made certain modifications in the table of abundances is clarified. The different source of neutrons that reportedly has been used is further elaborated on and the uncertainty in neutron energy, which led the author to assign abundances on the basis of measured ratios, pointed out. The advantage of the revised abundance compilation is explained, and the fact that new data will probably necessitate further revisions in the table is stated.

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California U. Dept. of Chemistry, Berkeley.

MATRIX ISOLATION STUDIES: INFRARED SPECTRA OF INTERMEDIATE SPECIES IN THE PHOTOLYSIS OF HYDRAZOIC ACID, II, by M. Van Thiel and G. C. Pimentel. Feb. 25, 1959 [25]p. incl. diagrs. tables, refs. (AFOSR-TN-59-223) (AF 49(638)1) AD 211805   Unclassified

Also published in Jour. Chem. Phys., v. 32: 133-140, Jan. 1960.

Further infrared studies of the photolysis of hydrazoic acid in solid nitrogen at $20°K$ confirm the spectroscopic detection of unusual molecular species, as postulated earlier. The two most prominent bands, at 1325 and 1290 cm^{-1}, are shifted by a factor near $\sqrt{2}$ when DN3 is photolyzed. The data indicate the presence of either imine radical, NH_2, or dimide, N_2H_2. (Contractor's abstract)

171

California U. Dept. of Chemistry, Berkeley.

FORMATION OF METHYL NITRITE IN THE PHOTOLYSIS OF GASEOUS NITROMETHANE, by G. C. Pimentel and G. Rollefson. Feb. 28, 1959 [12]p. incl. diagr. table. (AFOSR-TN-59-266) (AF 49(638)1) AD 212469   Unclassified

By infrared spectroscopic analysis methyl nitrite was found to be a product of photolysis of gaseous nitromethane. Its growth as a function of photolysis time shows that this product is itself photolyzed but that only a fraction of the decomposed parent molecules form methyl nitrite. The results are discussed in terms of the proposal that excited methyl nitrite is formed by recombination of CH_3 and NO_2 radicals formed in the primary photolytic process. These experiments cast light on the cage effect in the photolysis of nitromethane in solid Ar, as studied by Brown and Pimentel (Jour. Chem. Phys., v. 29: 883-889, 1958). (Contractor's abstract)

172

California U. Dept. of Chemistry, Berkeley.

PERTURBATION OF MOLECULAR DISTRIBUTION FUNCTIONS BY CHEMICAL REACTION, by B. H. Mahan. [1959] [3]p. (AFOSR-TN-59-990) (AF 49(638)1) AD 227606; PB 144017   Unclassified

Also published in Jour. Chem. Phys., v. 32: 362-364, Feb. 1960.

A collision cross section for radial combination reactions is derived which indicates that translationally hot free radicals combine faster than the average thermal radicals. The cross section is used to calculate the disturbance of the equilibrium distribution of velocities by radical combination reactions. It is concluded that the equilibrium assumption of chemical kinetics is justified for photochemical systems where the radical concentrations are low, but may be violated in systems where the free radical concentrations approach 0.1 mol fraction. (Contractor's abstract)

173

California U. Dept. of Chemistry, Berkeley.

SPECTROSCOPIC STUDY OF THE PHOTOLYSIS OF
DIAZOMETHANE IN SOLID NITROGEN, by T. D.
Goldfarb and G. C. Pimentel. [1959] [4]p. incl. diagr.
refs. (AFOSR-TN-59-991) (AF 49(638)1) AD 227605;
PB 144016   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 1865-
1868, Mar. 5, 1960.

Further experiments are described in which diazometh-
ane or partially deuterated diazomethane was suspended
in solid nitrogen at 20°K and photolyzed with filtered
light. Spectroscopic study extended from the ultraviolet
(2300A) through the infrared (to 420 cm^{-1}). An unstable
substance is stored which produces ethylene after dif-
fusion is permitted. This ethylene precursor is absent,
as are visible-ultraviolet absorptions at 4182, 3968,
and 3050-3300A, when the photolyzing radiation includes
only wave lengths longer than 3400A. In contrast, the
infrared absorptions observed earlier by Milligan and
Pimentel are produced under these conditions, showing
that the substance responsible is not the ethylene pre-
cursor. The data support the proposal that methylene
is the precursor and suggest that some or all of the visi-
ble-ultraviolet absorptions are caused by methylene.
Absorption at 2620A was detected only in experiments
at high concentration (low M/R), making it extremely
unlikely that this absorption is caused by CH_2. Finally,
an absorption at 2470A not caused by diazomethane was
present before photolysis. This could be the tautomeric
compound detected earlier by Müller and Ludsteck and
called "isodiazomethane." (Contractor's abstract)

174

California U. Dept. of Chemistry, Berkeley.

INFRARED DETECTION OF THE FORMYL RADICAL
HCO, by G. E. Ewing, W. E. Thompson, and G. C.
Pimentel. [1959] [6]p. incl. diagrs. tables, refs.
(AFOSR-TN-59-1197) (AF 49(638)1) AD 228570;
PB 144866   Unclassified

Also published in Jour. Chem. Phys., v. 32: 927-932,
Mar. 1960.

The photolysis of HI, DI, HBr, and DBr suspended in
solid CO at 20°K is described. The formyl radical,
HCO or DCO, is produced, as shown by broad absorp-
tions in the visible spectral region (6695, 6352, 6052,
5789, 5548, 5330, 5102A) which correspond to absorp-
tions of gaseous HCO. Infrared absorptions of HCO
(at 1860 and 1091 cm^{-1}) and of DCO (at 1860 and 856
cm^{-1}) provide a basis for discussing the chemical
bonding of this free radical and for calculating its
thermodynamic properties. These experiments, the 1st
infrared detection of a triatomic free radical by the

matrix isolation method, depend upon reactivity of the
matrix, possibly eliminating difficulties of the cage
effect. A correction in calculations is printed in Jour.
Chem. Phys., v. 34: 1067, Mar. 1961. (Contractor's
abstract)

175

California U. Dept. of Chemistry, Berkeley.

INFRARED SPECTRA OF H_2O, D_2O, AND HDO IN
SOLID ARGON, KRYPTON, AND XENON, by E.
Catalano and D. E. Milligan. [1959] [3]p. incl. diagrs.
tables. (AF 49(638)1)   Unclassified

Published in Jour. Chem. Phys., v. 30: 45-47, Jan.
1959.

Infrared spectra of H_2O and D_2O suspended in solid
argon, zenon, and krypton have been obtained in the tem-
perature range 20-4.2°K. A systematic study of the
spectra of these species as a function of concentration
and temperature has been carried out. Doublets with
components centered within a few wave numbers of the
gas phase OH and OD stretching frequencies are ob-
served at dilutions in the range 500-1300 for the quantity
M/R (M/R denotes molar ratio of rare gas to H_2O or
D_2O). Spectra of these species in the bending region
are considerably more complex. Between 3 and 8 bands
with frequency separations on the order of 10-20 cm^{-1}
are observed in this region. These features appear to
be independent of M/R in the range 500-1300. At least
one and possibly two of the lower frequency components
in the spectrum H_2O in argon decrease in intensity on
lowering the temperature of the sample. These re-
sults have been interpreted on the basis that H_2O and
D_2O rotate in solid Ar, Xe, and Kr. (Contractor's
abstract)

176

[California U. Dept. of Chemistry, Berkeley]

A MOLECULAR ORBITAL STUDY OF IONIZATION
POTENTIALS OF ORGANIC COMPOUNDS. I. RADI-
CALS AND NON-ALTERNANT HYDROCARBONS. II.
METHYL COMPOUNDS. III. SATURATED HYDRO-
CARBONS. IV. ACETYLENES AND ALLENES. V.
CHLORINE, OXYGEN AND NITROGEN COMPOUNDS,
by A. Streitwieser, Jr. [1959] 1v. incl. tables, refs.
(AFOSR-TN-59-893) (AF 49(638)105) AD 243130;
PB 144168   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 4123-
4135, Aug. 20, 1960. (Title varies)

The ω-technique in the simple lcao theory is applied to
a variety of organic compounds. A comparison of the

method with Pople's scf method shows that the use of the ω-parameter provides for electron repulsion effects in an empirical manner. Such a procedure is required when dealing with cations; for example, in the simple lcao theory the ionization potentials of methyl, allyl and benzyl radicals should be identical. The experimental values which vary over a 2 ev range are well reproduced by the ω-technique. The method is applied to several organic radicals of current interest, including cyclopentadienyl and tropylium. Agreement with experimental results, where available, is excellent. With aromatic hydrocarbons, however, including examples of the non-alternant hydrocarbon type, the simple lcao procedure gives a good correlation of ionization potentials; the ω-technique provides no advantage with such systems alone. Heteroatoms can be treated given 2 additional parameters characteristic of the heteroatom. A methyl group is treated as a pseudo-heteroatom donating 2 electrons to the π-system with parameter values differing slightly from those previously employed. Good agreement between calculated and experimental ionization potentials was obtained for a large number of methyl substituted hydrocarbons and radicals. Experimental potentials were used for chlorine, nitrogen and oxygen compounds to determine empirically the appropriate parameter values for those elements. The derived values are compared with those used previously in other applications in the literature. The ω-technique is extended to calculations of acetylenic and allenic systems. A simple model of an alkane is presented which requires only 1 additional disposable parameter. The derived value of 0 for this parameter is used with the ω-technique to give good agreement between calculated and experimental ionization potentials for a variety of alkanes. (Contractor's abstract)

177

[California U. Dept. of Chemistry, Berkeley]

SIMPLE MOLECULAR ORBITAL CALCULATIONS. [1959] 1v. incl. tables. (AFOSR-TN-59-893a; appendices A-D) [AF 49(638)105] AD 243577   Unclassified

Using an IBM 701 high-speed digital computer, molecular orbital calculations have been made for many of the compounds discussed in item no. 176. The data include eigenvalues and eigenvectors of the occupied orbitals, electron densities, and bond orders. The presentation of the data is interpreted in appendix A.

178

California U. Dept. of Mathematics, Berkeley.

A CHARACTERIZATION OF INVARIANT AFFINE CONNECTIONS, by B. Kostant. Mar. 1959, 23p. (Technical rept. no. 10) (AFOSR-TN-59-208) (AF 49-(638)79) AD 211662; PB 140426   Unclassified

Also published in Nagoya Math. Jour., v. 16: 35-50, Feb. 1960.

The following theorem is proved: Let A be an affine connection on a simply connected manifold M. Then M is a reductive homogeneous space with respect to a connected Lie group G whose action leaves A invariant if and only if there exists an affine connection B on M such that (1) R^A and T^A are covariant constant with respect to B, (2) A is rigid with respect to B, and (3) M is complete with respect to B. R and T are the torsion and curvature tensor fields on M, respectively.

179

California U. Dept. of Mathematics, Berkeley.

A NOTE ON CERTAIN POLYNOMIAL ALGEBRAS, by E. Thomas. Jan. 1960, 9p. (Technical rept. no. 12) (AFOSR-TN-59-937) (AF 49(638)79) AD 233363; PB 145556   Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 410-414, June 1960.

This note considers polynomial algebras defined over integral domains of characteristic 2. For each algebra a derivation β is defined, and the main theorem gives a splitting of the algebra relative to β. The theorem is then applied to several examples from Algebraic Topology: (1) the mod. 2 cohomology algebras of the Grassmann complexes, and (2) the subalgebra W of the Thom algebra N of non-oriented differentiable manifolds. (Contractor's abstract)

180

California U. Dept. of Mathematics, Berkeley.

WHICH LIE GROUPS ARE HOMOTOPY-ABELIAN?, by I. James and E. Thomas. Sept. 1959, 5p. incl. refs. (Technical rept. no. 11) (AFOSR-TN-59-982) (AF 49-(638)79) AD 226764; PB 144369   Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 737-740, May 1959.

A topological group G is homotopy-abelian if the mappings f and f̄, of G x G to G, are homotopic, where $f(x, y) = xy = f(y, x)$ $(x, y \in G)$. The problem considered in this paper is whether any of the non-abelian Lie groups are homotopy-abelian. The main result is: Theorem: The classical structure classes contain no Lie group which is homotopy-abelian but not abelian. The method used is a generalization of that used by H. Samelson to show that Sp(1) is not homotopy-abelian. (Contractor's abstract)

181

California U. Dept. of Mathematics, Berkeley.

BOUNDS FOR THE FIRST EIGENVALUE OF A

RHOMBIC MEMBRANE, by W. Hooker and M. H. Protter. Apr. 1959, 29p. incl. diagrs. tables. (Technical rept. no. 3) (AFOSR-TN-59-128) (AF 49(638)-398) AD 210616; PB 142374   Unclassified

Also published in Jour. Math. and Phys., v. 39: 18-34, Apr. 1960.

A new method for finding lower bounds for the first eigenvalue of elliptic equations is applied to the case of a rhombus. It is shown that a simple analytic expression can be obtained which is a superior lower bound to those obtained by symmetrization. Some refined upper bounds are obtained so that the exact value is confined to a narrow range for all angle openings. These results are useful in the application of the inclusion principle for lower bounds of arbitrary domains. (Contractor's abstract)

182

California U. Dept. of Mathematics, Berkeley.

UNIQUENESS THEOREMS FOR EQUATIONS OF MIXED TYPE III, by M. H. Protter. Mar. 1959, 15p. incl. refs. (Technical rept. no. 4) (AFOSR-TN-59-234) (AF 49(638)398) AD 212004; PB 142364   Unclassified

Uniqueness theorems for equations of the form $K(y)u_{xx} + u_{yy} = 0$ are established when it is assumed that u vanishes on a simple arc in the elliptic portion of the domain and on either a characteristic or noncharacteristic arc in the hyperbolic region. The restrictions on the domain that were required in the uniqueness proofs of earlier works are eliminated. (Contractor's abstract)

183

California U. Dept. of Mathematics, Berkeley.

VIBRATION OF A NONHOMOGENEOUS MEMBRANE, by M. H. Protter. Apr. 1959, 11p. (Technical rept. no. 5) (AFOSR-TN-59-279) (AF 49(638)398) AD 212912   Unclassified

Also published in Pacific Jour. Math., v. 9: 1249-1255, 1959.

A comparison theorem is established for the 1st eigenvalue of homogeneous and nonhomogeneous membranes of the same shape. The 1st eigenvalues λ_0 and λ_1 are considered for the equations $u_{xx} + u_{yy} + \lambda p(x,y)u = 0$ and $v_{xx} + v_{yy} + \lambda v = 0$, respectively, in the same domain D subject to the boundary conditions u = 0 and v = 0 on Γ, respectively. Also compared are the eigenvalues of 2 different nonhomogeneous membranes of the same shape.

184

California U. Dept. of Mathematics, Berkeley.

ON DIFFERENCE METHODS FOR THE SOLUTION OF A PARTIAL DIFFERENTIAL EQUATION OF MIXED TYPE, by H. Ogawa. Mar. 1959, 22p. incl. diagrs. (Technical rept. no. 6) (AFOSR-TN-59-280) (AF 49(638)398) AD 212913; PB 142365
                                        Unclassified

A boundary value problem for the mixed partial differential equation $K(y)u_{xx} + u_{yy} = f(x,y)$, with K > 0 for y > 0, K < 0 for y < 0 and K(0) = 0, is approximated by a boundary value problem for a difference equation, which is shown to have a solution under certain conditions on the function K. The solution of the difference equation is then shown to converge to the solution of the differential equation, provided the latter exists and is sufficiently smooth. The present work is a generalization of the methods used by Filippov in considering the equation with K(y) = y. These methods depend essentially on proving that the solution of the difference equation satisfies a maximum principle analogous to the maximum principle for the differential equation. (Contractor's abstract, modified)

185

California U. Dept. of Mathematics, Berkeley.

UNIQUE CONTINUATION FOR ELLIPTIC EQUATIONS, by M. H. Protter. May 1959, 18p. incl. refs. (Technical rept. no. 7) (AFOSR-TN-59-476) (AF 49-(638)398) AD 215719   Unclassified

Also published in Trans. Amer. Math. Soc., v. 95: 81-91, Apr. 1960.

A proof is given for a unique continuation theorem for linear 2nd-order elliptic equations. This is somewhat simpler than the previous proofs of Aronszajn, Cordes and Pedersen as no considerations of differential geometry are required. In addition the method of proof extends easily to higher order equations in which the highest derivative form is the iterated Laplacian. (Contractor's abstract)

186

California U. Dept. of Physics, Berkeley.

MICROWAVE FARADAY ROTATION: MEASUREMENT OF THE CONDUCTIVITY TENSOR, by A. M. Portis. [1959] [3]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, National Security Agency, Office of Naval Research under [Nonr-22201], and Signal Corps)   Unclassified

Presented at 1958 Internat'l. Conf. on Semiconductors, Rochester U., N. Y., Aug. 18-22, 1958.

Published in Jour. Phys. and Chem. Solids, v. 8: 326-329, Jan. 1959.

The application of microwave Faraday rotation to the measurement of magnetoconductivity is discussed. Interest is directed to the currents flowing transverse to the magnetic field. It is pointed out that the results of the microwave measurements may be directly related to the elements of the conductivity tensor. A number of effects which must be considered on comparing low frequency and microwave measurements are listed including surface charge effects, non-ohmic contacts' effects, and those of shunt capacity.

187

California U. Dept. of Physics, Berkeley.

ON THE TEMPERATURE DEPENDENCE OF ANISOTROPY ENERGY IN ANTIFERROMAGNETS, by P. Pincus. [1959] 8p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, National Security Agency, Office of Naval Research, and Signal Corps)   Unclassified

Published in Phys. Rev., v. 113: 769-770, Feb. 1, 1959.

The Akulov-Zener classical theory of the temperature dependence of ferromagnetic anisotropy energy is extended to the antiferromagnetic case. The result, for short range interactions only, is that

$$K_n(T)/K_n(0) = [M(T)/M(0)]^{n(n+1)/2},$$

where $K_n(T)$ is the nth order anisotropy constant and $M(T)$ is the sublattice magnetization. Here, $K_n(0)$ and $M(0)$ refer to the corresponding quantities at absolute zero. The result is verified by a spin calculation. (Contractor's abstract)

188

California U. Dept. of Physics, Berkeley.

METALLIC TRANSITION IN LITHIUM HYDRIDE, by R. E. Behringer. [1959] [6]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], National Security Agency, Office of Naval Research, and Signal Corps)   Unclassified

Published in Phys. Rev., v. 113: 787-792, Feb. 1, 1959.

The dependence on lattice parameter, or pressure, of the energy gap between the last filled and first empty energy band in LiH is investigated. The crystalline potential is approximated by a Wigner-Seitz atomic-spheres potential, corrected to account for the effects of overlapping spheres, and the wave functions are expanded in symmetrized plane waves. In addition the

effect of varying the relative size of the lithium and hydrogen ion spheres is considered. The energy levels at the top of the filled band and the bottom of the empty band are determined at several values of the lattice parameter, using 6, 7, 8, 9, and 10 symmetrized plane waves. The problem of convergence is examined. The model predicts that transition to the metallic state should occur at a pressure of about 35 megabars. The results are discussed in light of recent experimental investigations. (Contractor's abstract)

189

California U. Dept. of Physics, Berkeley.

THEORY OF NUCLEAR QUADRUPOLE INTERACTION IN BERYLLIUM METAL, by M. Pomerantz and T. P. Das. [1959] [9]p. incl. diagrs. refs. (In cooperation with Illinois U., Urbana AF 18(600)689) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46] and Office of Naval Research)
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 251, Apr. 30, 1959. (Title varies)

Published in Phys. Rev., v. 119: 70-78, July 1, 1960.

The theory of the origin of the field gradient at nuclei in metals has been analyzed. The contributions of the ion cores and conduction electrons have been separately considered. In the case of beryllium metal, using orthogonalized plane wave functions, the conduction electrons are shown to enhance, by about 8%, the field gradient due to the ion cores. Combining the results of our calculations with Knight's experimental value of 48 kc/sec for the Be^9 coupling constant e^2qQ/h, a value of $Q = 0.032 \times 10^{-24}$ cm^2 is obtained. The dependence of the potential for the conduction electrons on the mode chosen is analyzed in some detail. The various uncertainties in our field-gradient calculation and the theoretical value of the Knight shift in beryllium metal are discussed. (Contractor's abstract)

190

California U. Dept. of Physics, Berkeley.

INELASTIC FINAL-STATE INTERACTIONS: K$^-$ ABSORPTION IN DEUTERIUM, by R. Karplus and L. S. Rodberg. [1959] [53]p. incl. diagrs. tables, refs. (AFOSR-TN-59-332) (AF 49(638)327) AD 213653; PB 142409   Unclassified

Also published in Phys. Rev., v. 115: 1058-1069, Aug. 15, 1959.

In a reaction from which several strongly interacting

particles emerge, it is often possible to isolate the effects of forces between two of the outgoing particles. There are many cases in which this final-state interaction can produce inelastic reactions. The formalism that describes this situation is developed, and the reaction $K^- + D \to \pi + \Sigma + N \to \pi + \Lambda + N$ is studied in detail as an example. It is found that large Λ/Σ branching ratios can result and can be used to restrict the Σ-N and K-N interaction parameters. The gross features of the spectrum can be understood using a simple model. It does not seem possible to determine the parities of the strange particles from the momentum spectra. When the inelastic reaction in the final state is exothermic, as in the example, high partial waves may contribute. (Contractor's abstract)

191

California U. Dept. of Physics, Berkeley.

ANALYTIC PROPERTIES OF TRANSITION AMPLITUDES IN PERTURBATION THEORY, by S. Mandelstam. [1959] [38]p. incl. diagrs. refs. (AFOSR-TN-59-436) (AF 49(638)327) AD 214798; PB 142146
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 50, Jan. 28, 1959. (Title varies)

Also published in Phys. Rev., v. 115: 1741-1751, Sept. 15, 1959.

The analytic properties of 2-particle transition amplitudes as functions of both energy and momentum transfer are examined in perturbation theory. The modified Nambu representation previously proposed by the author for expressing these properties is discussed in a little more detail. It is shown that, as long as the masses do not satisfy certain inequalities connected with the existance of anomalous thresholds, the fourth-order terms, calculated in the usual manner, satisfy the representation. The spectral functions are calculated explicitly for spinless particles. The proof can be extended to the sixth order, but is not worked out here. The modifications necessary when there exist anomalous thresholds are mentioned.

192

California U. Dept. of Physics, Berkeley.

CONSTRUCTION OF THE PERTURBATION SERIES FOR TRANSITION AMPLITUDES FROM THEIR ANALYTICITY AND UNITARITY PROPERTIES, by S. Mandelstam. [1959] [42]p. incl. diagrs. refs. (AFOSR-TN-59-437) (AF 49(638)327) AD 214799; PB 142145
Unclassified

Also published in Phys. Rev., v. 115: 1752-1762, Sept. 15, 1959.

The analyticity properties of transition amplitudes are used in conjunction with the unitarity requirements to generate successive terms in the perturbation series, without referring to a specific Lagrangian. In the sixth and higher orders, production is neglected in the unitarity condition; subject to this approximation, it is found that the series can be so constructed. No analyticity properties which have not been rigorously proved need be employed, and the terms are found to satisfy the double dispersion representation. By examining the connection between this method and the conventional calculation of the perturbation series the types of spectral function corresponding to different Feynman diagrams can be found. Formulae are given for the regions in which the spectral functions are non-zero. (Contractor's abstract)

193

California U. Dept. of Physics, Berkeley.

THEORY OF THE LOW-ENERGY PION-PION INTERACTION, by G. F. Chew and S. Mandelstam. Apr. 15, 1959 [43]p. incl. diagrs. (Rept. no. UCRL-8728) (AFOSR-TN-59-520) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)327 and Atomic Energy Commission) AD 216251
Unclassified

Also published in Phys. Rev., v. 119: 467-477, July 1, 1960.

The double-dispersion representation is applied to the problem of pion-pion scattering, and it is shown that, if inelastic effects are important only at very high energies, a set of integral equations for the low-energy amplitudes can be derived. The solution of these equations appears to depend on only one arbitrary real parameter, which may be defined as the pion-pion coupling constant. The order of magnitude of the new constant is established, and a procedure for solving the integral equations by iteration is outlined. (Contractor's abstract)

194

California U. Dept. of Physics, Berkeley.

ONE PARTICLE SINGULARITIES OF GREEN FUNCTIONS IN QUANTUM FIELD THEORY, by W. Zimmermann. [1959] [19]p. incl. refs. (AFOSR-TN-59-568) (AF 49(638)327) AD 217002; AD 226911
Unclassified

Also published in Nuovo Cimento, Series X, v. 13: 503-521, Aug. 1959.

The general structure is investigated of the vacuum and the 1-particle singularities of the τ-functions, in

the case that all variables p_i are real 4 vectors. In

the case of forward scattering, the Fourier transform is applied to dispersion relations in order to determine the indefinite constant appearing in Bogoljubov's treatment of the 1-particle singularities. The result thus obtained is in agreement to Symanzik's form of the 1-particle term in the dispersion relation for forward scattering.

195

California U. Dept. of Physics, Berkeley.

NOTE ON THE K-MESON NUCLEON INTERACTION, by R. Karplus, L. Kerth, and T. Kycia. [1959] [9]p. incl. tables, refs. (AFOSR-TN-59-677) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)327 and Atomic Energy Commission) AD 225767; PB 145577   Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 510-513, June 15, 1959.

The K-nucleon-hyperon coupling terms are examined using the dispersion relation formalism. Two parameters are defined: p_Λ (p_Σ) describing the $K^-\Lambda(K^-\Sigma)$-nucleon relative parity, and $X_\Lambda(X_\Sigma)$ which is proportional to the $K^-\Lambda N(K^-\Sigma N)$ coupling constant $g^2_\Lambda(g^1_\Sigma)$. The calculation of an "average" coupling $\langle pX \rangle_{Av}$ at an "average" pole $\omega[\omega = 1/2\,(\omega_\Lambda + \omega_\Sigma)$ where ω is the K-meson laboratory energy and $X_\Lambda(X_\Sigma)$ is the magnitude of the residue evaluated at $\omega = \omega_\Lambda(\omega_\Sigma)]$ leads to the conclusion that the $K^\pm$-proton interaction calculated by this method is insufficiently sensitive to the coupling parameters to permit their evaluation from present data. A consideration of the real part of the K^--proton forward scattering amplitude suggests that the K^--proton force is attractive.

196

California U. Dept. of Physics, Berkeley.

SPECTRAL REPRESENTATIONS IN PERTURBATION THEORY. III. THE SCATTERING AMPLITUDE WITH TWO COMPLEX INVARIANTS, by J. Tarski. [1959] 45p. incl. diagrs. refs. (AFOSR-TN-59-1071) (AF 49-(638)327) AD 229981; PB 145322   Unclassified

Also published in Jour. Math. Phys., v. 1: 149-164, Mar.-Apr. 1960. (Title varies)

The partial Feynman amplitude corresponding to a particular 4th order diagram is examined as a function of energy and momentum transfer with both of these variables complex. The region of regularity of this function is found, and the types of singularities at the

remaining points are determined. An approach which requires only elementary calculations is developed. The condition for the validity of Mandelstam's representation in the 4th order is obtained. Spectral representations for exchange scattering processes at fixed momentum transfer are discussed as another application of the principal results. (Contractor's abstract)

197

California U. [Dept. of Physics] Berkeley.

UNIQUENESS OF RADIATIVE SOLUTIONS TO THE SCHROEDINGER WAVE EQUATION, by C. Zemach and F. Odeh. [1959] 23p. (AFOSR-TN-59-1112) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)327 and Office of Naval Research under Nonr-22260) AD 243991   Unclassified

Also published in Arch. Rational Mech. and Anal., v. 5: 226-237, 1960.

A report is presented on the uniqueness question for the exterior Dirichlet, or Neumann problem associated with the Schroedinger wave equation with a suitably restricted real potential V(r): $[\nabla^2 + k^2 - V(r)]\,\psi(r) = 0$. The main results of this research are: (1) under suitable restrictions (less strict than Miranker's) on V, there does exist a uniqueness theorem for the problem at hand. (2) The radiation condition implies the boundedness condition: $\psi(r) = 0(r^{-1})$ for the solution considered. (3) These considerations fail when k = 0, and a counterexample is given in this case.

198

California U. Dept. of Physics, Berkeley.

ELECTROMAGNETIC STRUCTURE OF THE NUCLEON, by A. M. Bincer. Nov. 1959, 34p. incl. refs. (AFOSR-TN-59-1217) (AF 49(638)327) AD 229978; PB 145041
Unclassified

Also published in Phys. Rev., v. 118: 855-863, May 1, 1960.

Dispersion relations are proved for the electromagnetic and mesonic nucleon vertex functions considered as a function of the nucleon mass. The results are used to express the isotopic scalar and the isotopic vector electromagnetic form factors of the nucleon in terms of pion electroproduction (or photoproduction) and pion-nucleon scattering amplitudes in the $J = \frac{1}{2}$, $T = \frac{1}{2}$ state. (Contractor's abstract)

199

California U. [Dept. of Physics] Berkeley.

RaE AND THE SHELL MODEL (Abstract), by A.

Bincer, E. Church, and J. Weneser. [1959] [1]p.
(Sponsored jointly by Air Force Office of Scientific
Research under [AF 49(638)327] and Atomic Energy
Commission)   Unclassified

Presented at meeting of the Amer. Phys. Soc., New
York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
59, Jan. 28, 1959.

In an extension of previous work, an attempt has been
made to correlate the spectral shape, longitudinal po-
larization, and lifetime of the beta decay of RaE(Bi^{210})
in terms of jj coupling model with configuration mixing.
The configurations considered important in the initial

(1-) state are: $(h_{9/2})p^1 (g_{9/2})n^1$, $(h_{9/2})p^1 (g_{7/2})n^1$,

$(h_{9/2})p^1 (i_{11/2})n^1$, and $(h_{11/2})p^{-1} (h_{9/2})p^2 (g_{9/2})n^1$.

The final (0 +) state is taken as $(h_{9/2})p^2$ plus the doubly
magic Pb^{208} core. Other admixed configurations would
not contribute importantly to the beta-decay matrix ele-
ments. The immediate objective is the use of the ex-
perimental data to fix the mixture of configurations,
with the usual assumptions of a 2-component neutrino
theory with VA interactions invariant under time re-
versal. It has been found that the choices of nuclear
configurations which best fit the shape and lifetime
yield a longitudinal polarization of $\sim$ -(85-90%)v/c.

200

California U. [Dept. of Physics] Berkeley.

SEARCH FOR LEPTONIC DECAY MODES OF THE
SIGMA, by J. Leitner, P. Nordin, Jr. and others.
[1959] [3]p. incl. diagrs. table. (Sponsored jointly by
Air Force Office of Scientific Research under [AF 49-
(638)327] and Atomic Energy Commission)
                                           Unclassified

Published in Phys. Rev. Ltrs., v. 3: 186-188, Aug. 15,
1959.

Presented at meeting of the Amer. Phys. Soc.,
Honolulu, Hawaii, Aug. 27-29, 1959.

Abstract also published in Bull. Amer. Phys. Soc.,
Series II, v. 4: 356, Aug. 27, 1959. (Title varies)

As part of a continuing study of K$^-$ absorption in
hydrogen, an attempt has been made to obtain evidence
of Σ leptonic decay modes. The selected sample con-
sisted of only well-measured events—750Σ^- and

250$\Sigma^+ \to \pi^+ + n$ (effectively 500Σ^+). The search was
carried out by studying the (lab) momentum distribution
of the Σ-decay products. The observed distribution was
roughly Gaussian, centered about 190 mev/c, the value

expected for $\Sigma^{\pm} \to \pi^{\pm} + n$. A detection cutoff was

chosen at 100 mev/c, just below the tail of the spectrum
due to small-angle single Coulomb scattering; 45% of
the leptonic phase-space spectrum falls below 100 mev/c.
No decays have been found below 115 mev/c among
(0.45 x 750 =) 335 effective Σ^- and 225 effective Σ^+, so
that the upper limits of leptonic branching fractions are

$$f(\Sigma^- \to \mu^- + e^- + \nu + n) \le 0.3\%,$$

$$f(\Sigma^+ \to \mu^+ + e^+ + \nu + n) \le 0.45\%.$$

201

California U. [Dept. of Physics] Berkeley.

ON THE BEHAVIOR OF THE SCATTERING PHASE
SHIFT IN THE PRESENCE OF INELASTIC PROCESSES
(Abstract), by M. A. Ruderman and C. M. Sommerfield.
[1959] [1]p. (Sponsored jointly by Air Force Office of
Scientific Research under [AF 49(638)327] and
National Science Foundation)   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
375, Aug. 27, 1959.

Under consideration are processes involving inelastic
scattering which may be described in terms of a non-
local, energy-dependent, complex potential. It is
found, with suitable restrictions, that a potential which
describes the propagation of fields with a speed less
than that of light yields a complex scattering phase shift
whose real part decreases by $(n_b - n_f)\pi$ as the energy

increases from threshold to infinity. Here n_b is the

number of bound states produced by the potential and
n_f is the number of elementary fields in the process.

To the extent that such potentials provide adequate
descriptions of the interactions, experimental deter-
mination of the energy behavior of the scattering phase
shifts will allow a distinction to be made between those
fields to be taken as elementary and those to be con-
sidered as composite.

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California U. [Dept. of Physics] Berkeley.

ANALYTIC PROPERTIES OF THE AMPLITUDE FOR
THE SCATTERING OF A PARTICLE BY A CENTRAL
POTENTIAL, by A. Klein and C. Zemach. [1959] [16]p.
incl. refs. (Sponsored jointly by [Air Force Office of
Scientific Research under AF 49(638)327], Atomic
Energy Commission, and National Science Foundation)
                                           Unclassified

Published in Ann. Phys., v. 7: 440-455, Aug. 1959.

A new proof is given that the scattering amplitude

considered as a function of energy, for fixed momentum transfer, has those analytic properties in the energy variable which imply a dispersion relation. The proof is based on the known behavior of the Green's function, as the resolvent of a self-adjoint transformation, and on the study of the Born series. The class of potentials considered is the same as in previous studies. It is shown that for potentials of arbitrary strength the Born series converges uniformly to its first term for sufficiently high energies, real or complex. The analytic properties of the scattering amplitude as a function of momentum transfer for fixed real energy are also investigated and used to establish the domain of convergence of partial wave and related expansions. In particular the use of such expansions to define the amplitude in the unphysical region which occurs in the dispersion relation is fully justified for the same domain of momentum transfer for which the relation itself is valid, i.e.: $\Delta < 2\alpha$, where Δ is the momentum transfer and α^{-1} the range of the potential. All proofs apply equally to the Schroedinger and to the Klein-Gordon equations. (Contractor's abstract)

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California U. [Dept. of Physics] Berkeley.

SIGMA SPIN AND PARITY CONSERVATION IN $K^- + p \rightarrow \Sigma^+ + \pi^-$, by J. Leitner, P. Nordon, Jr. and others. [1959] [2]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49-(638)327] and Atomic Energy Commission)

Unclassified

Published in Phys. Rev. Ltrs., v. 3: 238-239, Sept. 1, 1959.

A report is made of the finding of very strong evidence of a spin-1/2 sigma on the basis of an analysis of 145 Σ^+ hyperons produced in K^- absorption when K^- mesons come to rest in liquid hydrogen. A check on the hypothesis of parity conservation in the reaction $K^- + p \rightarrow \Sigma^+ + \pi^-$ is also reported. It is stated that if the assumption is that the K meson has zero spin and is captured from an s state, then the maximum component of angular momentum that the Σ can have along its direction of flight is 1/2. Furthermore, if the Σ has a spin greater than 1/2, this leads to an alignment of its spin, J, perpendicular to its direction of motion. This and other supporting evidence leads to the opinion that the s-state capture is well grounded. Assuming this, the folded distributions $f_J(|\cos \theta|)$ become $f_{1/2} = 1$, $f_{3/2} = 1/2(1 + 3 \cos^2 \theta)$ and analyzing the data in terms of the normalized function $\underline{f}$, $F(|\cos \theta|) = 1/2(1 + A \cos^2 \theta)(1 + A/B)^{-1}$ constitutes the strongest evidence to date that sigma spin is 1/2. Search is also made for parity nonconservation in the reaction $K^- + p \rightarrow \Sigma^+ + \pi^-$ and for parity violation. No evidence for parity nonconservation in Σ^+ production is found.

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF Br^{77} (Abstract), by T. M. Green, H. [L.] Garvin and others. [1959] [1]p. Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission)

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 250, Apr. 30, 1959.

The nuclear spin of 57-hr Br^{77} has been measured by the method of atomic beams. The isotope is produced by an $(\alpha, 2n)$ reaction using the 38-mev beam from the Berkeley 60-in. cyclotron. Bromine atoms are formed in a quartz rf discharge tube and detected by their radioactive decay, after collection on silver-coated buttons. For Br^{77} the spin is found to be 3/2, and because $I = J = 3/2$ both flop-in transitions occur at the same frequency, at low magnetic fields. The resonance has been observed at 5 different magnetic fields up to 48 gauss. A spin of 3/2 is expected from the previously observed spins of 3/2 for Br^{79} and Br^{81}, which differ from Br^{77} by 1 and 2 pairs of neutrons, respectively. Work is being continued to obtain values of the hyperfine-structure separations, magnetic moment, and electric quadrupole moment of this isotope.

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California U. [Dept. of Physics] Berkeley.

SUMMARY OF SOME NUCLEAR SPIN, MOMENTS, AND HYPERFINE STRUCTURE MEASUREMENTS, by H. A. Shugart. [1959] [3]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)339, Atomic Energy Commission, and Office of Naval Research)

Unclassified

Also published in Fourth Brookhaven Conf. on Molecular Beams, Heidelberg U. (Germany), June 9-11, 1959, p. 5(1-3). (AFOSR-TR-59-152, AD 228005)

A number of radioisotopes with half-lives from 18 min to 24,000 yr have been investigated by the atomic beam flop-in method with radioactive detection. The nuclear spin measurements and hyperfine structure separation measurements including nuclear moment calculations are presented in table form. The tables are a composite of results of many researchers.

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California U. [Dept. of Physics] Berkeley.

HYPERFINE STRUCTURE SEPARATION AND MAG-

NETIC MOMENT OF (3.3-Hr) Cu^{61} (Abstract), by B. Dodsworth, V. J. Ehlers and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission)   Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 353, Aug. 27, 1959.

The hyperfine structure splitting of 3.3-hr Cu^{61} has been measured by the method of atomic beam. The isotope was produced with the $(\alpha 2n)$ reaction by bom-

barding Co^{60} with the 34 mev α beam from the Berkeley 60-in. cyclotron. Chemistry was performed to separate the Cu metal from the Co target. Resonances were observed by inducing transitions between the $m_F = -1$

and $m_F = -2$ members of the $F = 2$ levels, at fields of

57, 111, 126, 176 and 239 gauss. The radioactive atoms were collected on sulfur-coated buttons which were counted in sodium iodide crystal scintillation counters. $\Delta\nu$ was calculated using the Breit-Rabi formula, assuming positive and negative values of g_I. The

assumed positive value of g_I gave the best fit to the data

and resulted in a $\Delta\nu = 11,200 \pm 400$ mc/sec. Using the Fermi-Segrè formula and the results of Cox and

Williams, the magnetic moment of Cu^{61} was found to be: $\mu = +2.12 \pm 0.08$ nm.

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF 2.3-Hr IODINE-132 (Abstract), by H. L. Garvin, E. Lipworth, and W. A. Nierenberg. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission)   Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 353, Aug. 27, 1959.

The nuclear spin of 2.3-hr iodine-132 has been measured by means of an atomic-beam magnetic-resonance experiment and found to have the value 4. The apparatus used for this measurement has been described elsewhere. Iodine-132 is conveniently obtained by a milking process from 77-hr tellurium-132 in an iodine generator provided by the Brookhaven National Lab. A

generator initially charged with 108 millicuries of I^{132} provided a sufficient quantity of active material to observe the "flop-in" resonances of the $F = 11/2$ and $F = 9/2$ hyperfine states of the $^2P_{3/2}$ atomic ground state at magnetic field values of 1.42, 2.82, 6.92, and 13.42

gauss. The I^{132} beam was detected by collection upon silver-coated buttons which were subsequently counted in continuous-flow proportional counters. Decay half life of both the principal sample and several resonance-maxima samples were used to reaffirm identification of the isotope. The observed value of 4 for the nuclear

spin of I^{132} is consistent with the single-particle shell model of the nucleus.

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF SAMARIUM-153 (Abstract), by A. Y. Cabezas, E. Lipworth and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission)   Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 354, Aug. 27, 1959.

Hyperfine structure investigations of 47-hr Sm^{153} by the atomic-beam magnetic-resonance technique indicate that the nuclear spin of this nuclide is $I = 3/2$. In a low field search, 3 resonances were observed which were ascribed to transitions occurring in the $J = 1$ and $J = 2$ excited electronic states. With the flop-in magnet geometry used in this experiment, these resonances must be of a multiple quantum character. Each of the transitions was observed at 3 fields. The data indicates that the g_J value of both observed electronic states is 1.5,

the value obtained in pure L-S coupling among the electrons of the configuration (5f). This configuration is the same as that inferred from optical spectroscopy.

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California U. [Dept. of Physics] Berkeley.

HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF BROMINE-82, by H. L. Garvin, T. M. Green and others. [1959] [9]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission)   Unclassified

Published in Phys. Rev., v. 116: 393-401, Oct. 15, 1959.

The nuclear spin, the magnetic dipole, and the electric quadrupole interaction constants have been measured

for 35-hr bromine-82 by the method of atomic beams. The results are I = 5, $|a|$ = 205.04 ± 0.05 mc/sec, $|b|$ = 870.7 ± 0.9 mc/sec, and b/a = – 4.246 ± 0.001. The nuclear magnetic and electric quadrupole moments obtained from these values of a and b are $|\mu|$ = 1.6264 ± 0.0005 nm, and $|Q|$ = 0.76 ± 0.03 barn. While only the relative sign of μ and Q is determined, both μ and Q are almost certainly positive. A new method for solving the interaction Hamiltonian with magnetic field, for arbitrary I and J, by using an IBM 650 computer, is described. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

NUCLEAR SPIN, HYPERFINE-STRUCTURE SEPARATION, AND MAGNETIC MOMENT OF 22-HOUR POTASSIUM-43, by F. R. Petersen, V. J. Ehlers and others. [1959] [18]p. incl. diagrs. tables. (Rept. no. UCRL-8738) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission)   Unclassified

Also published in Phys. Rev., v. 116: 734-737, Nov. 1, 1959.

With the atomic-beam magnetic-resonance method, the nuclear spin and hyperfine-structure separation have been measured for 22-hr K^{43}. The results are: I = 3/2, $\Delta\nu\ (^2S_{1/2})$ = 192.54 ± .05 mc/sec. The nuclear magnetic moment calculated from these measurements is: $|\mu|$ = 0.163 ± .002 nuclear magnetons. (Contractor's abstract)

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF 16-Hr Am^{242} (Abstract), by J. Wincour, R. Marrus, and W. A. Nierenberg. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339], Atomic Energy Commission, and Office of Naval Research)
Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 451, Dec. 28, 1959.

The spin of 16-hr Am^{242} has been measured by the atomic-beam magnetic resonance method. The result is I = 1. The isotope is obtained from the $Am^{241}(n,\gamma)$ Am^{242} reaction on Am_2O_3. A beam of atoms is produced by reducing the oxide with lanthanum metal. The radioactive beam is collected on freshly flamed thin platinum disks which are counted in continuous-flow

proportional counters. Three flop-in transitions were observed at several values of the magnetic field. Large quadratic shifts were observed in fields of only a few gauss, indicating a small hyperfine structure. This result is important in the light of the difficulties in interpreting the Am^{42} decay scheme and level structure.

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California U. [Dept. of Physics] Berkeley.

HYPERFINE STRUCTURE OF Ga^{67} AND Ga^{68} (Abstract), by V. J. Ehlers and W. A. Nierenberg. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission)   Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 452, Dec. 28, 1959.

Hyperfine structure separations of 78-hr Ga^{67} and 68-min Ga^{68} have been measured by means of an atomic-beam magnetic-resonance experiment using radioactive detection. The Ga^{67} has been measured in both the $^2P_{3/2}$ and $^2P_{1/2}$ electronic states, allowing a determination of the differential hyperfine-structure anomaly $^{67}\delta^{69}$, defined by $^{67}\delta^{69} = {}^{67}\Delta_{1/2}^{69} - {}^{67}\Delta_{3/2}^{69} = (\Delta\nu/a)^{67}\ (\Delta\epsilon/a)^{69} - 1$. Ga^{68} has been measured in the $^2P_{3/2}$ state and has shown a very small magnetic moment causing an energy-level inversion. For an assumed positive magnetic moment, the decreasing energy level is F = 5/2, 1/2, 3/2. The values obtained are

$$Ga^{67}$$

$^2P_{3/2}$ a = 175.092 ± 0.009 mc

$^2P_{3/2}$ b = 71.939 ± 0.025 mc

$^2P_{1/2}$ $\Delta\nu$ = 2457.733 ± 0.030 mc

μ = +1.845 ± 0.001 nm
Q = + 0.217 ± 0.009 barn

$$Ga^{68}$$

$^2P_{3/2}$ $|a|$ = 3.875 ± 0.050 mc

$^2P_{3/2}$ $|b|$ = 12.230 ± 0.125 mc

$^2P_{3/2}$ b/a > 0

$|\mu|$ = 0.0272 ± 0.0008 nm
$|Q|$ = 0.037 + 0.001 barn

The nuclear moments are obtained from the Fermi-Segrè formula and the moments of Ga^{71}. The magnetic moments contain no diamagnetic correction. By using the interaction constants of Ga^{69} with our values for Ga^{67} yields $^{67}\Delta^{69} = (6 \pm 5) \times 10^{-5}\%$.

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF 9.9-Min Cu^{62} (Abstract), by B. Dodsworth, V. J. Ehlers and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339], Atomic Energy Commission, and Office of Naval Research)

Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 452, Dec. 28, 1959.

The spin of 9.9-min Cu^{62} has been measured by the atomic beam method as I = 1. The isotope was produced by decay of 9.3-hr Zn^{62}, which was formed by the reaction Ni (α, 2n) Zn^{62} by using 40-mev α particles. The Cu^{62} was extracted chemically every 60 min and electroplated from the solution. For normalization a small amount of 3.3-hr Cu^{61} was added to the chemistry. A comparison of the ratio of 9.9-min/3.3-hr material in the oven sample with the ratio of 9.9-min/3.3-hr material in the spin sample then indicated the presence or absence of a resonance. A resonance was indicated by an enrichment of Cu^{62} (spin 1) with respect to Cu^{61} (spin 3/2) in the spin sample. In the spin search, each oven load was exposed on a single button at a radiofrequency corresponding to a particular value of spin. Spin values of 0, 1, 2, or 3 were tried at several values of the field. The sample corresponding to spin 1 consistently showed an enrichment of the Cu^{62}/Cu^{61} ratio over that of the oven sample.

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF YTTRIUM-90 (Abstract), by F. R. Petersen and H. A. Shugart. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission)

Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 452, Dec. 28, 1959.

The nuclear spin I = 2 for radioactive yttrium-90 ($T_{1/2}$ = 64 hr) has been measured in the electronic states $^2D_{5/2}$ and $^2D_{3/2}$ by the atomic-beam magnetic-resonance method. The low-frequency "flop-in" resonances that were observed correspond to the transitions F, m_F = 9/2, -3/2 $\leftrightarrow$ 9/2, -5/2 and F, m_F = 7/2, - 1/2 $\leftrightarrow$ 7/2, -3/2 in he $^2D_{5/2}$ state and to the transitions F, m_F = 7/2, -3/2 $\leftrightarrow$ 7/2, -5/2 in the $^2D_{3/2}$ state. All transitions were observed at fields of 8.5 and 17 gauss. Certain transitions observed at higher fields have given preliminary values for the interaction constants a and b. The radioactive isotope was produced from the stable metal by the reaction Y^{89} (n, γ) Y^{90} in the Livermore pool-type reactor. Resonance detection was accomplished by collecting the radioactive atoms on sulfur-coated "buttons" which were later counted in continuous-flow beta counters. All spin buttons were decayed to verify the identity of the radioactivity.

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California U. [Dept. of Physics] Berkeley.

FERMI ACCELERATION OF ELECTRONS IN THE OUTER VAN ALLEN BELT, by J. A. Crawford. [1959] 6p. (AFOSR-TN-59-1278) [AF 49(638)508] AD 243992

Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 360, Aug. 27, 1959.

Also published in Phys. Rev. Ltrs., v. 3: 316-318, Oct. 1, 1959.

Interface instabilities associated with arriving and departing magnetic storm clouds generate a strong Fermi acceleration which "dumps" all Van Allen electrons of the outer belt that are trapped on magnetic lines anchored in the earth. For this reason among others, the decay of albedo neutrons can account only for the inner belt which remains essentially undisturbed. This "sweeping" action of storms suffices to explain the presence of a gap between the belts. Thus the exterior electron belt must initially be trapped in the closed magnetic loops left behind by the decaying storm. These loops decay in turn, depositing their radiation in the geomagnetic field. The 1-ev storm electrons originally trapped in the loops undergo a Fermi acceleration produced by the departing cloud. This leads very quickly to high energies and accounts satisfactorily for the radiation observed in the outer belt, collisions between electrons being duly taken into account in the complete Fokker-Planck

equation. Thus it is unnecessary to assume that this radiation must be transported somehow from the sun. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

CYCLOTRON RESONANCE IN ALUMINUM, by D. N. Langenberg and T. W. Moore. [1959] [2]p. incl. diagrs. (AFOSR-3411) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)600] and Office of Naval Research) AD 613118   Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 137-138, Aug. 1, 1959.

Cyclotron resonance in a single crystal sample of aluminum at 24 kmc/sec and 4.2°K is observed. Both absorption and absorption-derivative measurements were made the latter using magnetic field modulation. It is shown that at fields above 2 kilo-oersteds, the absorption curve shows a component periodic in $1/H$ superimposed on a monotonically decreasing component. The oscillations, which can be seen more clearly on the absorption-derivative curve, correspond to a cyclotron mass of 1.5 m_o and an $\omega\tau$ of about 10. The dependence of the resonance on sample orientation with respect to the magnetic field was also explored. Present data did not permit a detailed analysis, but several general statements are presented concerning the resonance, its area of resolution and other related facts.

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California U. Dept. of Physics, Berkeley.

CYCLOTRON RESONANCE IN COPPER, by D. N. Langenberg and T. W. Moore. [1959] [3]p. incl. diagrs. table. (AFOSR-3412) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)600] and Office of Naval Research)   Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 328-330, Oct. 1, 1959.

A series of resonances up to the 12th harmonic were found at 24 kmc/sec in an artificially grown Cu crystal with its surface parallel to a (110) plane. The observed masses vary between 0.5 m_o and 5 m_o; most lie between 1.1 m_o and 1.4 m_o. For most orientations, except along the (100), (110) and (111) axes, 2 masses are resolved. The general behavior agrees well with that expected.

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California U. Electronics Research Lab., Berkeley.

STEADY STATE TRANSMISSION THROUGH A NET-

WORK CONTAINING A SINGLE TIME VARYING ELEMENT, by C. A. Desoer. Dec. 22, 1958 [31]p. incl. diagrs. tables, refs. (Series no. 60; issue no. 221) (AFOSR-TN-59-106) (AF 18(600)1521) AD 210388; PB 139993   Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., May 5-7, 1959.

Abstract published in I.R.E. Trans. on Antennas and Propagation, v. AP-7: 299, July 1959.

Also published in I.R.E. Trans. on Circuit Theory, v. CT-6: 244-252, Sept. 1959.

A new method of steady state analysis of a linear network, of arbitrary degree of complexity, containing a single periodically varying element is presented. The method makes full use of circuit theoretic ideas, such as impedance matching and tearing apart and of iterating techniques which are particularly suitable for automatic computation. The method has the additional feature of leading to the amplitude and phase of all side bands and of giving a bound on the error if the iterations are stopped at any particular point. More precisely, it is shown that, provided the impedance seen by the time varying element becomes capacitive at very high frequencies, the complete solution can be found within an arbitrary amount of accuracy.

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California U. Electronics Research Lab., Berkeley.

THE BANG-BANG SERVO PROBLEM TREATED BY VARIATIONAL TECHNIQUES, by C. A. Desoer. Nov. 2, 1959 [16]p. incl. diagr. table, refs. (Series no. 60; issue no. 257) (AFOSR-TN-59-408) (AF 18(600)1521) AD 238347   Unclassified

Also published in Inform. and Control, v. 2: 333-349, Dec. 1959.

Variational techniques are used to establish the following result: suppose a dynamical system is governed by the differential equation $\dot{y} = Ay + f(t)$ where A is a real constant matrix with distinct eigenvalues. Suppose that these eigenvalues are further restricted to have non-positive real parts but are not required to be purely real. Finally let each component $\varphi(t)$ of the vector forcing function $f(t)$ satisfy, for all t, the conditions $|\varphi_i(t)| < \gamma_i$ (i = 1,2,$\cdots$,n) where the γ_i's are preassigned constants. It is shown that, given an arbitrary initial condition $y(0)$, the forcing function that will bring the system to its equilibrium position in the shortest possible time is such that $c_i(t) = \pm \gamma_i$, and the instants of time at which $c_i(t)$ changes from $\pm \gamma_i$ to $\mp \gamma_i$ are obtained by considering the output of the adjoint system. Further relationship between the given system and the adjoint system is discussed. It is also shown that this solution, obtained by variational techniques, implies the concept of switching surfaces. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

MODES IN LINEAR CIRCUITS AND LINEAR
SAMPLED DATA SYSTEMS, by C. A. Desoer. July 27,
1959 [43]p. incl. diagrs. refs. (Series no. 60; issue no.
244) (AFOSR-TN-59-849) (AF 18(600)1521)
AD 227707; PB 144493   Unclassified

Also published in I.R.E. Trans. on Circuit Theory,
v. CT-7: 211-223, Sept. 1960.

A concept of modes in linear circuits is developed.
The contribution of this paper is to show that provided
a suitable point of view is taken, the concept of modes
does apply indeed to any linear circuit: more precisely,
it shows that it applies to any lossy or lossless, active
or passive, reciprocal or nonreciprocal circuit. The
importance of the mode concept lies in the fact that it
allows one to consider a linear circuit as a whole, to
break up its behavior as a sum of very simple patterns,
and to visualize easily the effect of externally applied
forces. Furthermore it provides a very informative de-
scription of the resonance phenomenon. In particular
it is shown that (1) any free oscillation of a linear cir-
cuit can be throught of as a superposition of non-inter-
acting modes of oscillation, (2) in the case of free
oscillations the amount of excitation of each mode can
easily be determined on the basis of initial conditions,
(3) any forcing function can be considered as exciting
each mode independently, and (4) the resonance phenome-
non can be given a very simple interpretation pointing
out, in particular, the importance of the proper type of
excitation. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

THE OPTIMUM FORMULA FOR THE GAIN OF A FLOW
GRAPH OR A SIMPLE DERIVATION OF COATES' FOR-
MULA, by C. A. Desoer. July 6, 1960 [7]p. incl. diagrs.
(Series no. 60; issue no. 295) (AFOSR-TN-59-851)
(AF 18(600)1521) AD 241087   Unclassified

Also published in Proc. Inst. Radio Engineers, v. 48:
883-889, May 1960.

Starting from the definition of a determinant and using
a few of its elementary properties, this paper gives an
independent and simpler derivation of the optimum for-
mula for the gain of a flow graph. The following set of
linear algebraic equations are solved by topological
methods: $\sum_{j=1}^{n} a_{kj}x_j - b_k = 0$ $(k = 1, 2, ..., n)$. A flow

graph is then associated to this set of equations which
is defined as a set of weighted oriented branches which
connect at nodes. That is, each branch has a positive
direction and a weight, the branch gain. The first 5
sections of this paper use exclusively Coates' procedure

for associating a flow graph to a system of equations.
Section VII discusses the difference between Mason's
signal-flow graphs and Coates' flow graphs; it shows
how either one may easily be obtained if the other is
given.

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California U. Electronics Research Lab., Berkeley.

RECENT ADVANCES IN THE FIELD OF SAMPLED-
DATA AND DIGITAL CONTROL SYSTEMS, by E. I.
Jury. Oct. 20, 1959, 37p. incl. diagrs. refs. (Series
no. 60; issue no. 256) (AFOSR-TN-59-1017) (AF 18-
(600)1521) AD 233272; PB 146738   Unclassified

Presented at First Internat'l. Cong. of the Internat'l.
Federation of Automatic Control, Moscow (U.S.S.R.),
1960.

Also published in Automatic and Remote Control, v. 1:
262-269, 1960.

Theoretical aspects are described of the progress made
in the field of sampled-data and digital control systems
during the last few years. The material is classified in-
to the following major topics: (1) linear theory, (2) sta-
tistical theory, (3) nonlinear theory, (4) time-varying
theory, and (5) digital control systems. The above
mentioned topics are briefly described and methods of
analysis and design with their major purposes and
achievements are enumerated. Each category is docu-
mented with a brief list of references which might
serve as a quick aid to new investigators in this field.
A brief survey of digital control systems is discussed,
and it is indicated how the above mentioned topics can
be extended to these systems. (Contractor's abstract)

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California U. [Electronics Research Lab.] Berkeley.

THE STABILITY AND COMPENSATION OF SATURAT-
ING SAMPLED-DATA SYSTEMS, by F. J. Mullin.
[1959] [9]p. incl. diagrs. (AF 18(600)1521)
                                    Unclassified

Presented at Winter General meeting of the AIEE,
New York, Feb. 1-6, 1959.

Published in Trans. Amer. Inst. Elec. Engineers, v. 78
(Part I): 270-278, July 1959.

Sampled-data feedback systems which contain a saturat-
ing element are investigated. A condition which must
be satisfied if these systems are to be stable is de-
veloped. It is shown that this is a necessary condition
for stability and an intuitive argument is presented to
indicate that this condition is probably sufficient. Fi-
nally, a method to obtain a digital filter for compensating
and/or stabilizing these systems is presented. (Con-
tractor's abstract)

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California U. Electronics Research Lab., Berkeley.

ON THE COUPLING COEFFICIENTS IN THE "COU-
PLED-MODE" THEORY, by A. Yariv. [1958] [2]p.
[AF 49(638)102]   Unclassified

Published in Proc. Inst. Radio Engineers, v. 46: 1956-
1957, Dec. 1958.

The coupling coefficients which govern the energy ex-
change phenomena between traveling waves are evalu-
ated, using Pierce's coupled-mode theory (Jour. Appl.
Phys., v. 25: 179-183, Feb. 1954). Results are obtained
for traveling-wave tubes and double-stream amplifiers.

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California U. Electronics Research Lab., Berkeley.

THEORY OF MASER OSCILLATION, by J. C. Kemp.
Nov. 30, 1959 [4]p. incl. diagr. (Series no. 60; issue no.
259) (AFOSR-TN-59-366) (AF 49(638)102) AD 231273
                                         Unclassified

Also published in Jour. Appl. Phys., v. 30: 1451-1452,
Sept. 1959.

The mechanism responsible for the amplitude modu-
lated nature of the signal from an inverted spin system
undergoing maser oscillation or coherent spontaneous
emission was studied theoretically. It is shown that the
observed waveforms are due to large amplitude muta-
tions of the magnetization vector.

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California U. Electronics Research Lab., Berkeley.

RADIATION DAMPING EFFECTS IN TWO LEVEL
MASER OSCILLATORS, by A. Yariv, J. R. Singer, and
J. [C.] Kemp. [1959] [1]p. (AF 49(638)102) Unclassified

Published in Jour. Appl. Phys., v. 30: 265, Feb. 1959.

A re-examination is made of the phenomenon concern-
ing the appreciable amplitude modulation oscillation
resulting from an inverted 2-level spin system as
permitted to radiate spontaneously. It is found that
the linearized coupling between the spin system and
the cavity explanation, which assumes M_z to be a con-
stant, predicts modulated oscillation only for the case
$M_z = + M_0$ and not for the 2-level maser case where
$M_z = - M_0$. It is believed that the explanation of the
phenomenon lies in the nonlinear solution of the equa-
tions of motion presented, in which M_z is allowed to
vary with time.

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California U. Electronics Research Lab., Berkeley.

PROPOSAL FOR A TUNABLE MILLIMETER WAVE
MOLECULAR OSCILLATOR AND AMPLIFIER, by J. R.
Singer. [1959] [5]p. incl. diagr. refs. (AF 49(638)102)
                                         Unclassified

Published in I.R.E. Trans. on Microwave Theory and
Tech., v. MTT-7: 268-272, Apr. 1959.

An atomic beam apparatus suitable for a millimeter
wave generator is theoretically discussed. The beam
consists of atoms having a net magnetic moment. The
upper and lower Zeeman levels of the atomic beam in a
magnetic field are spatially separated by an inhomoge-
neous magnetic field. The upper state atoms enter a
cavity where transitions occur at a frequency deter-
mined by a static magnetic field. The resonant frequen-
cy of the cavity is set at the transition frequency. The
positive feedback of the cavity allows operation as an os-
cillator. Some of the more important parameters for
oscillator operation are evaluated. The upper frequency
limit is determined primarily by the resonant structure
design. (Contractor's abstract)

228

California U. [Electronics Research Lab.] Berkeley.

THIN FILM MAGNETIZATION ANALYSIS, by K. Chu and
J. R. Singer. [1959] [8]p. incl. diagrs. refs. [AF 49-
(638)102]   Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 1237-
1244, July 1959.

A "graphical method" is used for analysis of the magneti-
zation direction in terms of the magnetic energy, and for
prediction of the hysteresis loop shape of ferromagnetic
thin films. Three major magnetization conditions are
discussed: (1) condition of magnetization with an 180°
field applied; (2) condition of magnetization with a 90°
field applied; and (3) condition of magnetization with both
the 90° and the 180° field applied. Corresponding to these
magnetization conditions, the hysteresis loop shapes are
predicted and constructed showing close identity to those
experimentally observed. These conditions are chosen
because of their importance to computer applications.
In the graphical method, the principle of superposition
applies. Using this method, the magnetic energy relation-
ships are readily established. The general expression
for the total free energy equation is: $E_t = E_k + E_\sigma + E_{H\theta}$
where E_k is the anisotropy energy, E_σ is the magneto-
striction energy, and $F_{H\theta}$ is the magnetization energy.
Since the method of construction of the total free energy
curve as well as the hysteresis loop is simple and me-
chanical, a quite complex magnetization condition with a
multiplicity of fields of differing magnitudes and direc-
tions may be simplified and handled by graphical means
with ease. Thus, the present scheme should be a

practical and useful tool for analysis and engineering design of magnetic devices and systems utilizing ferromagnetic thin films. (Contractor's abstract)

229

California U. Electronics Research Lab., Berkeley.

EXPERIMENTAL PROCEDURE FOR THE DETERMINATION OF CAVITY PARAMETERS, by A. Yariv and F. D. Clapp. [1959] [4]p. incl. illus. diagrs. [AF 49-(638)102] Unclassified

Published in Rev. Scient. Instr., v. 30: 684-687, Aug. 1959.

A new experimental procedure for the determination of cavity parameters is described. The procedure follows the basic steps described by Slater. In this method one measures the frequencies at which the voltage standing wave ratio at the input to the cavity reaches a predetermined value. The knowledge of these frequencies coupled with a determination of the state of coupling to the cavity yields the necessary information. An exposition of some pertinent theoretical points is followed by a detailed description of the experimental procedure. (Contractor's abstract)

230

California U. Inst. of Engineering Research, Berkeley.

SELF-DIFFUSION IN NICKEL SINGLE CRYSTALS, by A. Messner, R. Benson, and J. E. Dorn. July 15, 1959, 12p. incl. diagrs. table. (Technical rept. no. 2: series no. 114; issue no. 2) (AFOSR-TN-59-1005) (AF 49(638)58) AD 225174 Unclassified

Using a sensitive surface monitoring technique, the volume diffusivity of Ni (63) into single Ni crystals was found to be given by $D = 5.8 \exp (69,700/RT)$ over the temperature range from 680°C to 830°C. (Contractor's abstract)

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California U. [Inst. of Engineering Research] Berkeley.

VECTOR POLAR METHOD FOR SHOCK INTERACTIONS WITH AREA DISTURBANCES, by A. K. Oppenheim and P. A. Urtiew. July 1959, 1v. incl. diagrs. tables, refs. (Technical note no. DR 4) (AFOSR-TN-59-701) (AF 49(638)166) AD 220405; PB 143670 Unclassified

The application of the vector polar method to the study of interactions between plane traveling shock waves and area disturbances involves the introduction of steady flow polars. The study covers first the interaction of shock waves with single area disturbances, that is divergences or convergences placed between 2 constant area tubes. Resulting wave systems for the whole field

of area ratios, R, and incident shock Mach numbers, M_i, are described. Representative cases are evaluated by the vector polar method and the regimes of solutions delineated on the $R - M_i$ diagrams for perfect gases with constant specific heats. Then interactions with convergent-divergent nozzles are treated in a similar manner. The solutions obtained by the vector polar method are shown to compare favorably with analytical and experimental results obtained by other investigators who studied the interactions of shocks with a variety of obstacles, such as grids and gauzes, in shock tubes. (Contractor's abstract)

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California U. [Inst. of Engineering Research] Berkeley.

FUNDAMENTALS OF THE POLAR METHOD IN GAS WAVE DYNAMICS, by R. A. Stern and A. K. Oppenheim. Nov. 1959 [95]p. incl. diagrs. tables, refs. (Technical note no. DR-5) (AFOSR-TN-59-1152) (AF 49(638)166) AD 230888; PB 145544 Unclassified

Gas wave dynamics is concerned with the analysis of interactions between waves propagating in compressible and reacting media. Multiple interactions, such as those occurring in shock tubes or during the development of detonation, require solutions by analysis which considers only the compatibility conditions for the wave system resulting from each interaction without any regard for the details of its progress. These dynamic boundary conditions are expressed in terms of invariance relations between equilibrium states across each component wave. For the solution of the wave system they have to be pieced together, either numerically by an iterative procedure, or graphically by the polar method. The present study introduces the fundamentals of the polar method. It consists of (1) the formulation of the basic problem leading to the establishment of invariance relations in the general case of a wave process, (2) the derivation of invariance relations for an elementary wave process in the general case of a compressible and reactive medium, and (3) the illustration of the analysis by the derivation of invariance relations for 2 special cases of simple waves: 1 with friction and the other with chemical reaction. (Contractor's abstract)

233

California U. [Inst. of Engineering Research] Berkeley.

STATISTICAL STUDY OF ACCELERATING FLAMES. ANALYSIS OF VARIANCE, by R. A. Stern, A. J. Laderman, and A. K. Oppenheim. Nov. 1959 [73]p. incl. diagrs. tables, refs. (Technical note no. DR-6) (AFOSR-TN-59-1171) (AF 49(638)166) AD 230889; PB 145637 Unclassified

Also published in Phys. Fluids, v. 3: 113-120, Jan.-Feb. 1960.

The study of velocity fluctuations observed by means of ionization probes during the development of detonation reveals its significance as an indicator of physical characteristics of the flame. The scatter in time of arrival-the reciprocal of the velocity-was found normally distributed at an 85% probability level. The means and standard deviation were determined within 5% and 20% respectively at a confidence level of 90%. The intensity of scatter is interpreted consequently as indicative of the combustion front fluctuation that can be considered to delineate the effective flame thickness. It is found then that as the flame accelerates, its effective thickness 1st increases, reaching a maximum in the vicinity of velocity overshoot, and then decreases, attaining finally a minimum, constant value when the steady detonation wave is established. An interesting bimodal distribution of scatter for the $2H_2 - O_2$ mixture has been

observed, indicating a possible existence of 2 alternative, independent modes for the development of the process. The results of the study are used to establish the requirements for more detailed, systematic investigation of the fluctuating characteristics of accelerating flame fronts. (Contractor's abstract)

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California U. [Inst. of Engineering Research] Berkeley.

PECULIARITY OF SHOCK IMPINGEMENT ON AREA CONVERGENCE, by A. K. Oppenheim, P. A. Urtiew, and R. A. Stern. 1959 [5]p. incl. diagrs. refs. (AFOSR-TN-59-1187) (AF 49(638)166) AD 230900
Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 361, Aug. 27, 1959.

Also published in Phys. Fluids, v. 2: 427-431, July-Aug. 1959.

General study of wave systems which can result from the interaction of plane shock with an area convergence has led to the discovery of an interesting regime, specified in terms of functional relationships between shock Mach numbers and area ratios, where two or three solutions exist at the same time, all satisfying the dynamic boundary conditions imposed by the conservation laws. The ambiguity is resolved by invoking the extremum principle of irreversible thermodynamics. (Contractor's abstract)

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California U. [Inst. of Engineering Research] Berkeley.

IONIZATION WORLD LINES IN GASEOUS PREDETO-NATION (Abstract), by G. J. Hecht, A. J. Laderman and others. [1959] [1]p. [AF 49(638)166]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 364, Aug. 27, 1959.

The techniques and apparatus required to extend the use of "pin or gap" type ionization detectors to yield reliable timing signals throughout the predetonation zone in detonation tube research with gaseous mixtures is fully described. Accurate timing signals in this zone provide direct data for a recent analysis by Oppenheim and Stern of the events leading up to detonation. Their analysis rests solely on the space-time history or "world lines" of flame fronts, shocks, rarefactions, and contact discontinuities. A consideration of the mechanisms of ionization in the predetonation zone is presented and it is shown that flame induced ionization can be distinguished unambiguously from that due to shocks on the basis of pulse amplitude of the signals appearing at the detectors. Design and construction of the probes, amplifier-thyratron timing channels, and operational requirement are presented. Precision of the apparatus is shown to be better than 2% throughout the entire predetonation zone. Experiments with H_2-O_2 mixtures are

described and the results shown to yield the flame world line.

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California U. Inst. of Engineering Research, Berkeley.

THEORY OF THE STAGNATION POINT LANGMUIR PROBE, by L. Talbot. Mar. 30, 1959, 27p. incl. diagrs. refs. (Rept. no. HE-150-168, series no. 132, issue no. 1) (AFOSR-TN-59-474) (AF 49(638)502) AD 215717; PB 142263   Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 365, Aug. 27, 1959.

Also published in Phys. Fluids, v. 3: 289-298, Mar.-Apr. 1960.

The theory of the stagnation point Langmuir probe is developed to show that measurements made with such a probe can be used to determine free stream ion concentration and temperatures in a supersonic plasma jet stream. From the analysis, it appears that a variation in probe potential will produce a variation in heat transfer which may prove useful in plasma jet diagnostics. A sample computation is given to illustrate the application of this theory and to exhibit orders of magnitude of the quantities of interest.

237

California U. Inst. of Engineering Research, Berkeley.

LOW DENSITY SUPERSONIC DIFFUSER PERFORM-
ANCE, by A. M. Collins. Jan. 15, 1959 [16]p. incl. illus.
diagrs. refs. (Rept. no. HE-150-164; series no. 20, is-
sue no. 126) (Sponsored jointly by Air Force Office of
Scientific Research and Office of Naval Research under
Nonr-22245) AD 215973   Unclassified

The impact pressure and static pressure recoveries of
a supersonic, converging-diverging diffuser were meas-
ured in the range $M = 1.7 - 4.1$, Re_L 500 - 3200. The
Reynolds number was with respect to the leading edge
diam. It was found that, for subsonic flow in the back
end of the diffuser, normal shock static and impact
pressure recoveries were the best that could be ob-
tained. Afterglow photographs were taken of the low
density flow inside the transparent plastic diffuser.
(Contractor's abstract)

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California U. Inst. of Engineering Research, Berkeley.

HEAT TRANSFER, RECOVERY FACTOR, AND PRES-
SURE DISTRIBUTIONS AROUND A CYLINDER NOR-
MAL TO A SUPERSONIC RAREFIED-AIR STREAM.
PART I. EXPERIMENTAL DATA, by O. K. Tewfik and
W. H. Giedt. Jan. 30, 1959, 1v. incl. illus. diagrs.
tables. (Rept. no. HE-150-162; series no. 20, issue no.
124) ([Sponsored jointly by Air Force Office of Scien-
tific Research and Office of Naval Research] under
Nonr-22245' AD 214435   Unclassified

Local heat transfer, recovery factor, and pressure dis-
tributions around a circular cylinder normal to a su-
personic rarefied air stream were measured from
$M = 1.3$ to 5.9, from $Re = 37$ to 4100, and at 2 cylinder
wall average temperature levels of 90° and 210°K under
steady state thermal and flow conditions. A correlation
equation for the stagnation point Nusselt number was
determined in terms of Reynolds number just after the
normal part of the detached bow shock wave, or in terms
of the undisturbed stream Mach and Reynolds numbers.
Empirical expressions for the local heat transfer co-
efficient and coefficient of pressure distribution around
the entire cylinder surface were obtained in the form
of a Fourier series. Effects of cylinder wall tempera-
ture level and gradient on the heat transfer and pres-
sure distribution are discussed.

239

California U. Inst. of Engineering Research, Berkeley.

OXYGEN RECOMBINATION PROGRAM, by S. A. Hoenig.
Mar. 23, 1959 [42]p. incl. illus. tables, refs. (Rept. no.
HE-150-163; series no. 20, issue no. 125) (Sponsored

jointly by Air Force Office of Scientific Research and
Office of Naval Research under Nonr-22245) AD 216800
                                    Unclassified

A program was initiated to measure the catalytic effi-
ciency for a series of surfaces which would simulate
the condition that will exist on a high speed aircraft at
extreme altitudes. The study is concerned with the ef-
fects of the vehicle surface on the aerodynamic flow.
These effects can arise from 2 causes: (1) the flight
Mach number may be so high that a significant fraction
of the air which passes through the shock wave is dis-
sociated or ionized, or (2) the air itself may consist not
of diatomic oxygen and nitrogen, but of free atoms of
these substances. The catalytic efficiency is defined as
the ratio of the number of reactions occurring on the
surface per unit time to the total number of collisions of
reactive species with the surface per unit time. An ex-
perimental apparatus was designed to measure the cata-
lytic properties of various metals toward gaseous re-
combination. The equipment consists of a series of
valves through which the test gas is drawn to reduce the
pressure, and a silica-gel dryer to remove water-vapor.
The gas flows through a heater, then to a stagnation
chamber and effuses into the test tank. The probe as-
sembly consists of a plexiglass disc which supports the
2 thermistors, which in turn carry the probes. A wheat-
stone bridge is also used with the thermistor forming one
arm. (ASTIA abstract)

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California U. Inst. of Engineering Research, Berkeley.

DESIGN, FABRICATION, AND EVALUATION OF AXI-
SYMMETRIC NOZZLES, by L. L. Lynes. Sept. 10, 1959,
1v. incl. illus. tables. (Rept. no. HE-150-174; series
no. 20, issue no. 132) (Sponsored jointly by Air Force
Office of Scientific Research and Office of Naval Re-
search under Nonr-22245) AD 226224   Unclassified

The pumping capacity of the no. 3 wind tunnel was in-
creased in 1954 in order to accommodate a Mach 6 noz-
zle of a usable test section size. This increased capaci-
ty left the previous nozzles still usable in their own
range, but with a smaller test section size than would
have been available with the increased capacity. Since
it is most desirable to have as large a test section as
possible, it is necessary to have the nozzles designed
at max capacity. Scaling procedures are given for in-
creasing the size of the existing nozzles to meet the in-
creased capacity. This was accomplished by application
of scaling laws to a Mach 4 nozzle, followed by fabrica-
tion and experimental evaluation of the resulting nozzle.
(Contractor's abstract)

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California U. [Inst. of Engineering Research] Berkeley.

VISCOUS INTERACTION EXPERIMENTS AT LOW
REYNOLDS NUMBERS, by S. A. Schaaf, F. C. Hurlbut

and others. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research, Bell Aircraft Corp., and Office of Naval Research under [Nonr-22245]) Unclassified

Published in ARS Jour., v. 29: 527-528, July 1959.

Data are presented which suggest that slip flow phenomena occur at the sharp leading edge of a flat plate at zero angle of attack in supersonic flow. Disturbance of pressure due to boundary layer displacement is shown to result in slip above certain limiting values of surface pressure.

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California U. Minerals Research Lab., Berkeley.

ARC IMAGE FURNACE, by D. O. Horning and E. R. Parker. Final rept. May 1959 [22]p. incl. ilius. diagrs. table, refs. (Series no. 141) (AFOSR-TR-59-88) (AF 18(603)123) AD 220856; PB 143622
Unclassified

An arc image furnace was designed to provide an uncontaminated high-intensity heated zone of appreciable size in the temperature range of 6000° to 10,000°K. "Uncontaminated" is inferred to cover conditions arising due to atmospheric pollutants and electrical or magnetic influences. The furnace consists of an external spherical shell and vacuum system, paraboloid mirror mounts, arc container, power supply, and preliminary instrumentation. The initial low-power operation and calibration were completed. The furnace is to be tested at high arc current rates in final tests. The initial low-power operation and calibration indicate that the final tests should be successful.

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California U. Minerals Research Lab., Berkeley.

INTERNAL STRESSES IN MODEL CERAMIC SYSTEMS II. A. X-RAY STRAIN MEASUREMENT TECHNIQUES FOR CERAMIC BODIES. B. EXTENDING THE RANGE OF REPLICATION TECHNIQUES, by L. N. Grossman, R. M. Fulrath, and R. B. Langston. Technical progress rept. no. 2, Oct. 1, 1959, 1v. incl. illus. diagrs. tables, refs. (Series no. 119; Issue no. 2) (AFOSR-TN-59-1181) (AF 49(638)4) AD 229892; PB 145018
Unclassified

Pt. A also published in Jour. Amer. Ceram. Soc., v. 44: 567-571, Nov. 1961.

Part A. X-ray diffractometer techniques for measuring triaxial and biaxial strain in ceramic bodies are described. The results of the techniques as applied to model ceramic systems using Al_2O_3 and ThO_2 crystal phases with various glasses in the $Na_2O-B_2O_3-SiO_2$ system are presented. It is shown that internal stresses

due to expansion coefficient mismatches occur in these systems and that their magnitudes often exceed the bulk strength of the body. Further applications of the techniques are discussed. Part B. In a progress report on obtaining the microstructures of model ceramic systems used in the investigation of internal stresses in ceramics, it is concluded that: (1) The microstructures of polished ceramic specimens could not be observed until etchants were used to produce relief and difference in texture. (2) Preparation of a number of replicas from the same surface allows simultaneous studies of the microstructure under a wide range of magnifications. (3) Differences in relief and texture, which allows one to study particle size, packing, and orientation, were best observed using oblique lighting and shadowing techniques. (4) Carefully controlled studies on etchants and etching techniques are necessary to obtain the microstructural information on ceramic systems with and without the use of replicas.

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California U. Minerals Research Lab., Berkeley.

THE EFFECT OF IMPURITIES ON THE STRENGTH OF SILVER CHLORIDE, by W. J. Luhman and A. E. Gorum. [1959] [3]p. incl. diagrs. (Contribution no. 98; IER reprint no. 20-60) (AFOSR-4397) (AF 49(638)56)
Unclassified

Published in Acta Metall., v. 7: 685-687, Oct. 1959.

The results of investigations to obtain the effect of small impurity additions on the stress-strain characteristics of a representative ionic material are presented. It is shown that all additions caused AgCl to become more light sensitive. Silver bromide was easily added to AgCl in any proportion while the other materials, if added in great amounts, would cause decomposition. Different addition materials gave different effects and different proportions of the same additive gave different results. Some rather large changes in lattice parameter were noted in some cases. It was noted that the effect of these additions on the stress-strain curve is similar to that found in metal solid systems.

245

California U. Minerals Research Lab., Berkeley.

FRACTURE OF CERAMIC MATERIALS, by E. R. Parker. [1959] [12]p. incl. illus. diagrs. refs. [AF 49-(638)56] Unclassified

Published in Proc. Internat'l. Conf. on the Atomic Mechanisms of Fracture, Swampscott, Mass. (Apr. 12-16, 1959), Cambridge, MIT Technology Press, 1959, p. 181-192.

The microscopic observations of deformed and etched MgO single crystals are described. It is stated that etch-pit studies reveal slip bands densely populated with

dislocations and that these slip bands act as barriers to dislocations of intersecting slip planes. Cleavage cracks on (001) and (011) planes are found at the junctions on intersecting slip bands. The formation of these cracks is evidently associated with the high local stresses produced by dislocation pile-up. (Contractor's abstract)

246

California U. Minerals Research Lab., Berkeley.

HIGH TEMPERATURE HEAT CONTENTS OF SOME BINARY IRON ALLOYS, by W. B. Kendall, P. L. Orr, and R. Hultgren. July 1, 1959, 14p. incl. tables. (Technical note no. 2; series no. 137; issue no. 2) (AFOSR-TN-59-524) (AF 49(638)83) AD 216258; PB 143647. Unclassified

Although the detailed behavior of the heat capacity in regions of thermal anomalies is, in general, poorly defined by heat content measurements, the Curie temperatures derived from the present data for $Co_{0.309}Fe_{0.691}$, $Cr_{0.094}Fe_{0.906}$, and $Fe_{0.880}Si_{0.120}$ are in excellent agreement with those shown in the new edition of Hansen. The heat contents reported here have been measured with an average experimental precision of about $\pm 0.3\%$. As a result of the method used to calibrate the calorimeter, the experimental measurements are all referenced to the heat content of platinum; thus the absolute accuracy of the smoothed data is about the same order of magnitude as that for pure platinum (probably about $\pm 0.3\%$). Errors due to uncertainty in the sample composition are considered inconsequential, since small amounts of metallic impurities generally have a negligible effect on the heat content of an alloy. The hypothesis that the anomalous hump in each of the heat capacity curves of $Fe_{0.512}Mn_{0.488}$ and $Fe_{0.696}Mn_{0.304}$ corresponds to an antiferromagnetic transformation could easily be checked by measuring the magnetic susceptibilities of these alloys over the temperature range of interest. A maximum in the susceptibility in the vicinity of the anomalously high heat capacities would clearly support such a hypothesis. (Contractor's abstract)

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California U. Minerals Research Lab., Berkeley.

THE HEAT CAPACITY OF DILUTE SOLUTIONS OF CHROMIUM IN NICKEL, by R. Hultgren and C. Land. July 1, 1959 [2]p. incl. tables. (Technical note no. 1; series no. 137; issue no. 1) (AFOSR-TN-59-525) (AF 49(638)83) AD 216259   Unclassified

Also published in Trans. Metall. Soc. AIME, v. 215: 165-166, Feb. 1959.

Heat contents of four Cr-Ni alloys were determined in a diphenyl ether calorimeter. Aside from ferromagnetic

effects, Kopp's law of additivity of heat capacities is approximately followed, in disagreement with earlier results of A. W. Foster (Philos. Mag., v. 18: 470-488, Sept. 1934). (Contractor's abstract)

248

California U. School of Public Health, Berkeley.

FURTHER STUDIES OF GASEOUS ION ACTION ON TRACHEA, by A. P. Kreuger, R. F. Smith and others. [1959] [11]p. incl. table. (AFOSR-TN-59-884) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)669 and Atomic Energy Commission) AD 230696   Unclassified

Also published in Proc. Soc. for Exper. Biol. and Med., v. 102: 355-357, 1959.

The trachea of the living rabbit was observed during exposure to un-ionized and ionized N_2, O_2 and CO_2 using a separate airway for respiration. Positively charged CO_2 was found to be responsible for: reduction of ciliary activity, contracture of smooth muscle, ischemia and enhanced vulnerability to trauma. (Contractor's abstract)

249

California U. School of Public Health, Berkeley.

SOME BIOLOGIC PROPERTIES OF GASEOUS IONS, by A. P. Krueger. [1959] [10]p. incl. diagrs. refs. (AFOSR-TN-59-1143) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)669, Atomic Energy Commission, and National Institutes of Health) AD 142526   Unclassified

Also published in Jour. Albert Einstein Medical Center, v. 8: 79-88, Apr. 1960.

Positively and negatively charged atmospheric ions exert profound influences on ciliary activity, mucous flow and vulnerability to trauma of the living cells of the trachea. Original experiments suggest that these effects are mediated through cytochrome oxidase and possibly through local 5-hydroxytryptamine release and oxidation. (Contractor's abstract)

250

California U. School of Public Health, Berkeley.

THE BIOLOGICAL MECHANISMS OF AIR ION ACTION. 1. 5-HYDROXYTRYPTAMINE AS THE ENDOGENOUS MEDIATOR OF POSITIVE AIR ION EFFECTS ON THE MAMMALIAN TRACHEA, by A. P. Krueger and R. F. Smith. [1959] [8]p. incl. diagrs. refs. (AFOSR-TN-59-1300) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)669 and Atomic Energy Commission) AD 234189   Unclassified

Also published in Jour. Gen. Physiol., v. 43: 533-540, Jan. 1960.

Intravenous administration of 5-hydroxytryptamine to rabbits and guinea pigs is shown to bring about changes very similar to those produced by (+) air ions, including (1) decreased ciliary rate, (2) contraction of the posterior tracheal wall, (3) exaggerated response of the tracheal mucosa to trauma, (4) marked vasoconstriction in the tracheal wall, and (5) increased respiratory rate. These effects are reversed by (-) air ions. Iproniazid, which raises 5-hydroxytryptamine levels in the animal by blocking monamine oxidase, produces similar but non-reversible effects. Reserpine, which depletes 5-hydroxytryptamine in the animal, causes changes that resemble those produced by (-) air ions, including (1) increased ciliary rate, (2) relaxed posterior sulcus, (3) hyperemia of the tracheal mucosa, (4) lowered respiratory rate, and (5) increased volume and rate of mucus flow. On the basis of these facts, the hypothesis is advanced that (+) air ion effects are mediated by the release of free 5-hydroxytryptamine, while (-) air ion effects depend on the ability of (-) ions to accelerate the enzymatic oxidation of 5-hydroxytryptamine. (Contractor's abstract)

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California U. Dept. of Astronomy, Los Angeles.

EFFICIENT PRECISION ORBIT COMPUTATIONAL TECHNIQUES, by R. M. L. Baker, Jr., G. B. Westrom and others. June 11, 1959, 1v. incl. diagrs. tables, refs. (Astrodynamical rept. no. 3) (AFOSR-TN-59-766) (In cooperation with Aeronutronic, Newport Beach, Calif.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)498 and Army Ballistic Missile Agency under DA-04-495-ORD-1389) AD 227519; PB 144014   Unclassified

Presented at meeting of the Amer. Rocket Soc., San Diego, Calif., June 8-11, 1959.

Also published in ARS Jour., v. 30: 740-747, Aug. 1960.

A comparison is made of the methods of Cowell, Encke and the variation-of-parameters for the computation of high-precision orbits. Analysis of the integration of an analytical 3-body trajectory and an analytical low-thrust spiral trajectory indicated the importance of decreasing the overall number of integration steps to avoid round-off errors. Comparative computations demonstrated that Encke's method is preferable in the ballistic lunar trajectory, variation-of-parameters in the low-thrust trajectory, and Cowell's method in the high-thrust trajectory. The overall computational efficiency of the Encke's and the variation-of-parameters method is also shown. (Contractor's abstract)

252

California U. Dept. of Astronomy, Los Angeles.

THREE-DIMENSIONAL DRAG PERTURBATION TECHNIQUE, by R. M. L. Baker, Jr. July 1, 1959 [6]p. incl. diagr. refs. (Astrodynamical rept. no. 4) (AFOSR-TN-59-767) (In cooperation with Aeronutronic, Newport Beach, Calif.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)498 and Army Ballistic Missile Agency under DA-04-495-ORD-1389) AD 263780   Unclassified

Also published in ARS Jour., v. 30: 748-753, Aug. 1960.

The analysis of the application of an astronomical special perturbation technique to the entry of space vehicles (into a resistive medium) is extended to three dimensions. Furthermore, perturbations resulting from the asphericity of Earth and the rotation of Earth's atmosphere were explicitly included, and the effects of ablation, cross winds and lift are considered. Use of the variation-of-parameters perturbation technique allows for the more efficient and accurate computation of a large class of entry orbits. (Contractor's abstract)

253

California U. Dept. of Astronomy, Los Angeles.

DIFFERENTIAL EXPRESSIONS FOR LOW-ECCENTRICITY GEOCENTRIC ORBITS, by S. Herrick, L. G. Walters, and C. G. Hilton. June 11, 1959 [33]p. incl. diagrs. tables. (Astrodynamical rept. no. 2) (AFOSR-TN-59-768) (In cooperation with Aeronutronic, Newport Beach, Calif.) (AF 49(638)498) AD 227518; PB 144277   Unclassified

Also published in Proc. Tenth Internat'l. Astronaut. Congress, London (Gt. Brit.) (Aug. 30-Sept. 5, 1959), Vienna, Springer-Verlag, v. 1: 327-340, 1960.

In the planning and evaluation of a tracking complex for space vehicles, two functions are served by differential expressions relating uncertainties, errors, or corrections in selected orbital elements to corresponding uncertainties, errors, or corrections in the observed coordinates. These functions are: (1) The translation of orbit uncertainties into observed quantities, or vice versa, for an evaluation of ability to correct an orbit from given observations, or for an evaluation of the accuracy of an ephemeris based upon these observations. (2) The translation of residuals in observed coordinates into differential corrections to the orbital elements (or parameters). The analysis presented here is divided into two steps because of the need for data intermediate between the parameters and the ephemeris.

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California U. Dept. of Astronomy, Los Angeles.

PRECISION ORBITS AND OBSERVATION REDUCTION, by S. Herrick. June 11, 1959. 21p. (Astrodynamical rept. no. 1) (AFOSR-TN-59-769) (In cooperation with Aeronutronic, Newport Beach, Calif.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)498, Army Ballistic Missile Agency under DA-04-495-ORD-1389, National Aeronautics and Space Administration under NASA-204, Pacific Missile Range under NOas-59-6110-C, and Wright Air Development Center under AF 33(616)6005) AD 227517; PB 144278
Unclassified

The advantages and disadvantages (1) in the reduction of observations, (2) of "fixes", (3) triangulation, (4) assumed motions or orbits, (5) reduction to the center of the Earth, (6) and reference systems are discussed in the light of astrodynamical experience and the requirements of different types of orbit and of errors of observation. The differential correction is defined and outlined. The "fix" and "complete observations" are discussed in relation to the determination of orbits and compared with the differential correction. The provinces of observer and orbit analyst are differentiated. The need for accurate observations and reductions is stressed. (Contractor's abstract)

255

California U. Dept. of Astronomy, Los Angeles.

THE "ASTRONOMICAL UNIT" AND THE SOLAR PARALLAX, by S. Herrick, G. [B.] Westrom, and M. W. Makemson. Sept. 30, 1959, 25p. incl. diagrs. tables, refs. (Astrodynamical rept. no. 5) (AFOSR-TN-59-1044) (In cooperation with Aeronutronic, Newport Beach, Calif.) (AF 49(638)498) AD 234711; PB 148266
Unclassified

The pros and cons of utilizing laboratory or astronomical units in measuring distance and trajectory constants are discussed along with the best way of handling trajectory calculations in connection with specific orbit problems. The discussion covers both the classical astronomical determinations of the solar parallax and the possibility of new determinations based upon the recent radar contact with Venus and upon possible radar or transponder-assisted contacts with minor planets or vehicles in space.

256

California U. Dept. of Astronomy, Los Angeles.

FUNDAMENTALS OF ASTRODYNAMICS, by R. M. L. Baker, Jr. and M. W. Makemson. Sept. 30, 1959, 336p. incl. diagrs. tables, refs. (Astrodynamical rept. no. 6) (AFOSR-TN-59-1045) (In cooperation with Aeronutronic, Newport Beach, Calif.) (Sponsored jointly by Air Force

Office of Scientific Research under AF 49(638)498, Army Ballistic Missile Agency under DA-04-495-ORD-1389, and National Astronautics and Space Administration under NAS-5-76 and NAS-1-204) AD 234696
Unclassified

An extensive report is made on astrodynamics, its history, nomenclature, practical applications, and fundamental techniques from an engineer or non-astronomer point of view. Emphasis is placed on the problems of space vehicle trajectories. In particular, the topics of minor planets, comets, astronomical constants, orbit determination, n-body problems, perturbation techniques, non-gravitational forces, observation theory, and application to interplanetary orbits are singled out for more complete discussion.

257

California U. [Dept. of Astronomy] Los Angeles.

OBSERVATION REQUIREMENTS FOR PRECISION ORBIT DETERMINATION, by S. Herrick. [1959] [18]p. incl. refs. (AF 49(638)498)   Unclassified

Published in Proc. Durand Centennial Conf. on Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-8, 1959), New York, Pergamon Press, 1960, p. 417-434. (AFOSR-TR-59-108)

An examination is made of such matters as triangulation, the use of incomplete observations, the nature and treatment of errors, the connection of observations with the dynamic center, the adequacy of current astronomical frames of reference and in general the definition and separation of the functions of observer and orbit analyst. In short, the observer should not apply general corrections which might be handled differently by other observers, or which might be more experimentally and judiciously treated by the analyst, who has a wider perspective over the situation. On the other hand, the smoothing out of accidental errors and compression of extensive data are definitely within the sphere of the observer. It is also pointed out that to achieve spot landings on the Moon, to establish and supply expeditions, bases and depots required for scientific and other purposes of the future, it is clear that improvements must be made in several directions including correction for imperfect burnout conditions and derivation of more precise geophysical and astronomical constants by means of accurate theories and observations.

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California U. Dept. of Chemistry, Los Angeles.

THE CRYSTAL STRUCTURE OF AMMONIUM CHLORITE AT -35°C, by R. B. Gillespie and K. N. Trueblood. Dec. 1958 [33]p. incl. diagrs. tables, refs. (Perchlorates technical note no. 5) (AFOSR-TN-59-103) (AF 18(600)857) AD 210385; PB 139996   Unclassified

Also published in Acta Cryst., v. 12: 867-872, Nov. 10, 1959.

The structure of ammonium chlorite has been determined using 3-dimensional Fourier and least squares refinement of the parameters. The previously published structure is shown to be incorrect. The crystals are tetragonal with space group $P\overline{4}2_1 m$, and 2 molecules in the unit cell of dimensions $a_o = 6.35A$ and $c_o = 3.78A$ at $-35°C$. The chlorite ion is triangular with the O-CL-O angle $110°$ and the CL-O distance $1.57A$. Single crystals of ammonium chlorite decompose to crystalline ammonium chloride and ammonium chlorate which are found to be precisely oriented with respect to the original ammonium chlorite. A preliminary crystallographic examination of ammonium chlorate shows this substance to be trigonal, with $a_o = 4.43A$ and $\alpha = 86.5°$. The crystals appear to be isomorphous with potassium bromate, and thus the space group is probably R3m. (Contractor's abstract)

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California U. Dept. of Chemistry, Los Angeles.

REFINEMENT OF THE CRYSTAL STRUCTURES OF SODIUM CHLORATE AND POTASSIUM CHLORATE, by J. G. Bower, R. A. Sparks, and K. N. Trueblood. Jan. 1959, 28p. incl. tables, refs. (Perchlorates technical note no. 6) (AFOSR-TN-59-104) (AF 18(600)857) AD 210386; PB 139994   Unclassified

The crystal structures of sodium chlorate and potassium chlorate have been reinvestigated with 3-dimensional visual x-ray intensity data obtained with CuKa radiation. Each structure has been defined by Fourier and least squares methods. The dimensions of the chlorate ion in the 2 structures are the same within experimental error. In sodium chlorate the chlorate ion lies on a 3-fold axis, the Cl-O distance is 1.45_5A, with standard deviation of about 0.02A, and the O-Cl-O angle is $107.4° \pm 1.50$. In potassium chlorate the ion lies on a mirror plane; the 2 independent Cl-O distances are $1.46_0 \pm 0.01$ and $1.46_1 \pm 0.03A$, and the 2 O-Cl-O angles are $108.1 \pm 1.1°$ and $108.7 \pm 0.7°$. Thus the marked asymmetry of the chlorate ion in potassium chlorate which was originally reported by Zachariasen (0.18A in bond distance and 21° in bond angle) does not in fact exist. The findings are in accord with the quadrupole spectrum measurements by Zeldes and Livingston, which indicate that the chlorate ion in potassium chlorate must possess very nearly a 3-fold axis of asymmetry. In sodium chlorate each sodium atom is surrounded by an octahedron of oxygen atoms, the 2-independent Na-O distances being 2.45 and 2.47A. In the potassium salt, the potassium atom has 9-nearest oxygen neighbors at distances of 2.78 to 3.11A. (Contractor's abstract)

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California U. Dept. of Chemistry, Los Angeles.

THE CRYSTAL STRUCTURE OF TETRACYANO-ETHYLENE, by D. A. Bekoe and K. N. Trueblood. Jan. 1959, 23p. incl. diagrs. tables, refs. (Perchlorates technical note no. 7) (AFOSR-TN-59-186) (AF 18(600)-857) AD 211326; PB 140316   Unclassified

Also published in Zeitschr. Krist., v. 113: 1-22, Apr. 1960.

Tetracyanoethylene, $(NC)_2C = C(CN)_2$, forms monoclinic crystals of space group $P2_1/n$, with a = 7.51, b = 6.21, c = 7.00A and $\beta = 97°10'$. There are 2 centrosymmetric molecules in the unit cell. The structure was solved with the aid of a sharpened 3-dimensional Patterson synthesis and was refined by least-squares methods. The thermal vibration parameters resulting from the refinement were analyzed to provide approximate librational corrections to the apparent bond distances. The corrected distances, with their estimated standard deviations, are: the central double bond, $1.317 \pm 0.009A$; the 2 crystallographically independent C-C bonds, 1.454 ± 0.007 and $1.443 \pm 0.006A$; the 2 independent C-N bonds, $1.15 \pm 0.012A$. The larger standard deviations and lower precision for the latter bonds reflect uncertainties in the librational corrections. No atom in the molecule is as much as 0.01A from the least-squares plane through the molecule. (Contractor's abstract)

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California U. Dept. of Chemistry, Los Angeles.

STUDIES OF THE STRUCTURES OF CRYSTALLINE PERCHLORATES AND RELATED SUBSTANCES, by K. N. Trueblood. Final technical rept. Jan. 1959, 17p. incl. refs. (AFOSR-TR-59-13) (AF 18(600)857) AD 210387; PB 140315   Unclassified

Investigations were conducted on crystal structures by x-ray diffraction techniques including (a) determination of x-ray diffraction patterns of lithium perchlorate trihydrate, anhydrous lithium perchlorate, silver perchlorate monohydrate, anhydrous silver perchlorate, and related substances, and also of simple molecular complexes, (b) analysis of the x-ray patterns by means of 3-dimensional Patterson or modified Fourier functions, and (c) work on new precise methods of structure refinement on high-speed computers.

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California U. Dept. of Engineering, Los Angeles.

YIELD SURFACE AND PLASTIC POTENTIAL OF METALS, by T. H. Lin. July 1959, 9p. incl. diagr. refs. (AFOSR-TN-59-714) (AF 49(638)20) AD 229478; PB 144931   Unclassified

The coincidence of the plastic potential and yield surface for both single crystal and polycrystal aggregate is derived from the consideration of elastic strain and slips in individual crystals. Uniqueness in single crystals for incremental stress and strain is discussed. Corners in yield surfaces of a polycrystal aggregate are shown to exist and the sharpness of the corner is shown to increase with loading. (Contractor's abstract)

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California U. Dept. of Engineering, Los Angeles.

STRESS FIELD OF A UNIFORMLY PLASTICALLY DEFORMED CRYSTAL IN AN AGGREGATE, by T. H. Lin and S. Uchiyama. Oct. 1959, 33p. incl. diagrs. refs. (AFOSR-TN-59-1048) (AF 49(638)20) AD 233074; PB 145867   Unclassified

It is shown that the stress due to slip decreases rapidly with the distance from the slip. The region at a distance of 2 to 3 linear lengths of the cube is practically free from the effect of the slipped region. This shows that the slip in 1 crystal only affects the stresses locally and does not affect the main part of the aggregate. When the aggregate stress produces a resolved shear stress in the most favorably oriented crystal greater than its critical shear stress, this excess shear stress is relieved by slips. It is also shown that the shear stress τ_{12}, relieved due to a uniform slip in

the crystal, varies with the distance from the center. For relieving the same amount of excess shear stress in the crystal, a heterogeneous slip is required.

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California U. Dept. of Engineering, Los Angeles.

ON THE OPTIMUM SYNTHESIS OF MULTIPOLE CONTROL SYSTEMS IN THE WIENER SENSE, by H. C. Hsieh and C. T. Leondes. Mar. 1959, 61p. (AFOSR-TN-59-263) (AF 49(638)438) AD 212466
                                               Unclassified

Also published in I.R.E. Nat'l. Convention Record, Pt. 4: 18-31. 1959.

This report is concerned with obtaining the optimum system in the Wiener sense for a certain multipole system. Earlier literature has shown how to obtain the mean-square value of the error when the multipole system transfer function has been specified, but thus far no published work has shown how to solve the synthesis problem, in general, for this case. The principal reason that this problem has appeared to be impossible of analytic solution thus far for cross correlation between the inputs is based on the fact that the usual variational approach results in a set of untractable simultaneous integral equations involving many complicated cross products of the desired weighting functions and the variational functions. The synthesis

problem for the above-mentioned multipole system is first solved for the case in which there is no correlation between the inputs to the various terminals. Following this, the far more complicated case of the synthesis problem when the inputs to all the various terminals are correlated is considered. In this case, a rather unique technique is utilized to avoid the difficulties inherent in the use of the usual variational techniques. Through the technique utilized in this report, the usual set of untractable simultaneous integral equations is completely avoided, and instead, a set of ordinary algebraic equations results. The report then concludes with an illustrative example for the more complicated case of correlated inputs.

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California U. Dept. of Engineering, Los Angeles.

A PARAMETER TRACKING SERVO FOR ADAPTIVE CONTROL SYSTEMS, by M. Margolis and C. T. Leondes. Aug. 1959, 30p. incl. diagrs. table, refs. (AFOSR-TN-59-917) (AF 49(638)438) AD 229570; PB 144769   Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 18-21, 1959.

Also published in I.R.E. WESCON Convention Record, Pt. 4: 104-115, 1959.

Also published in I.R.E. Trans. on Automatic Control, v. AC-4: 100-111, Nov. 1959.

A general approach to the design of adaptive control systems is described. The particular systems considered are process adaptive. The dynamic characteristics of the physical process are determined by the parameter tracking servo. The parameters determined are used to program the process controller. The parameter tracking servo is a closed loop self-adjusting system with (1) the physical process, (2) the learning model, and (3) the adjusting mechanism. The learning model and the physical process are subjected to the same input signals. Their outputs are compared and the resultant error is fed to the adjusting mechanism where some function of this error is used to adjust the parameters of the learning model. The mechanism will continuously track the parameters of the physical process as they change with time. The adjusting mechanism operates on an approximation to the method of steepest descent. These equations are derived for a first order process and the overall system is analyzed. The equations describing the tracking servo's operation are both nonlinear and nonautonomous. System response as a function of input signal, gain, and error function is described analytically. Experimental results are included to demonstrate the validity of the analytic solutions. (Contractor's abstract)

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California U. Dept. of Engineering, Los Angeles.

TECHNIQUES FOR THE OPTIMUM SYNTHESIS OF
MULTIPOLE CONTROL SYSTEMS WITH RANDOM
PROCESSES AS INPUTS, by H. C. Hsieh and C. T.
Leondes. Sept. 1959 [39]p. incl. diagrs. (AFOSR-TN-
59-1132) (AF 49(638)438) AD 230196; PB 145488
                                                Unclassified

Presented at Nat'l. Automatic Control Conf., Dallas,
Tex., Nov. 4-6, 1959.

Also published in I.R.E. Trans. on Automatic Control,
v. AC-4: 212-231, Dec. 1959.

The general problem of obtaining the optimum multipole
system when the inputs to the system are stationary
random processes is considered. The system under in-
vestigation was linear and time invariant. The input to
each terminal consists of signal and noise. The synthe-
sis procedure was carried out under the basis that a
fixed plant must be compensated in order to perform
certain desired tasks. The design criterion employed
was the minimum mean-square error between actual
outputs and ideal outputs of the system. A set of inte-
gral equations is obtained, which is converted into alge-
braic equations through transformation. By solving
these equations and using the method of undetermined
coefficients, the transfer functions of the compensation
is uniquely determined. (Contractor's abstract)

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California U. Dept. of Engineering, Los Angeles.

ON THE PHILOSOPHY OF ADAPTIVE CONTROL
FOR PROCESS ADAPTIVE SYSTEMS, by M. Margolis
and C. T. Leondes. Jan. 1960, 13p. incl. diagrs.
(AFOSR-TN-59-1199) (AF 49(638)438) AD 233499;
PB 146376   Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill.,
Apr. 12-14, 1959.

Also published in Proc. Nat'l. Electronics Conf., v. 15:
27-33, 1959.

A very general approach to the design of process adap-
tive systems is described. A brief look is taken at the
development of feedback control theory and practice.
Process adaptive control is discussed as a logical ex-
tension of the basic concepts of feedback theory. A par-
ticular mechanism for process adaptive control is sug-
gested. This mechanism makes use of a learning model
whose form is the same as the physical process and
whose parameters are continually adjusted so that the
model and process behave as much alike as possible.
The parameters of the model are used to set the pa-
rameters of the controller for the overall control of the
system. (Contractor's abstract)

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California U. Dept. of Engineering, Los Angeles.

ON THE THEORY OF ADAPTIVE CONTROL SYSTEMS,
THE LEARNING MODEL APPROACH, by M. Margolis
and C. T. Leondes. Oct. 1959 [25]p. incl. diagrs.
(AFOSR-TN-59-1200) (AF 49(638)438) AD 233275;
PB 146736   Unclassified

Presented at First Internat'l. Cong. of the Internat'l.
Federation of Automatic Control, Moscow (USSR), 1960.

Also published in Automatic and Remote Control, v. 2:
556-563, 1960.

The main objective of feedback control is to maintain
satisfactory performance despite adverse environmental
effects. A process adaptive system is one which deter-
mines the values of the significant parameters in the
physical process and used these values to program the
controller according to the specified control laws. The
physical process must either be indeterminate or vary
widely in its dynamic characteristics as its environment
changes to justify the use of a process adaptive system.
The use of a process adaptive system then makes it pos-
sible to design the complete control system for a speci-
fied requirement without compromising the setting of the
controller parameters for the range of dynamic charac-
teristic variation. The learning model will determine
these variations and present the exact values to the
proper computing circuits for adjusting the parameters
in the controller. The particular method for determin-
ing the dynamic characteristics of the physical process
makes use of a model, referred to as the learning model,
and a mechanism to adjust the parameters of the model.
The model is a computer mechanization of the physical
process with undetermined parameters.

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California U. Dept. of Engineering, Los Angeles.

EXTENDED SYNTHESIS TECHNIQUES FOR MULTI-
POLE SAMPLED-DATA CONTROL SYSTEMS, by E.
B. Stear and C. T. Leondes. Oct. 1959, 12p. incl.
diagrs. (AFOSR-TN-59-1223) (AF 49(638)438)
AD 233276   Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill.,
Oct. 12-14, 1959.

Also published in Proc. Nat'l. Electronics Conf., v. 15:
299-309, 1959.

A logical and efficient procedure for the synthesis of
multipole sampled-data control systems is presented.
It is assumed that the specifications on the system are
stated in the time domain, and this is in fact a common
situation. Furthermore, it is not assumed in the synthe-
sis procedure presented that the specifications are
stated only at the sampling instants of the system, but
rather at arbitrary and necessary instants of time. In

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addition to this, a lower bound is established for the sampling rate based on system requirements. This last exceedingly important aspect has received very little attention in the literature. (Contractor's abstract)

270

California U. Santa Barbara [Coll.] Goleta.

NUCLEAR ABSORPTION CROSS SECTIONS FOR 3.6 BEV NEUTRONS, by P. H. Barrett. Dec. 22, 1958 [9]p. incl. diagrs. table. (AFOSR-TN-59-15) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)9 and Atomic Energy Commission)
AD 208596   Unclassified

Also published in Phys. Rev., v. 114: 1374-1375, June 1, 1959.

The absorption cross section for Pb, Cu, and Al were measured by means of poor geometry transmission measurements. The neutrons were produced by bombarding a 1 in. thick polyethylene target with 6.2 bev protons in the Bevatron. Neutron detection was accomplished by measuring the density of stars in nuclear emulsion. These measurements gave for the absorption cross sections for Pb, Cu, and Al 1930 ± 300 mb, 704 ± 140 mb, 430 ± 56 mb. An absorption mean free path in emulsion of $\lambda = 50 \pm 10$ cm was obtained. The source strength of the neutrons was calculated to be 0.19 neutron/steradian/proton striking the target. By comparing the multiplicity of mesons produced in nuclear interactions by the neutron beam and by protons of known energy the average energy of 3.6 ± 0.7 bev was obtained for the neutron beam. (Contractor's abstract)

271

California U. Santa Barbara [Coll.] Goleta.

[NEUTRON INTERACTION STUDIES] by P. H. Barrett. Final rept. [1959] [1]p. (AFOSR-TR-59-193) (AF 49-(638)9)   Unclassified

The research performed on this contract was concerned with a group of nuclear emulsions which were exposed to the neutron beam of the Bevatron in order to ascertain (a) the energy spectrum of the neutrons and (b) the nuclear absorption cross section for Al, Cu, and Pb. A published version of the results is appended (see item no. 270). A new approach to determining the neutron energy by analyzing the angular distribution of the mesons produced in nuclear interactions yielded an average neutron energy value of 5 ± 2 bev.

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Cambridge U. Cavendish Lab. (Gt. Brit.).

STRUCTURAL INVESTIGATIONS, BY X-RAY DIFFRAC-

TION METHODS, OF TRANSITION-METAL ALLOYS, by W. H. Taylor. Technical status rept. no. 4, Jan. 1-Dec. 31, 1958, 6p. (AFOSR-TN-59-345) (AF 61(052)50)
AD 264283   Unclassified

A report is presented on the progress made under this contract which involves the analysis of the structures of a number of transition-metal alloys and also the application of highly-refined techniques to 1 or more of these alloys, and to pure metals, with a view to the determination of electron distribution. The study of Fe-Al system included the discovery and description of a new phase and the re-examination and refinement of a structure previously proposed. The study on Fe_2Al_5 system shows that there are significant differences between the Al-rich and Fe-rich structures. The Mn-Al system was also reexamined in the phase-diagram between 33% and 45% Mn, for temperatures below 880°C. Two previously unknown phases were isolated, and the Hofman phase was shown to be stable only above 880°C. An x-ray fluorescence spectrometer was developed for the analysis of minute single crystals.

273

Cambridge U. Cavendish Lab. (Gt. Brit.).

THE CRYSTAL STRUCTURE OF Mn_3Al_{10}, by M. A. Taylor. [1959] [10]p. incl. tables, refs. (AFOSR-TN-59-346) (AF 61(052)50)   Unclassified

Also published in Acta Cryst., v. 12: 393-396, May 1959.

The crystal structure of a previously unknown metallic compound Mn_3Al_{10}, hereinafter referred to as φ(AlMn), has been determined by x-ray analysis. The cell dimensions and atomic parameters of the structure and the interatomic distances between neighboring atoms are given. The structure is very similar to that of Robinson's β(AlMnSi) (Acta Cryst., v. 5: 397-403, July 1952), and comparisons between the 2 structures are made.

274

Cambridge U. Cavendish Lab. (Gt. Brit.).

ON AN ANALYTIC APPROXIMATION TO THE ATOMIC SCATTERING FACTOR, by J. B. Forsyth and M. Wells. [1959] [12]p. incl. tables, refs. (AFOSR-TN-59-347) (AF 61(052)50)   Unclassified

Also published in Acta Cryst., v. 12: 412-415, May 1959.

The atomic scattering factor, f, is approximated as a function of $\sin \theta/\lambda = s$. A table is presented of analytic constants using the most recently published values of the atomic scattering factor. It is shown that the scattering factors for Al^{3+}, Ca^{2+}, Mn^{2+}, and Mn^0 agree

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with those by Freeman. Interpolations for the scatter-
ing factor values for V^{2+}, Cr^{2+}, Co^{2+}, and Ni^{2+} are
made, much because of the availability of wave func-
tions with exchange for these elements. A table is
proposed for new scattering factor values from the
work reported in this paper, and a possible explanation
for their non-compactibility with previous values made.

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[Cambridge U.] Cavendish Lab. (Gt. Brit.).

[MAGNETIC EFFECTS OF TRANSITION IMPURITIES
IN ALUMINUM] Effets magnétiques d'impuretés de
transition dans l'aluminium, by M. A. Taylor, J. P.
Burger, and J. Wucher. [1959] [2]p. incl. diagrs.
table. (AFOSR-3916) [AF 61(052)50]   Unclassified

Also published in Jour. Phys. et Radium (Paris), v. 20:
829-830, Oct. 1959.

Magnetic measurements were made on aluminum-rich
transition-metal alloys. Susceptibilities over a range
of temperatures between 90° and 290°K were deter-
mined for weak concentrations of V, Cr, and Mn in Al.
The results are tabulated. Measurements of the Hall
coefficient for aluminum alloys are included.

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Cambridge U. Dept. of Applied Mathematics and
Theoretical Physics (Gt. Brit.).

DISPERSION RELATION PREDICTIONS FOR π,p SCAT-
TERING, by T. D. Spearman. Oct. 1959 [5]p. incl.
diagrs. refs. (Scientific note no. 1) (AFOSR-TN-59-
1313) (AF 61(052)233) AD 232058; PB 145682
Unclassified

The dispersion relations for forward elastic π-p scat-
tering are used to calculate the real parts of the for-
ward scattering amplitude. It is found that using more
accurate experimental data, the discrepancy observed
by Puppi and Stanghellini can be resolved. A more
precise value for the renormalized π, N coupling con-
stant is predicted. (Contractor's abstract)

277

Cambridge U. Dept. of Applied Mathematics and
Theoretical Physics (Gt. Brit.).

LOW ENERGY PION PHENOMENA, by J. Hamilton and
W. S.Woolcock. Oct. 1959, 33p. incl. diagrs. refs.
(Scientific note no. 2) (AFOSR-TN-59-1314) (AF 61-
(052)233) AD 234215; PB 146739   Unclassified

Also published in Phys. Rev., v. 118: 291-290, Apr. 1,
1960.

The relation between low energy pion-nucleon scattering
and pion photoproduction is examined. Correct extrap-
olation to threshold of both the π^+ and π photoproduc-
tion data gives agreement with theory. A recent new
method for analyzing the scattering data is applied,
giving $a_1 = 0.178$, $a_3 = 0.087$, and reasonable agreement
with the Panofsky ratio $P = 1.5$ is obtained. An inner
Coulomb correction to the scattering data helps to im-
prove this agreement. The possibility of detecting a
$\pi - \pi$ interaction by low energy pion scattering is ex-
amined. A new dispersion relation connects the s- and
p-wave phase shifts at low energies; this relation ex-
cludes some well known sets of phase shift curves.
(Contractor's abstract)

278

Cambridge U. Medical Research Council (Gt. Brit.).

RESEARCH ON REVERSIBLE PERCEPTION OF
SPEECH SOUNDS, by R. M. Warren. Final rept. Sept.
30, 1959, 25p. incl. tables. (AFOSR-TR-59-148) (AF 61-
(052)184) AD 232057; PB 146098   Unclassified

If a loop of tape containing a single word is played over
and over, the word heard seems to shift suddenly to
another word. After a while another illusory change is
experienced with this unchanging stimulus, sometimes
back to the 1st form and sometimes to a 3rd form.
These transitions continue at frequent intervals as long
as the tape is played. This verbal transformation effect
was studied to determine the factors governing the rate
of transitions and the variety of the different forms
heard. Various repeating verbal stimuli were presented
to 18 naval ratings, each stimulus being played for 3
min. The principal findings are: (1) verbal transforma-
tions were obtained with all the repeating experimental
stimuli, varying in complexity from 2 speech sounds to
complete sentences; (2) repeating speech made indis-
tinct by masking noise produced fewer transitions and
fewer different forms than the same recording heard
clearly; (3) when loudness of speech was sufficient to
incur clarity, further increase in loudness seemed to
have little effect on verbal transformations; (4) repeating
unfamiliar words tended to be distorted in the first (and
subsequent) forms into familiar words; (5) tapes of the
same word, each with silent intervals of different
length between repetitions were employed; and (6) pre-
vious stimulation by a word of closely related phonetic
structure was followed (even after a few days) by re-
sponses related to the previous word. (Contractor's
abstract)

279

Cambridge U. Psychological Lab. (Gt. Brit.).

THE EFFECT OF MEPROBAMATE ON AUDITORY DIS-
CRIMINATION, DELAYED RESPONSE AND TIME INTER-
VAL ESTIMATION IN RHESUS MONKEYS, by C. G. Gross,
J. M. Oxbury, and L. Weiskrantz. [1959] [1]p. [AF 61-
(052)185]   Unclassified

Published in Proc. First Internat'l. Cong. of Neuro-psychopharmacology, Rome (Italy) (Sept. 1958), Amster-dam, Elsevier, 1959, p. 318.

Injections of meprobamate into Rhesus monkeys re-sulted in slight to severe ataxia depending upon the dosage, but no taming effect was observed. Each ani-mal was tested 5 times after drug injection and 5 times as controls. All the animals showed a deficit on the auditory discrimination. No animal showed a deficit on the delayed response problem. In fact, 1 animal improved its delayed response performance after the injection. The drug appeared to have the effect of de-laying the timing sense in the animals. It is concluded that tranquilizing drugs block incoming sensory infor-mation. The fact that certain electrophysiological data have been interpreted as evidence that meprobamate selectively affects thalamic nuclei may also be rele-vant to the finding of an auditory deficit.

280

Cambridge U. Press, New York.

JOURNAL OF FLUID MECHANICS, ed. by G. K. Batchelor. Jan. 1959-Dec. 1959. (MIPR-680-59-3 and Nonr-254800)   Unclassified

This international periodical covers theoretical and ex-perimental research investigations of all aspects of fluid mechanics.

281

Carnegie Inst. of Tech. Dept. of Civil Engineering, Pittsburgh, Pa.

FRACTURE ARREST BY RIVETED STIFFENERS, by J. P. Romualdi and P. H. Sanders. [1959] [12]p. incl. diagrs. table, refs. (AF 49(638)237)   Unclassified

Published in Proc. Fourth Midwestern Conf. on Solid Mech., Texas U., Austin (Sept. 9-11. 1959), Austin, Texas U. Press, 1959, p. 74-90.

The total stress intensity factor at the tip of a crack is theoretically determined and good agreement is ob-tained between calculated values and those determined by strain gages. The kinetic energy of the material surrounding a running crack is found to be an important factor affecting the max rivet force at fracture arrest. Tests show that when a running crack is stopped by a riveted stiffener the max rivet force can be as much as 25% greater than that which would be obtained with a slowly moving crack.

282

Carnegie Inst. of Tech. Dept. of Mathematics, Pittsburgh, Pa.

ON A CLASS OF NON-LINEAR SECOND-ORDER DIF-

FERENTIAL EQUATIONS, by Z. Nehari. Apr. 1959 [32]p. (Technical rept. no. 25) (AFOSR-TN-59-179) (AF 49(638)227) AD 211319; PB 140046   Unclassified

Also published in Trans. Amer. Math. Soc., v. 95: 101-123, Apr. 1960.

Oscillatory properties are outlined solutions of the dif-ferential equation (a) $y'' + y F(y^2, x) = 0$, $y = y(x)$, where $F(t, x) > 0$ for $x > 0$, $t > 0$, and $t^{-\epsilon} F(t, x)$ is an increas-ing function of t for some positive ϵ and constant x. A number of conditions are derived which are either nec-essary or sufficient for the existence of a non-oscilla-tory solution of (a). In the discussion, a central role is played by the variational problem $\int_a^b [y'^2 - G(y^2, x)]dx = $ min under the side conditions $\int_a^b y'^2 dx = \int_a^b y^2 F(y^2, x)dx$, $y(a) = y'(b) = 0$, $y \in D^1[a, b]$, $y \neq 0$, where $G(tx) = \int_0^t F(s, x)ds$. The problem is shown to have a solution which satisfies equation (a), and it therefore becomes possible to investigate the behavior of the solutions of (a) by means of variational techniques. (Contractor's abstract)

283

Carnegie Inst. of Tech. Dept. of Mathematics, Pittsburgh, Pa.

SOME EIGENVALUE ESTIMATES, by Z. Nehari. Apr. 1959 [13]p. (Technical rept. no. 26) (AFOSR-TN-59-331) (AF 49(638)227) AD 213652; PB 140533
                                        Unclassified

Also published in Jour. Anal. Math. (Jerusalem), v. 7: 79-88, 1959.

The following 2 inequalities are proved: (1) If p(x) is non-negative, monotonic and L^1 in [a,b], and λ denotes the lowest eigenvalue of the system $y'' + \lambda p(x)y = 0$, $y(a) = y(b) = 0$, then $\lambda^{1/2} \int_a^b \sqrt{p(x)}dx > \frac{\pi}{2}$. (2) If, under the same conditions for p(x), Λ is the lowest eigenvalue of $y'^V - \Lambda p(x)y = 0$, $y(a) = y'(a) = y(b) = y'(b) = 0$, then $\Lambda^{1/4} \int_a^b \sqrt[4]{p(x)}dx > k \sim 1.88$, where k is the smallest positive root of $\cos k \cosh k + 1 = 0$. Both constants are best possible. The inequalities are used to derive oscillation criteria for the equations $y'' + p(x)y = 0$ and $y'^V - p(x)y = 0$, respectively. (Contractor's abstract)

284

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

ON A CLASS OF NONLINEAR INTEGRAL EQUATIONS,
by Z. Nehari. May 1959 [14]p. (Technical rept. no. 27)
(AFOSR-TN-59-425) (AF 49(638)227) AD 214775;
PB 142153   Unclassified

Also published in Math. Zeitschr., v. 72: 175-183,
1959.

The Hammerstein-type nonlinear integral equation

$$y(x) = \int_b^a K(x,t)y(t)F(y^2,t)dt \text{ is shown to possess a con-}$$

tinuous solution in [a,b] under the following hypotheses:
(1) $K(x,t)$ is a continuous, symmetric, positive-definite
kernel; (2) the function $F(u,x)$ is, for $u \epsilon (0,\infty)$ and
$x \epsilon [a,b]$, positive and continuous; and (3) there exists a
positive ϵ such that $u_1^{-\epsilon}F(u_1,x) < u_2^{-\epsilon}F(u_2,x)$ if
$0 < u_1 < u_2 < \infty$. The existence of a solution of the more
general equation $y(x) = \int_b^a K(x,t)y(t)[p(t) + F(y^2,t)]dt$

is proved under the assumption that $p(x)$ is continuous
and non-negative in [a,b], and that the lowest eigenvalue
Λ of the linear integral equation

$$v(x) = \Lambda \int_b^a k(x,t)v(t)dt \text{ is larger than unity. (Contrac-}$$

tor's abstract)

285

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

BOUNDS FOR THE EIGENVALUES OF SOME VIBRAT-
ING SYSTEMS, by D. Banks. June 1959, 53p. incl. refs.
(Technical rept. no. 28) (AFOSR-TN-59-508) (AF 49-
(638)227) AD 216273   Unclassified

Also published in Pacific Jour. Math., v. 10: 439-474,
1960.

Lower bounds for the smallest eigenvalue λ_1 of the
system $u'' + \lambda p(x)u = 0$, $u(0) = u(1) = 0$, where $(p(x) \geq 0$,
are found under 3 assumptions: (1) if $p(x)$ is monotone,
(2) if $p(x)$ is convex with respect to the x-axis, and
(3) if $p(x)$ is concave. A geometric characterization of
the density function which gives the lower bound for
the higher eigenvalues is obtained in each of the 3
cases. Some of the results for the lowest eigenvalue
are extended to the case of a more general Sturm-
Liouville system. A sharp lower bound for the lowest
eigenvalue of a rod with clamped ends is found when
the density is given by a concave function. For mono-
tone and convex density functions the form of the func-

tion which gives a sharp lower bound is obtained.
Sharp lower bounds for the lowest eigenvalue of a mem-
brane with fixed edges are found for a bounded density
function, and for a concave density function over a con-
vex domain. (Contractor's abstract)

286

Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

ON THE SCATTERING OF WAVES BY A DISK, by A. E.
Heins and R. C. MacCamy. June 1959 [20]p. (Techni-
cal rept. no. 29) (AFOSR-TN-59-721) (AF 49(638)227)
AD 225546; PB 143773   Unclassified

Also published in Zeitschr. Angew. Math. and Phys.,
v. 11: 249-264, 1960.

The scattering of sound waves by a circular disk of so-
called soft material is analyzed. The appropriate bound-
ary value problem is the determination of a function
$U(r,\Theta,z)$ satisfying the equation, $U_{rr} + \frac{1}{r}U_r + \frac{1}{r^2}U_{\Theta\Theta} +$

$U_{zz} + k^2U = 0$ with the condition $U(r,\Theta,O) = 0$ for $r < 1$.
In addition $U(r,\Theta,z)$ is to be made up of an incident field
$U^0(r,\Theta,z)$, which is prescribed, and a term $U^s(r,\Theta,z)$
satisfying a radiation condition at infinity. One method
of solution is to formulate the problem as an integral
equation. This method is outlined, and some simple
calculations are presented for the case in which
$U_0(r,\Theta,z)$ represents a plane wave of arbitrary angle of

incidence. An approximate formula is included for the
scattering cross section, as a function of angle of inci-
dence, when the wave number k is small. (Contractor's
abstract)

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Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

ON THE SCATTERING OF WATER WAVES BY A
CIRCULAR DISK, by R. C. MacCamy. Dec. 1959 [26]p.
incl. refs. (Technical rept. no. 30) (AFOSR-TN-59-
1261) (AF 49(638)227) AD 230355; PB 145323
                                             Unclassified

The boundary-value problem describing the diffraction
of 2-dimensional water waves by a dock of finite width
has not as yet been solved in explicit fashion. It has
however received considerable attention. The general
problem of diffraction by surface obstacles was inves-
tigated thoroughly by John and later by Peters and
Stoker. An existence proof for the finite dock problem,
using the calculus of variations was given by Rubin.
Finally it was shown by the author that the integral equa-
tion approach can be greatly simplified for the dock

problem. It is the purpose of this paper to point out
that the earlier results can be extended to the 3-dimen-
sional problem of diffraction by a circular dock.

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Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

CHARACTERISTIC VALUES ASSOCIATED WITH A
CLASS OF NONLINEAR SECOND-ORDER DIFFEREN-
TIAL EQUATIONS, by Z. Nehari. Dec. 1959, 45p.
(Technical rept. no. 31) (AFOSR-TN-59-1262) (AF 49-
(638)227) AD 231156; PB 145492   Unclassified

Also published in Acta Math., v. 105: 141-175, 1961.

The purpose of this study is to investigate the proper-
ties of those solutions $y(x)$ of $y'' + yF(y^2,x) = 0$, or,
more generally, $y'' + p(x)y + yF(y^2,x) = 0$, which satisfy
the boundary conditions $y(a) = y(b) = 0$. It is shown that
there exists a countable set of such solutions, and that
these solutions — which may be characterized by the
number of their zeros in (a,b) — correspond to the
stationary values of a certain functional. The latter are
termed characteristic values of the problem, and their
asymptotic behavior is studied.

289

Carnegie Inst. of Tech. [Dept. of Mathematics]
Pittsburgh, Pa.

POSTULATES FOR COMMUTATIVE GROUPS, by M.
Sholander. [1959] [3]p. [AF 49(638)227]
                                    Unclassified

Published in Amer. Math. Monthly, v. 93-95, Feb. 1959.

Two 1-postulate systems which characterize commuta-
tive groups are given. The more striking of the results
asserts that a system closed under a binary operation
x-y satisfying the identity $y = x -[(x-z) - (y-z)]$ is an
Abelian group. (Math. Rev. abstract)

290

Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

OXIDATION OF METALS, by W. W. Smeltzer and L.
H. Everett. May 15, 1959 [6]p. incl. tables, refs.
(AFOSR-TN-59-306) (AF 18(600)1572) AD 213090
                                    Unclassified

Also published in Indus. and Eng. Chem., v. 51: 406-
411, Mar. 1959.

A review is presented of publications related to the
prevention of metal oxidation. Studies are reviewed of
oxidation kinetics, diffusion coefficients, and structural
and compositional properties of oxide layers. Publica-
tions are cited giving critical assessments of oxidation
theories with emphasis placed on ionic transport, oxide
plasticity, and epitaxial properties. There are 196
foreign and domestic references cited covering a time
period from 1956 to 1958.

291

Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

THE KINETICS OF WUSTITE SCALE FORMATION ON
IRON, by W. W. Smeltzer. [1959] [7]p. incl. illus.
diagrs. table, refs. (AFOSR-TN-59-640) (AF 18(600)-
1572) AD 247825   Unclassified

Also published in Acta Metall., v. 8: 377-383, June 1960.

The kinetics of scale formation on iron in carbon diox-
ide atm have been determined in the temperature range
600°-1100°C by a thermogravimetric technique. The
scale constituents were identified by means of x-ray
and microscopic examinations. The oxidation rates
obeyed linear and parabolic time laws for short and
long exposures, respectively. Linear scaling was de-
termined by the rate of incorporation of chemisorbed
oxygen into the wustite lattice at temperatures lower
than 910°C, and by dissociation of carbon dioxide and
incorporation of oxygen into wustite at higher tempera-
tures. The theoretical temperature coefficient of the
parabolic rational rate constant for wustite formation
was evaluated over the temperature range of its stabil-
ity. Results from the literature on parabolic oxidation
of iron in oxygen were in good agreement with the theo-
retical evaluation, whereas the results obtained for oxi-
dation in carbon dioxide were of smaller magnitude
above the Curie temperature of iron. This behavior
was explained by the consideration that the chemical ac-
tivity of oxygen in wustite at the oxide gas interface was
insufficient for equilibration of wustite with magnetite.
(Contractor's abstract)

292

Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

FIELD EMISSION MICROSCOPY OF METAL CRYSTAL
NUCLEATION, by K. L. Moazed and G. M. Pound.
Final rept. Sept. 15, 1959, 110p. incl. illus. diagrs.
tables, refs. (AFOSR-TR-59-131) (AF 18(600)1572)
AD 225717; PB 143829   Unclassified

Techniques were developed for a field emission micro-
scopic investigation of the heterogeneous nucleation of
metal vapors on metallic substrates. Quantitative meas-
urements were made for the nucleation of silver on
tungsten. Nucleation was observed to occur when the
population of adsorbed silver atoms reached a critical
value. There were definite preferred sites on the

substrate surface where nucleation occurred. An extension of the present theory of nucleation was made so that the present experimental case could be treated. Qualitative observations on the mobility of silver on tungsten showed the mobility of the silver deposit to be anisotropic on the emitter tip. Qualitative observations were also made on the evaporation and desorption of silver from a tungsten emitter tip, and the adsorption and desorption of residual gases on the emitter tip. (Contractor's abstract)

293

Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

DISLOCATION DYNAMICS AT LOW TEMPERATURES, by J. Lothe and J. P. Hirth. [1959] [8]p. incl. diagrs. refs. (AFOSR-3394) (AF 49(638)551) Unclassified

Published in Phys. Rev., v. 115: 543-550, Aug. 1, 1959.

A model for low-temperature dislocation motion is developed using the concept of nucleation and growth of kinks in dislocations lying in Peierls potential troughs. The model is compared with existing experimental data. (Contractor's abstract)

294

Catholic U. of America. [Dept. of Chemistry] Washington, D. C.

THE PROBLEMS ENCOUNTERED IN CONSTRUCTING POTENTIAL ENERGY SURFACES (Abstract), by V. Griffing. [1959] [1]p. (AF 18(600)1537) Unclassified

Presented at Symposium on Reaction Rate Theory, Wisconsin U., Madison, Mar. 30-Apr. 1, 1959.

It may be expected from present developments in the field of molecular quantum mechanics that reliable potential energy surfaces can be calculated by M. O. method in the next few years. However, even when the computational difficulties are solved, the calculation of a multi-dimensional surface will remain an enormous undertaking. Thus the best that can be hoped for in the near future are calculations over a limited range of configuration space and this for only a few typical systems. In addition, it is shown that the interaction between hydrogen atoms are atypical. Since the only extensive surfaces that have been calculated quantum mechanically in the past are these systems it is possible that some of the difficulties in present rate theory can be attributed to an intuitive generalization of these systems. Even after reliable and typical surfaces are calculated the interpretation of these surfaces in terms of the dynamical problems concerning colliding molecules and which are in vibrational and rotational excited states still present many puzzles. (Contractor's abstract)

295

Catholic U. of America. [Dept. of Chemistry] Washington, D. C.

THEORY OF REACTION RATES FROM A COLLISIONAL VIEWPOINT (Abstract), by K. F. Herzfeld and V. Griffing. [1959] [1]p. (AF 18(600)1537) Unclassified

Presented at Symposium on Reaction Rate Theory, Wisconsin U., Madison, Mar. 30-Apr. 1, 1959.

The current theory of the monomolecular decomposition of a polyatomic molecule assumes a two-step process, energy supply by collision and subsequent break up. The relative rate of these steps can be found from the pressure at which the transition between monomolecular (break up) and binmolecular (energy supply) mechanism occurs. From the experimental data it is concluded that a high efficiency of energy supply exists. In the simpler case of dissociation of a diatomic molecule, the present picture is that of transfer of sufficient kinetic energy by collision to the vibration so that, after about half a period of vibration, the molecule can fly apart without further quantum jump. In the reverse reaction, a triple collision between two atoms and a third partner is needed, the partner carrying off the excess energy. The efficiency of the energy transfer and of the triple collision must be equal, from equilibrium considerations. Experiments on recombination (bromine, iodine, oxygen, nitrogen) seem to show a high efficiency, again in contradiction to the type of calculation which has been successful in evaluating ultrasonic results, and which gives efficiencies below 1%. Furthermore, experimental results seem to indicate cooperation of rotational motion, which points to the importance of other than head-on collision. (Contractor's abstract)

296

Catholic U. of America. Dept. of Physics, Washington, D. C.

[ABSORPTION SPECTRA OF POLYATOMIC MOLECULES] by K. F. Herzfeld. Final rept. Oct. 20, 1959, 3p. (AFOSR-TR-59-156) (AF 18(600)890)
Unclassified

The work on this project was broken down into 4 parts, the 1st of which was the problem of spectrograph slit illumination. The work is reported in detail in the following Master's thesis: (1) The Optimum Slit Width of a Spectrograph, by Brother M. Guttman. (2) Central Intensity of a Spectral Line under Approximate Experimental Conditions, by A. E. Cahill. (3) An Experimental Study of Off-Axis Coherent Illumination of a Spectrograph, by D. W. Harkabus. (4) The Half-width of a Spectral Line as a Function of Slit Width for Various Widths of Entrance Slit under Coherent, Non-coherent or Intermediate Modes of Illumination, by D. F. Ressler. The 2nd phase concerns itself with the work in Raman Spectra and the more recent work is reported in the following Master's thesis: (I) Raman Spectra of Pure Liquids and

Solution of Pure Liquids, by D. A. Nordling. (2) Photo-
ionization and Photofluorescence in P-diiodobenzene,
by E. D. Hall. (3) Liquid Filters for the Raman Spectra,
by Sister M. M. Boyle. In the 3rd phase the speed of
the instrument was improved to help approach theoreti-
cal resolution and was reported in the following: Test-
ing of East Raman Spectrograph, by J. E. Barry. The
final work was concerned with the measurement of
HCl. Results indicated that the brightest discharge is
at about .1mm of mercury. Because slight impurities
of CO tend to change the nature of the discharge, a
method of purifying HCl was also devised.

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Catholic U. of America. Dept. of Physics,
Washington, D. C.

LINEARITY AND MINIMUM ENTROPY PRODUCTION,
by P. H. E. Meijer. Final rept. Feb. 2, 1959 [14]p.
incl. refs. (Technical note no. SM-1) (AFOSR-TR-59-
178) (AF 18(603)120)   Unclassified

The purpose of this paper is to show that the minimum
entropy production principle actually does hold in a
limited range outside what is conventionally called lin-
ear irreversible thermodynamics. It is concluded that
the expression "linear" refers either to the Onsager
relations between flukes and forces or it refers to the
Fokker-Planck or Master equation. Linear processes
in the Onsager sense form a much more restrictive
class than the linear processes in the Fokker-Planck
equation. The minimum entropy production theorem,
i.e. its equivalence for the steady state holds for the
linear processes in the Fokker-Planck sense.

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Catholic U. of America. Dept. of Physics,
Washington, D. C.

LINEARITY AND MINIMUM ENTROPY PRODUCTION,
by P. H. E. Meijer. Feb. 2, 1959, 14p. incl. refs.
(Technical note no. SM-1) (AFOSR-TN-59-152)
(AF 49(638)452) AD 262974   Unclassified

The application of the entropy production principle is
discussed in terms of linear irreversible thermody-
namics. The description of these processes is based
on a set of linear, master equations. The most im-
portant aspect of these equations (Fokker-Planck) is
that they are 1st-order differential equations in time
and are asymmetric in character. Conclusions are
presented for both internal and external systems.

299

Catholic U. of America. Dept. of Physics,
Washington, D. C.

MEAN FREE PATH IN DENSE GASES AND LIQUIDS,

by P. H. E. Meijer and J. I. Bowen. Mar. 29, 1959
[6]p. incl. diagrs. (AFOSR-TN-59-694) (AF 49(638)452)
Unclassified

A simple expression for the mean free path in a fluid
is derived. The derivation used is strictly speaking
only correct for hard sphere atoms. It is shown that
low densities give the usual exponential distribution
and that the high density limit, in which the atoms are
supposed to be boxed in, gives rise to a mean free path
equal to the reduced length of the box. Under the as-
sumption that it is proper to make use of the general
properties of the 2 particle correlation function some
tentative conclusions are made about the behavior of
the mean free path as a function of the density. (Con-
tractor's abstract)

300

Chicago Development Corp., Riverdale, Md.

ELECTROLYTE EQUILIBRIA AND ELECTRODE BE-
HAVIOR IN THE SOLUBLE ANODE TITANIUM PROC-
ESS, by R. S. Dean, W. W. Gullett and others. [Jan. 12,
1959] [26]p. incl. refs. [Rept. no. 2] (Bound with its
AD 217781) [AF 18(600)1458]   Unclassified

Crystal intergrowths of Mn-Ti alloy, with an average
analysis of 8.3% Mn and of V-Ti alloy with an average
analysis of 1.35% V, were produced on an experimental
basis by the soluble anode process. The electrolyte was
a single-phase liquid at 800° to 850°C consisting of NaCl
in which was dissolved Ti as lower chlorides with an
average valence of 2.3 to 2.5 and 0.1 to 0.5% metallic
sodium. Such a bath, unlike other halide baths does not
dissolve metal oxides so that complete refining from O
was possible. The anode material in the case of the 8%
Mn alloy was sheet clipping of scrap alloy. In the case
of the 1 to 1.5% V alloy, the anode material was turnings
of an arc-melted 5% V alloy made from scrap Ti sponge
and ferrovanadium. (ASTIA abstract)

301

Chicago U., Ill.

SOME RESEARCH ON THE NATURE OF THE ACTION
POTENTIAL IN NERVE, by R. J. Moon and D. A. Eggen.
[Final rept.] Oct. 1959, 53p. incl. diagrs. refs. (AFOSR-
TR-59-153) (AF 18(600)1482) AD 249549
Unclassified

This research was designed to investigate the details of
the behavior of the action potential in nerve. In order
to accomplish this, a gated microspectrophotometer
which could be synchronized with the nerve-stimulating
pulse and a gated scanning x-ray microscope similarly
synchronized and phased were developed. It is con-
cluded that the following new tools and approaches are
now available for the study of nervous activity. (1) A
gated microspectrophotometer for the study of time
sequence of chemical events that occur during nervous

activity. (2) The utilization of the 7.16μ absorption peak for the examination of polarization changes that occur in nerve during the passage of the action potential. (3) The scanning x-ray microscope and its pulse sorter viewing system provides a means of determining the time change of the spatial distribution of sodium, potassium and calcium in axon during activity.

302

Chicago U. Chicago Midway Labs., Ill.

RECOMBINATION PROCESSES IN p-TYPE INDIUM ANTIMONIDE, by R. N. Zitter, A. J. Strauss, and A. E. Attard. [1959] [8]p. incl. diagrs. refs.
[AF 18(603)9]   Unclassified

Published in Phys. Rev., v. 115: 266-273, July 15, 1959.

Photoelectromagnetic and photoconductive lifetimes have been measured from 77° to 300°K in monocrystalline p-type indium antimonide of net acceptor concentration ranging from less than 10^{15} cm^{-3} to 10^{-18} cm^{-3}. It is concluded that at the lower temperatures, excess electrons are trapped in immobile states in the forbidden band and that the trap concentration is the same in all samples, regardless of net acceptor concentration. At intermediate temperatures, trapping becomes negligible but recombination continues to take place through states in the forbidden gap; there is some reason to believe that in this temperature region lifetimes are determined by more than one level of forbidden-band states. At still higher temperatures, where the samples are intrinsic, the lifetime data are consistent with the hypothesis of a direct interband Auger recombination process.

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Chicago U. Chicago Midway Labs., Ill.

OPTICAL ABSORPTION IN PURE SINGLE CRYSTAL InSb AT 298° AND 78°K, by S. W. Kurnick and J. M. Powell. [1959] [8]p. incl. illus. diagrs. table, refs.
[AF 18(603)9]   Unclassified

Published in Phys. Rev., v. 116: 597-604, Nov. 1, 1959.

The absorption spectra of single crystal homogeneous InSb were measured in the spectra range 5 to 10 microns at temperatures of 78°K and 298°K. Primary emphasis was placed on the precise determination of absorption coefficients less than 400 cm^{-1}. Absorption spectra were measured in many samples over the following range of impurity concentrations. Net impurity concentrations, expressed in atoms cm^{-3}, ranged from 5×10^{15} to 9.5×10^{16} in p-type samples, and from 2×10^{15} to 3×10^{17} in n-type samples, as determined from Hall coefficients measured at 78°K. In general, the spectral range covered included regions where the ab-

sorption was dominated by either free-carrier absorption or valence-conduction band transitions. Free-carrier absorption in p-type InSb indicates a simple valence-band structure about $k = 0$, consisting of light and heavy hole bands. Free-carrier cross sections at 298°K are $\sigma_p = 8.65 \times 10^{-16}$ cm^2 per hole and $\sigma_n = 0.23 \times 10^{-16}$ cm^2 per electron (at 9 μ). Whereas the free hole absorption coefficient is roughly independent of wavelength, the free electron absorption σ_n varies as λ^2 and agrees with the classical Zener-Drude model. The main absorption edge at both temperatures may be extended to lower absorption coefficients α by subtracting the extrapolated free-carrier absorption coefficients α_c. The resultant band edge in $(\alpha - \alpha_c)$ values when plotted against photoenergy $(h\omega)$ fits a straight line. The slopes of these band edges increase at the lower temperature and decrease (either at 78° or 298°K) as the acceptor concentration in the optical sample increases. Various models previously proposed are compared with the experimental results. (Contractor's abstract)

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Chicago U. Committee on Mathematical Biology, Ill.

NOTE ON THE FUSION FREQUENCY FOR STIMULI OF ALTERNATING DURATION, by H. D. Landahl. [1959] [5]p. incl. diagr. (AFOSR-TN-59-374) (AF 49-(638)414) AD 213856   Unclassified

Also published in Bull. Math. Biophys., v. 21: 283-287, Sept. 1959.

The case of alternating stimulus patterns of moderately high intensity is considered in terms of the 2 factor theory model (Landahl, Bull. Math. Biophys., v. 19: 157-162, 1957). If both of the alternating patterns have the same light-dark ratio, then the relation between the period of the longer and the period of the shorter pattern at the critical flicker frequency is independent of the light-dark ratio and is given by a dimensionless expression which is roughly in agreement with data in which the light-dark ratio is one. (Contractor's abstract)

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Chicago U. Committe on Mathematical Biology, Ill.

AN APPROACH TO COMPUTERS THAT PERCEIVE, LEARN, AND REASON, by P. H. Greene. [1959] [6]p. incl. refs. (AFOSR-TN-59-375) (AF 49(638)414) AD 213855   Unclassified

Also published in Proc. Western Joint Computer Conf., San Francisco, Calif. (Mar. 3-5, 1959), New York, Inst. of Radio Engineers, v. 15: 181-186, 1959.

A discussion is given of some of the problems which are estimated to be central to the designing of machines that

can in some sense be said to perceive, think, learn, make reasonable influences, or learn to perform acts of skill. Basic to the problem is the need to embody complex patterns in their entirety for presentation to the computer rather than discursive codes that utilize a one-dimensional sort of language. Thus a need for more than the principles of abstraction and association is advocated. What is desired is the presentation nature of the symbolism of the machine, involving the ability to perceive patterns too complex to be communicated verbally and the ability to acquire skills which are not able to be programmed discursively for the machine. The specific techniques which now exist for dealing with the problem of reasonable inference and inductive judgment, but which have not been considered in connection with computers and control mechanisms, are given.

306

Chicago U. Committee on Mathematical Biology, Ill.

MATHEMATICAL BIOPHYSICS ON COLOR VISION. III. COLOR CONSTANCY, by H. D. Landahl. Aug. 1, 1959 [8]p. incl. diagrs. (AFOSR-TN-59-904) (AF 49-(638)414) AD 230021 Unclassified

Also published in Bull. Math. Biophys., v. 21: 395-402, 1959.

A mechanism is presented which can account for certain aspects of the phenomena of color constancy. The mechanism involves interaction between a given region and the remaining field. Each region is represented by a color center having the structure previously introduced (Landahl, Bull. Math. Biophysics, v. 14: 317-325, 1952) to account for a number of phenomena of color vision. The trichromatic, symmetric mechanism is introduced for simplicity. The interaction is such that collaterals from each of the primaries representing the background send elements to each of the centers corresponding to the primaries representing the spot. However, the collaterals impinging upon unlike centers are excitatory while the collaterals impinging on like centers, corresponding to the same primary colors, are inhibitory. With proper choice of coefficients, the result is that for small changes in illumination, the resulting apparent color is unchanged. However, for greater changes in the color of the illumination, there results a distortion of the apparent color. A number of examples are illustrated numerically. (Contractor's abstract)

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Chicago U. Dept. of Mathematics, Ill.

THE LAW OF THE ITERATED LOGARITHM FOR LACUNARY TRIGONOMETRIC SERIES, by M. Weiss. [1959] [26]p. (AF 18(600)1111) Unclassified

Published in Trans. Amer. Math. Soc., v. 91: 444-469, June 1959.

The purpose of this paper is to prove the following theorem: Let $S(x) = \sum_{k=0}^{\infty} (a_k \cos n_k x + b_k \sin n_k x)$ be a lacunary trigonometric series, that is to say, one such that $n_{k+1}/n_k > q > 1$ for all k. B_N is written $B_N = (1/2 \sum_{k=1}^{N} (a_k^2 + b_k^2))^{1/2}$, M_N as $M_N = \underset{1 < k < N}{\text{Max}} (a_k^2 + b_k^2)^{1/2}$ and $S_N(x) = \sum_{k=1}^{N} (a_k \cos n_k x + b_k \sin n_k x)$. If for $N \to +\infty$, $B_N \to \infty$ and $M_N = 0 \dfrac{B_N}{(\log \log B_N)} 1/2$, then for almost all x $\lim \sup_{N \to +\infty} \dfrac{S_N(x)}{(2B_N^2 \log \log B_N)^{1/2}} = 1$.

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Chicago U. [Dept. of Mathematics] Ill.

ON HARDY-LITTLEWOOD SERIES, by M. Weiss. [1959] [10]p. (AF 18(600)1111) Unclassified

Published in Trans. Amer. Math. Soc., v. 91: 470-479, June 1959.

The behavior of the series $\sum_{1}^{\infty} n^{-1/2} \exp (i\beta n \log n + in \Theta)$ and $\sum_{1}^{\infty} n^{-1/2} (\log n)^{-1/2} \exp (i\beta n \log n + in \Theta)$ is discussed. β is real and nonzero. The results concerning $S_N(\Theta)$ are $\lim_{N \to \infty} \sup S_N (\Theta)/\log N \log \log \log N)^{1/2} = 1$ for nearly all Θ, and Θ representing a variable contingent on a measurable whole, given the bidimensional distribution of $S_N(\Theta)/1/2 \log N)^{1/2}$ tends toward the Gauss distribution.

309

Chicago U. [Dept. of Mathematics] Ill.

TWO THEOREMS CONCERNING CONVERGENCE OF FOURIER SERIES, by S.-I. Izumi. [1959] [11]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1111 and National Science Foundation) Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 744-754, Oct. 1959.

Let f be an integrable function of period 2π, and let $\varphi x(t) = f(x + t) + f(x - t) - 2s$. The hypothesis that $\int_0^h \varphi x(t) dt = 0(h)$ as $h \to 0$ in the Lebesgue criterion for the

convergence of the Fourier series for f at x to s, is replaced by $\int 0^h \{ \varphi x(t) - \varphi x(t+h) \}\, dt = 0(h)$ as $h \to 0$. The conclusion is again that of convergence at x, but not necessarily to s. (Math. Rev. abstract)

310

Chicago U. Dept. of Mathematics, Ill.

THE H_p-PROBLEM AND THE STRUCTURE OF H_p-GROUPS, by D. R. Hughes and J. G. Thompson. Jan. 1959, 11p. (AFOSR-TN-59-26) (AF 18(600)1383) AD 208869   Unclassified

Also published in Pacific Jour. Math., v. 9: 1097-1101, 1959.

Let G be a group, p a prime, and $H_p(G)$ the subgroup of G generated by the elements of G which do not have order p. For the case where G is finite and not a p-group, the following is proved to be true: $H_p(g) = 1$, $H_p(G) = G$, or $[G:H_p(G)] = p$. A precise description is given for the structure of G when $[G: H_p(G)] = p$.

311

Chicago U. Dept. of Mathematics, Ili.

FINITE GROUPS WITH FIXED-POINT-FREE AUTO-MORPHISMS OF PRIME ORDER, by J. G. Thompson. Feb. 1959, 8p. incl. refs. (AFOSR-TN-59-180) (AF 18(600)1383) AD 211320   Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 578-580, Apr. 1959.

Using the following theorem, N, the normal subgroup of G, is shown to be nilpotent. Let G be a finite group with a p-Sylow subgroup P, p an odd prime, and let c be a group of automorphisms of G which leaves P invariant. Suppose for every φ-invariant normal subgroup Q of P, elements of order prime to p which normalize Q also centralize Q. Then G possesses a normal p-complement. The maximal subgroups of a finite group are discussed.

312

Chicago U. Dept. of Mathematics, Ili.

COLLINEATION GROUPS OF NON-DESARGUESIAN PLANES. II. SOME SEMI-NUCLEAR DIVISION ALGE-BRAS, by D. R. Hughes. Mar. 1959, 12p. (AFOSR-TN-59-281) (AF 18(600)1383) AD 212914; PB 142366
Unclassified

Also published in Amer. Jour. Math., v. 82: 113-119, Jan. 1960.

Two classes of non-associative division algebras and the projective planes they coordinatize are considered with the aim of determining the collineation groups of the planes. These are the fourth and fifth classes of finite non-Desarguesian planes so analyzed, and, like the twisted fields, the groups are solvable. This is in sharp contrast to the other two situations, the finite Hall Veblen-Wedderburn planes and the (non-Veblen-Wedderburn) Hughes planes, both of which have non-solvable collineation groups. Since both the Hall and Hughes planes appear more removed from the Desarguesian planes than any division ring plane, it is perhaps peculiar that all the known finite non-associative division ring planes have solvable groups. (Contractor's abstract)

313

Chicago U. Dept. of Mathematics, Ill.

SIMPLICIAL TOPOLOGY I, by S. MacLane and J. Yao. Mar. 1959, 42p. incl. diagrs. (AFOSR-TN-59-361) (AF 18(600)1383) AD 213671; PB 140806
Unclassified

Studies on simplicial complexes and their applications in abstract homotopy theory and adjoint functions are reported. Much of the material is derived from the lectures of S. MacLane during the winter of 1959. The conceptual proofs of several theorems is given showing the possible complexes that satisfy the properties of a fiber space. The application of these groupings to homotopy theory is then given.

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Chicago U. Dept. of Mathematics, Ill.

GROUP EXTENSIONS BY PRIMARY ABELIAN GROUPS, by S. MacLane. May 1959, 26p. (AFOSR-TN-59-457) (AF 18(600)1383) AD 315262; PB 144935
Unclassified

Also published in Trans. Amer. Math. Soc., v. 95: 1-16, Apr. 1960.

The effective calculation of the functor Ext(A, G) is considered which is defined as the group of all Abelian group extensions of the Abelian group G by the Abelian group A. For finitely generated A, the functor is known: (1) it is additive in A, (2) Ext(Z, G) = 0 when A = Z is the infinite cyclic group and (3) for A the finite cyclic group Z/mZ of order m, Ext(Z/mZ, G) = G/mG. The case when A is a torsion group is considered. The assumption is made that A is a p-primary group T, i.e., a group in which every element has order a power of the prime p. (Contractor's abstract)

315

Chicago U. Dept. of Mathematics, Ill.

SEMINUCLEAR EXTENSIONS OF GALOIS FIELDS, by D. R. Hughes and E. Kleinfeld. Apr. 1959, 7p. (AFOSR-TN-59-497) (In cooperation with Ohio State U., Columbus) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1383 and Office of Ordnance Research) AD 215922; PB 142358
Unclassified

Also published in Amer. Jour. Math., v. 82: 389-392, July 1960.

Consideration is given to the problem of obtaining all division rings R (not associative) that are quadratic extensions of a Galois field F, where F is to be contained in the right and middle nuclei of R. This problem was inspired by the discovery of such a division ring with 16 elements. A new class of finite division rings and a corresponding class of projective planes are obtained. It is found that every Galois field not a prime field is capable of being extended in this way. If R is further restricted, so that F is to be contained in the nucleus of F, then exactly those Galois fields which are themselves quadratic extensions permit such an extension. (Contractor's abstract)

316

Chicago U. Dept. of Mathematics, Ill.

THE TEN TYPES OF H-SPACES, by I. M. James. Aug. 1959, 10p. incl. refs. (AFOSR-TN-59-857) (AF 18(600)1383) AD 228377; PB 144495
Unclassified

The 10 types of H-spaces are classified as follows: (1) equivalent to an associative, commutative multiplication, (2) equivalent-associative and equivalent-commutative but not of type 1; (3) homotopy-associative and equivalent-commutative but not equivalent-associative; (4) homotopy-commutative and equivalent-associative but not equivalent-commutative; (5) homotopy-associative and homotopy-commutative but neither equivalent-associative nor equivalent-commutative; (6) homotopy-associative but neither equivalent-associative nor homotopy-commutative; (7) homotopy-commutative but neither equivalent-commutative nor homotopy-associative; (8) equivalent-associative but not homotopy-commutative; (9) equivalent-commutative but not homotopy-associative; and (10) neither homotopy-associative nor homotopy-commutative.

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Chicago U. Dept. of Mathematics, Ill.

REVIEW OF SOME RESULTS IN COLLINEATION GROUPS, by D. R. Hughes. Oct. 1959, 17p. incl. refs. (AFOSR-TN-59-1124) (AF 18(600)1383) AD 230410; PB 145486
Unclassified

Presented at Finite Groups Symposium, New York, N. Y., Apr. 23-24, 1959.

Also published in Proc. Symposium in Pure Math., v. 1: 42-55, 1959.

Collineation groups of finite projective planes are reviewed. The classical aspects of Desarguesian geometry, and the infinite planes are disregarded. Basic fundamentals, including non-existence theorems and configuration theorems are discussed. Known finite non-Desarguesian planes are listed and their collineation groups, so far as they have been determined, are given.

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[Chicago U. Dept. of Mathematics, Ill.]

SECONDARY COHOMOLOGY OPERATIONS: TWO FORMULAS, by F. P. Peterson and N. Stein. [1959] [25]p. incl. diagrs. refs. (Also bound with its AFOSR-TN-57-759; AD 136759) (In cooperation with Princeton U., N. J.) (AF 18(600)1383 and AF 18(600)1494)
Unclassified

Published in Amer. Jour. Math., v. 81: 281-305, Apr. 1959.

Two formulas are given relating secondary cohomology operations to primary and functional primary cohomology operations. A discussion is also presented on the higher order cohomology operations, paying particular attention to the difficulties which arise in the non-stable cases. The 2 formulas which are proven are as follows. Let Φ be a secondary operation coming from the relation $\Theta'\Theta = 0$, where $\Theta \in H^{n'+1}(\pi, 1; \pi')$ and $\Theta' \in H^{q+1}(\pi', n'+1; G)$. (1) Let $f: L \to K$ and let $u \in H^{n}(K; \pi)$ be such that $f^*(u) = 0$ and $\Theta(u) = 0$. Then $f^*\Phi(u) = {}^1\Theta'(\Theta_f(u)) \in H^q(L;G)/{}^1\epsilon' f^*(H^{n'}(K;\pi'))$, where ${}^1\epsilon'$ denotes the suspension of Θ'. (2) Let $f: L \to K$ and let $u \in H^{n}(K;\pi)$ be such that $f^*\Theta(u) = 0$. Then $\Phi(f^*(u)) = \Theta'_f(\Theta(u)) \in H^q(L;G)/{}^1\Theta'(H^{n'}(L;\pi')) + f^*(H^q(K;G))$. The analogs of these formulas for some non-stable operations on more than one variable are also proven. In addition, applications of these 2 formulas are also shown. Finally, it is shown how the knowledge of secondary cohomology operations in the base of a fibre space gives information on primary cohomology operations in the total space.

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Chicago U. [Dept. of Mathematics] Ill.

ON THE LOCAL THEORY OF CONTINUOUS INFINITE PSEUDO GROUPS I, by M. Kuranishi. [1959] [36]p. (In cooperation with Inst. of Advanced Study, Princeton, N. J.) (AF 18(600)1383)
Unclassified

Published in Nagoya Math Jour., v. 15: 225-260, Aug. 1959.

The theory of continuous infinite pseudo-groups of E. Cartan is developed by introducing parameter local groups. Chapter I is devoted to formal analytic mappings which generalize formal power series. In chapter II, using formal analytic mapping, the formal Lie (F)-groups and formal Lie (F)-algebras are defined. Lie's fundamental theorems are proved by establishing a 1-to-1 correspondence between the formal Lie (F)-groups and the formal Lie (F)-algebras.

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Chicago U. [Dept. of Mathematics] Ill.

FREE MONADIC ALGEBRAS, by P. R. Halmos. [1959] [9]p. (AFOSR-T 59-858) (AF 49(638)30) AD 220959
Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 219-227, Apr. 1959.

A free monadic extension of a Boolean algebra B is a monadic algebra A with the properties that (1) B is a Boolean subalgebra of A, (2) A is (monadically) generated by B, (3) every Boolean homomorphism of B into a monadic algebra C can be extended to a monadic homomorphism of A into C. The following steps are shown to lead to a free monadic extension A of an isomorphic image of B: Let W be the space of all functions on B into a two-element Boolean algebra 2. Let X be the subspace of W x W consisting of all (y, v) such that y is a homomorphism, v is a hemimorphism and $y < v$. Let A be the dual algebra of X, i.e., the set of all continuous functions on X into 2, and for p in A define $\exists p$ by letting $(\exists p)(y,v)$ be the supremum of p(u,v) ranging over all u with $(u,v) \in X$. The mapping h of B into A is defined by letting $h(p)(y,v) = p(y)$ for all $p \in B$ and $(y,v) \in X$. (Math. Rev. abstract)

321

Chicago U. [Dept. of Mathematics] Ill.

THE REPRESENTATION OF MONADIC BOOLEAN ALGEBRAS, by P. R. Halmos. [1959] [8]p. incl. diagrs. (AFOSR-TN-59-1105) (In cooperation with Inst. for Advanced Study, Princeton, N. J.) [AF 49(638)30] AD 230221
Unclassified

Also published in Duke Math. Jour., v. 26: 447-454, Sept. 1959.

Presentation is made of a new proof of the fundamental representation theorem for monadic algebras, much simpler than the original one. Attention is also called to some hitherto unnoticed relations among 4 results: the monadic representation theorem, Sikorski's extension theorem for Boolean homomorphisms, Gleason's characterization of "projective" compact spaces, and

Michael's theorem on cross sections of mappings with a zero-dimensional range. The representation theorem reads: If K is the set of all C-constants of a C-rich monadic algebra A, then A is isomorphic to a C-valued functional monadic algebra with domain K.

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Chicago U. [Dept. of Mathematics] Ill.

SUBJECTIVE PROBABILITY AND STATISTICAL PRACTICE, by L. J. Savage. Oct. 28, 1959 [45]p. incl. diagr. (AFOSR-TN-59-1161) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-391 and Office of Naval Research under Nonr 212109) AD 230444; PB 145491
Unclassified

The concept of subjective, or personal, probability has much to contribute to statistical practice. It leads to criticism and amplification of conventional methods and the development of new ones. This is illustrated in problems of estimation, where precise measurement can be shown to justify sharp and rather well-defined final probability distributions of parameters. (Contractor's abstract)

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Chicago U. Dept. of Mathematics, Ill.

FUNCTION SPACES AND DUALITY, by E. H. Spanier. Mar. 1959, 57p. incl. refs. (Technical note no. 1) (AFOSR-TN-59-359) (AF 49(638)393) AD 213669; PB 142148
Unclassified

Also published in Ann. Math., v. 70: 338-378, Sept. 1959.

A more general and natural approach is described for the duality in S-theory. The duality is based on imbedding X and its dual X' in a sphere S^n in such a way that each is an S-deformation retract of the complement of the other. If Y and Y' are similarly defined, there is a duality isomorphism $D_n : \{X, Y\} \approx \{Y', X'\}$ of the S-groups having many of the properties of duality. The construction of this isomorphism involves factoring a map into a composite of inclusion maps and retractions by deformation, defining the dual of the map to be the composite of the duals of the factors, and then proving that the end results do not depend on the factorization and other choices involved in the construction. This method of defining duality map $f : S^k X \to S^k Y$ represents an element of $\{X, Y\}$ corresponding (under D_n) to the element of $\{Y', X'\}$ represented by a map $f : S^{k'} Y' \to S^{k'} X'$. A more explicit relation is given between maps representing corresponding elements of the S-groups. The concepts of spectrum and functional dual are developed. Using these concepts, a proof is presented of a theorem on the existence of an isomorphism characterized by homotopy commutativity. (ASTIA abstract)

324

Chicago U. Dept. of Mathematics, Ill.

TWO REMARKS ON FIBER HOMOTOPY TYPE, by J. Milnor and E. [H.] Spanier. May 1959, 10p. incl. refs. (Technical note no. 2) (AFOSR-TN-59-545) (AF 49-(638)393) AD 216621 Unclassified

Also published in Pacific Jour. Math., v. 10: 585-590, 1960.

The normal sphere bundle of a manifold M^n imbedded in euclidean space is considered. It is shown that if the dimens   the euclidean space is sufficiently high, then the norn   phere bundle has the fiber homotopy type of a prcь.: bundle if, and only if, there exists an S-map from S^n to M^n of degree 1. The procf is based on the fact that the Thom space of the normal bundle is dual in the sense of Spanier-Whitehead to the disjoint union of M^n and a point. The tangent sphere bundle of a homotopy n-sphere is studied also. This has the fiber homotopy type of a product bundle if, and only if, n equals 1, 3 or 7. (Contractor's abstract)

325

Chicago U. Dept. of Mathematics, Ill.

RESEARCH ON DUALITY AND HOMOTOPY THEORY, by E. H. Spanier. Technical rept. July 1, 1958-June 30, 1959. July 1959 [1]p. (AFOSR-TR-59-83) (AF 49-(638)393) Unclassified

The progress made to date under this contract is reported. In the 1st report (item no. 323, Vol. III) a new approach to the duality in the su:: ension category which is based on properties of function spaces is discussed. The 2nd (item no. 324, Vol. III) relates the fiber homotopy type of the normal bundle of a manifold imbedded in euclidean space to properties of the manifold itself. It is reported also that work is now being prepared on the suspension categories with coefficients and a new approach to higher order cohomology operations and will be presented later.

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Chicago U. Dept. of Mathematics, Ill.

NOTE ON THE PRESERVATION OF CLASSES OF FUNCTIONS, by A. Zygmund. Apr. 1959, 13p. (Technical note no. 2) (AFOSR-TN-59-370) (AF 49(638)451) AD 213860; PB 140999 Unclassified

Also published in Jour. Math. and Mech., v. 8: 889-895, Nov. 1959.

The problem is solved for the necessary and sufficient conditions of a 2-way infinite sequence of numbers to be of type (P,Q), where P and Q are any 2 classes of peri-

odic functions, or, alternately the classes of Fourier series of such functions. A 2-way infinite sequence of numbers is of type (P,Q) if whenever $\Sigma c_n e^{inx}$ is in P, $\Sigma c_n \lambda_n e^{inx}$ is in Q. The class λ_α $(0 < \alpha < 1)$ of periodic functions f is considered such that $f(x + h) - f(x) = 0(h^\alpha)$ for $h \to + 0$. (ASTIA abstract)

327

Chicago U. Dept. of Mathematics, Ill.

ON THE EXISTENCE OF CONJUGATE FUNCTIONS OF HIGHER ORDER, by M. Weiss and A. Zygmund. Apr. 1959, 23p. (Technical note no. 1) (AFOSR-TN-59-371) (AF 49(638)451) AD 213859; PB 140998 Unclassified

Also published in Fundamenta Math., v. 48: 175-187, 1959.

Properties of certain extensions are investigated for the notion of conjugate function. The following theorem is proved: Let f(x) be periodic and integrable and suppose that $f_{(r-1)}(x)$ exists at each point of a set E of positive measure. Then a necessary and sufficient condition for the r-th conjugate $\tilde{f}_r(x)$ to exist almost everywhere in E is that the indefinite integral of f has a generalized derivative of order r + 1 almost everywhere in E. (ASTIA abstract)

328

[Chicago U. Dept. of Mathematics, Ill.]

SINGULAR INTEGRALS, by V. E. Morley. [1959] 21p. (Technical note no. 3) (AFOSR-TN-59-373) (AF 49-(638)451) AD 213857; PB 140997 Unclassified

The existence and properties are considered for certain singular integrals in n-dimensional Euclidean space E^n. The integrals are of the type $\int_{E^n} K(P;P-Q) f(Q)dQ = \int K(P;Q) f(P-Q)dQ$, where $K(P;Q) = \Omega(P;Q')/|Q|^n$. The presentation of results are discussed for the marginal cases when i is in L or L log L. If f is restricted to be a member of $L_p(E^n)$, the integral is viewed as defining a linear transformation on $L_p(E^n)$. Only L_p classes for $1 < p < 2$ are treated. The convergence of f_ϵ as $\epsilon \to 0$, is studied. Under suitable restrictions on $\Omega(P;Q)$, proofs are presented that the $\tilde{f}_\epsilon$ converge in L_p norm with $\|\tilde{f}_\epsilon\|_p < A_p \|f\|_p$ for the f in L_p, $1 < p < 2$, and that f_ϵ converges almost everywhere for f in L_1. (ASTIA abstract)

329

Chicago U. Dept. of Mathematics, Ill.

A NOTE ON SMOOTH FUNCTIONS, by M. Weiss and
A. Zygmund. [1959 [7]p. (Technical note no. 4)
(AFOSR-TN-59-400) (AF 49(638)451) AD 214520
Unclassified

Also published in Koninkl. Nederl. Akad. Wetensch.
Proc., Indag. Math., v. 62A: 52-58, 1959.

Proof is presented for the following theorems: (1)
If $F(x)$ is periodic and for some $\beta > 1/2$ satisfies
$\Delta^2 F(x, h) = F(x + h) + F(x-h)-2F(x) = O\left(\frac{h}{|\log h|\beta}\right)$
uniformly in x, then F is the indefinite integral of an

f belonging to every L^p. This theorem permits sim-
plification of Salem's theorem (Koninkl. Nederl. Akad.
Wetensch. Proc., v. 57A: 550-557, 1954). (2) Suppose
that a periodic and continuous F satisfies the condition
$\Delta^2 F(x, h) = o\left(\frac{h}{\log h}\right)$ and let S_n and σ_n be respectively
the partial sums and (C, 1) means of $S'[F]$ (i.e. $S[F]$ dif-
ferentiated termwise). Then $S_n - \sigma_n \to 0$ uniformly in x.

It is pointed out that theorem 1 does not hold true for
$\beta = 1/2$. Theorem 2 is generalized in the metric

L^p. (Math. Rev. abstract)

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Chicago U. Dept. of Mathematics, Ill.

NON-UNIQUENESS IN CAUCHY'S PROBLEM, by A.
Plis. Aug. 1959, 9p. (Technical note no. 5) (AFOSR-
TN-59-1034) (AF 49(638)451) AD 228409; PB 145070
Unclassified

Also published in Jour. Math. and Mech., v. 9: 557-562,
July 1960.

Proof is presented of the following theorem: There ex-
ists a linear system of partial differential equations of
elliptic type for which the Cauchy problem possesses 2

distinct solutions of class C^∞. The leading coefficients

are constant and the remaining ones are of class C^m
$(0 < m < \infty)$. The (imaginary) characteristics are $(m + 3)$-
fold. The system consists of $2(m + 3)$ complex equations
in 2 independent (real) variables; it corresponds to
$4(m + 3)$ real equations defined on the who e plane.

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Chicago U. [Dept. of Psychology] Ill.

FREQUENCY DISCRIMINATION AFTER SECTION OF
BRACHIUM OF THE INFERIOR COLLICULUS (Ab-
stract), by J. M. Goldberg, B. A. Dalen, and W. D. Neff.
[1959] [1]p. (Sponsored jointly by Air Force Office of

Scientific Research under [AF 49(638)99] and Office of
Naval Research) Unclassified

Presented at meeting of the Acoust. Soc. Amer.,
Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1575,
Nov. 1959.

After complete bilateral section of the brachium of the
inferior colliculus, cats cannot relearn in auditory fre-
quency discrimination, a task which can be easily re-
learned after ablation of all known auditory neocortical
areas and the subsequent degeneration of the thalamic
auditory nuclei (the medial geniculate body and the
posterior nucleus). The problem can be relearned when
a small part of the brachium remains intact; the rate
of relearning depends upon the anatomical locus of the
remaining fibers. These results suggest that the bra-
chium may contain fibers that do not end in the medial
geniculate body and that these fibers, which probably
come from the inferior colliculus and/or the nucleus of
the lateral lemniscus, play an important role in the
neural mechanisms underlying frequency discrimination.

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

[NEW DETERMINATION OF THE DECAY RATE OF
NATURAL TRITIUM AND THE QUESTION OF THE
ORIGIN OF NATURAL TRITIUM] Neubestimmung der
natürlichen Tritium-zerfallsrate und die Frage der
Herkunft des natürlichen Tritium, by F. Begemann.
[1959] [28]p. incl. diagrs. tables, refs. (AFOSR-TN-
59-66) (AF 18(600)564) AD 209610 Unclassified

Also published in Zeitschr. Naturforsch., v. 14a: 334-
342, Apr. 1959.

The decay rate of "natural" tritium has been redeter-
mined from measurements of the tritium content of old
snow samples from Greenland. The finding by Craig
and Begemann and Libby has been confirmed that the
tritium decay rate is about 10 times higher than was
anticipated previously. Two mechanisms to explain
the discrepancy are discussed, (a) production by the
low energy component of the cosmic radiation and (b)
the accretion of solar tritium by the earth, as sug-
gested by Feld and Arnold. It is shown that in case all
the tritium is produced by cosmic radiation, the tro-
pospheric production rate may be expected to vary in
antiphase with the sunspot cycle, whereas in case of
accretion of solar tritium by the earth, the variation
should be in phase with the sunspot cycle. In both cases
a phase shift between the stratospheric production rate
and the amount of tropospheric tritium is to be expected
because of the residence time of tritium in the strato-
sphere. A measurement of the phase shift should ena-
ble the determination of this residence time. The data
obtained on the Greenland samples appear to show such
a variation of the production rate. The results can be
explained best by assuming that all the tritium is

produced by cosmic radiation. This result, however, is only preliminary. More systematic measurements are required to decide between the 2 possibilities. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

[He^3 - H^3 RADIATION AGE OF A STONE METEORITE] ^{3}He - ^{3}H - Strahlungsalter eines Steinmeteoriten, by F. Begemann, P. Eberhardt, and D. C. Hess. [1959] [11]p. incl. diagr. tables, refs. (AFOSR-TN-59-434) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)564 and Atomic Energy Commission under AT(11-1)101) AD 214796

Unclassified

Also published in Zeitschr. Naturforsch., v. 14A: 500-503, May-June 1959.

The tritium and He^3 contents of 3 samples of the ABEE stone meteorite have been measured. Within the experimental limits of error both are found to be the same at the surface and near the center of the meteorite. At the time of the fall of the meteorite (1952) the tritium activity was (0.26 ± 0.04) disintegrations/min g. The He^3 content was measured to be (0.13 ± 0.01) x 10^{-6} cc STP/g. The amount of He^3 accumulated and the tritium decay rate yield a maximum radiation age of 30 million yr. If it is assumed that equal amounts of He^3 and H^3 are produced by the interaction of cosmic rays with the meteoritic matter, the radiation age is 15 million yr. The He^4/U-age of the meteorite is greater than 3800 million yr. The possible significance of this discrepancy is discussed. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

THE PRIMARY COSMIC RAY PROTON AND ALPHA PARTICLE INTENSITIES AND THEIR VARIATION WITH TIME, by P. Meyer. Apr. 1959 [32]p. incl. diagrs. tables, refs. (Rept. no. EFINS 59-19) (AFOSR-TN-59-455) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666 and U. S. Committee for the I.G.Y.) AD 233359 Unclassified

Also published in Phys. Rev., v. 115: 1734-1741, Sept. 15, 1959.

A series of high altitude balloon flights was conducted in 1957 and 1958 to study the flux of primary cosmic ray protons and α-particles during variations in the total cosmic ray intensity. The following results were obtained for α-particles with energies exceeding 530 mev/nucleon under 13.5 g/cm^2 of air: (1) during a large Forbush-type decrease the α-particle and proton

intensities were closely correlated; (2) at certain times variations in the α-particle intensity were observed within a few hours which were not accompanied by corresponding changes in the proton flux; and (3) while there existed an intensity decrease in the proton flux between 1957 and 1958 which is also observed in the neutron monitor station data, no such variation occurred in the γ-particle flux. A division of the α-particles into 2 energy groups (450 mev/nucleon $<$ E$_I$ $<$ 960 mev/nucleon and E$_2$ $\geq$ 960 mev/nucleon) shows (1) that the Forbush decrease is of the same magnitude in both energy groups; (2) that the hourly flux increase observed in some flights is about the same in both energy groups; and (3) that from 1957 to 1958 the flux in the low energy group increased, while it decreased in the high energy interval, contrary to the well known behavior of the proton flux. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

PLASMA DYNAMICAL DETERMINATION OF SHOCK THICKNESS IN AN IONIZED GAS, by E. N. Parker. [1959] [7]p. incl. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Published in Astrophys. Jour., v. 129: 217-223, Jan. 1959.

It is shown that the principal interaction in a shock front in a tenuous ionized gas is a plasma interaction in which the ions transfer their translational energy to the plasma oscillations. The effect is, of course, of interest in auroral theories and in solar radio noise. It turns out to be the dominant effect in determining shock thicknesses nearly everywhere that the gas density is less than the solar photospheric value of 10^{16} atoms/cm^3. It is estimated that shock thicknesses in interstellar H II regions and in interplanetary space will be 1 km or less, even though the mean free paths may be 10^8 km or more than the ion Larmor radius ~ 100 km. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

FINAL STATE INTERACTION IN $_\Lambda$He^5 DECAY, by R. G.] Ammar, R. Levi Setti and others. May 1959 [19]p. incl. diagrs. tables. (Rept. no. 318) (AFOSR-TN-59-1021) (In cooperation with Northwestern U., Evanston, Ill.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)209, Atomic Energy Commission and National Science Foundation) AD 234947 Unclassified

Also published in Nuovo Cimento, Series X, v. 13: 1156-1164, Sept. 1959.

The distribution of certain kinematic quantities defined in the decay $_\Lambda He^5 \to \pi^- + p + He^4$ are interpreted as being due to the presence of a strong final site interaction. In particular the data are discussed with reference to two simple theories, one of which takes into account the specific $p - He^4$ nuclear interaction. The experimental evidence, although not conclusive, is consistent with the expectation that the $p - He^4$ $p_{3/2}$ resonance plays an important role in determining the final state configurations. (Contractor's abstract)

337

Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

A POSSIBLE EXPERIMENTAL METHOD FOR THE PRODUCTION AND DETECTION OF HEAVY HYPER-FRAGMENTS, by R. Levi Setti and W. E. Slater. [1959] [3]p. incl. illus. diagr. (AFOSR-TN-59-1022) (AF 49(638)209) AD 234948   Unclassified

Also published in Nuovo Cimento, Series X, v. 14: 895-897, 1959.

A process of production is devised in which large energies can be imparted to very heavy nuclear fragments. In the experiment a uranium-loaded stack of 80 600μm Ilford G-5 2 in. x 4 in. was exposed to an enriched beam of K^- moderated so as to stop in the stack. The uranium concentration was found to be $2.6 \cdot 10^{20}$ nuclei/cm^3 or 0.6% of all nuclei of the dry emulsion excluding hydrogen. It is shown that the K^- induced fission is slightly asymmetric, yielding a probable proton and 2 heavy particles of unequal mass. Because the evidence suggests that the initiating particle must have been much heavier than a muon, it is concluded that it was a K^- and that track p was probably caused by a proton.

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

A POSSIBLE METHOD OF SPECIFIC CHARGE IDEN-TIFICATION FROM PROFILE MEASUREMENTS IN NUCLEAR EMULSIONS, by R. G. Ammar. [1959] [12]p. incl. diagrs. table. (AFOSR-TN-59-1023) (AF 49(638)-209) AD 234949   Unclassified

Also published in Nuovo Cimento, Series X, Suppl., v. 15: 181-192, 1960.

A discussion is given of a method of specific charge identification in nuclear emulsions (e.g. 1200 μm thick K-5 pellicles processed unmounted) requiring ~50 μm projected range. Using a constant cell length t, the

width of the track T_n was measured at each residual range nt, yielding a distribution $\{T_n\}$. Typically $\{T_n\}$ consisted of 100 measurements made at a basic cell length $t \approx 0.57$ μm. Each track was subjected to about three such measurements in order to estimate the measurement errors. The mean T and standard spread σ of this distribution, which are conventional charge sensitive parameters, often require normalizations for best results. A search amongst the dimensionless parameters associated with the distribution $\{T_n\}$ indicates that the third moment of the distribution, $\alpha_3 = \Sigma (T_n - T)^3 / \sigma^3$, is a charge sensitive parameter. A truncated distribution $\{T'_n\}$ with mean $\overline{T}'$, spread σ' and skewness α(pσ') is derived from $\{T_n\}$ by replacing all $T_n > \overline{T}' + p\sigma'$ by $\overline{T}' + p\sigma'$. α(pσ') with p = 3.75 is found to be the most sensitive parameter of those tried. It is presumed that its ability to discriminate is based on the presence of < sub-δ-rays > and the tendency to form gaps.

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

HYPERFRAGMENTS PRODUCED BY K^- CAPTURE IN NUCLEAR EMULSION: π^0 DECAY MODES, by R. G. Ammar. [1959] [23]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1024) (AF 49(638)209) AD 234950   Unclassified

Also published in Nuovo Cimento, Series X, v. 14: 1226-1248, Dec. 1959.

A systematic study was made of the π^0-decays of light hypernuclei (A ≤ 5) produced by K^- capture in nuclear emulsion. Approximately $3 \cdot 10^4$ K^- stars were examined, yielding a total of 94 1-prong events satisfying the following conditions: $R_c \geq 5$ μm, $8 \leq m \leq R_0 \leq 50$ μm, $\theta \geq 60°$, where R_c is the range of the primary (connect-track), R_0 that of the secondary (recoil) and θ the angle between their directions at their point of intersection. Of the 69 events which could be charge (Z) identified, 55 had Z = 1 and 14 Z = 2. In the Z = 1 category the true π^0-events could not be separated from 1-prong Σ^--events because of the overwhelming (~90%) contribution of the latter. It is concluded that probably all the 14 Z = 2 events represent true $_\Lambda$He decays (~10 $_\Lambda He^4$ and ~4 $_\Lambda He^5$). In addition, three 2-prong events were consistent with the interpretation as $_\Lambda He^4$ decays. One can define for the π^0 decays of $_\Lambda He^4$ the ratio: R' ($_\Lambda He^4$) = (two-body decays)/(all decays — < unobservable > ones); the < unobservable > ones being π^0-neutron-recoil

decays with recoil momenta < 110 mev/c and other

modes with $\geq$ 1 neutron. A value R'$({}_\Lambda He^4)$ = 0.82 $^{+.15}_{-.16}$

is found. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

MESIC DECAYS OF HYPERNUCLEI FROM K⁻ CAP-
TURE. I. BINDING ENERGIES, by R. [G.] Ammar,
R. Levi Setti and others. [1959] [20]p. incl. diagrs.
tables, refs. (AFOSR-TN-59-1025) (In cooperation
with Northwestern U., Evanston, Ill.) (Sponsored
jointly by Air Force Office of Scientific Research un-
der AF 49(638)209, Atomic Energy Commission, and
National Science Foundation) AD 238741
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., May 1-3, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II,
v. 3: 175, May 1, 1958.

Also published in Nuovo Cimento, Series X, v. 15: 181-
200, Jan. 1960.

The analysis of 134 uniquely identified mesic decays
yields increased accuracy in the knowledge of the bind-
ing energies of the hypernuclides ${}_\Lambda H^3$, ${}_\Lambda H^4$ ${}_\Lambda He^4$, ${}_\Lambda He^5$,
${}_\Lambda Li^7$, ${}_\Lambda Li^8$, ${}_\Lambda Li^9$, and ${}_\Lambda Be^9$. In addition, individual
examples of the new species ${}_\Lambda He^7$, ${}_\Lambda B^{11}$ and ${}_\Lambda B^{12}$ are
described. The present data are combined with those
collected in the EFINS survey. The isotopic spin multip-
let structure of the light hypernuclei is discussed with
reference to the information derived from the binding
energies. (Contractor's abstract)

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Chicago U. [Enrico Fermi Inst. for Nuclear Studies] Ill.

PRECESSION OF THE POLARIZATION OF PARTI-
CLES MOVING IN A HOMOGENEOUS ELECTROMAG-
NETIC FIELD, by V. Bargmann, L. Michel, and V. L.
Telegdi. [1959] [2]p. incl. refs. [AF 49(638)209]
Unclassified

Published in Phys. Rev. Ltrs., v. 2: 435-436, May 15,
1959.

Covariant classical equations of motion of the spin are
formulated for the axial 4-vector describing the polari-
zation. In addition some special cases of practical
interest are considered.

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Chicago U. Inst. for the Study of Metals, Ill.

THE EFFECT OF PRESSURE ON SELF-DIFFUSION
IN LEAD, by N. H. Nachtrieb, H. A. Resing, and S. A.
Rice. Feb. 1959 [13]p. incl. diagrs. table, refs.
(AFOSR-TN-59-24) (AF 18(600)1489) AD 208754;
PB 138703   Unclassified

Also published in Jour. Chem. Phys., v. 31: 135-136,
July 1959.

Data are presented for the self-diffusion of lead as a
function of temperature from 174° to 322° and for pres-
sures from 1 to 8100 atm. The decrease in the self-
diffusion coefficient with pressure follows a relation-
ship of the form:

$$\frac{d \ln D}{d\xi} = -\frac{1}{RT_0}\left[Q_0 - \frac{\Delta V_{act}}{\frac{dT_m}{dP}}\right], \text{ where } \xi = \frac{T_m}{T},$$

T_0 and Q_0 are the normal melting point and the zero
pressure activation energy, respectively, and ΔV_{act}
is the activation volume. To 1st order the derivative
is constant, deviations arising at high pressure because
of the pressure-dependence of $\frac{dT_m}{dP}$. Several relation-
ships are derived from thermodynamic considerations of
the activated state, and are shown to be valid experi-
mentally: (1) $\Delta H_{act} = bRT_m$ k with b = 20.7, and (2)
$\Delta H_{act} = \Delta H_m \cdot \frac{\Delta V_{act}}{\Delta V_m}$, where ΔH_m and ΔV_m are the la-
tent heat and volume change on fusion, respectively.
(Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

A METHOD OF PREPARING THIN FILMS OF ALLOYS
SUITABLE FOR OPTICAL STUDIES, by L. G. Schulz.
Feb. 1959 [17]p. incl. diagrs. (AFOSR-TN-59-25)
(AF 18(600)1489) AD 208755; PB 138702
Unclassified

Also published in Jour. Opt. Soc. Amer., v. 49: 1191-
1195, Dec. 1959.

An experimental procedure is described for producing
thin films of binary alloys by evaporation and condensa-
tion in a vacuum. The components of the desired alloy
are evaporated successively and the alloy is then pro-
duced by diffusion. A feature of the method is the use
of a rotating modulator located between the vapor
source and the substrate which controls the relative
thickness of the deposit. During the first evaporation
a uniform gradient of one metal is deposited. The

substrate is then rotated 180° in its own plane and a gradient of another material is superposed. This results in a sample of approximately uniform thickness with pure metal components at the ends and with a composition gradient in between. The procedure is easily extended to permit the production in one evaporation of several samples having different thicknesses. An annealing treatment is usually helpful in promoting diffusion. Representative results on several alloys are described. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

ON THE DYNAMICAL THEORY OF DIFFUSION IN CRYSTALS. II. PRESSURE DEPENDENCE OF THE SELF DIFFUSION CONSTANT, by S. A. Rice and N. H. Nachtrieb. Mar. 1959, 22p. incl. refs. (AFOSR-TN-59-93) [AF 18(600)1489] AD 210183; PB 139556
Unclassified

Also published in Jour. Chem. Phys., v. 31: 139-145, July 1959.

A dynamical theory of diffusion developed previously is extended to the study of the pressure dependence of the self diffusion constant. Application of the theory is made to Na and Pb. For Pb, the computed heat of activation is 23,300 cal to be compared with the experimental value of 23,210 cal. (Contractor's abstract)

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Chicago U. [Inst. for the Study of Metals] Ill.

DIFFUSION OF Ga, As, Cd, AND Hg IN Cu (Abstract), by C. T. Tomizuka and D. L. Garrett. [1959] [1]p. [AF 18(600)1489]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 171, Mar. 30, 1959.

The diffusion of various types of impurities in single crystals of copper was studied with the standard technique of radioactive tracers and lathe sectioning. The activation energies and the frequency factors are determined over a temperature range of 700°-1040°C. The results indicate that the electronic screening does not necessarily account for the observed change in the activation energy. They also suggest that it is impossible to isolate the effect of excess electronic charge from that of the elastic strain introduced by the impurities.

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Chicago U. [Inst. for the Study of Metals] Ill.

EFFECT OF SIMULTANEOUS TORSIONAL STRAIN ON SELF-DIFFUSION IN SILVER (Abstract), by J. B. Darby, Jr., C. T. Tomizuka, and R. W. Balluffi. [1959] [1]p. [AF 18(600)1489]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 171-172, Mar. 30, 1959.

The effect of deformation on silver self-diffusion, previously investigated for extension and compression, was studied during torsion. Polycrystalline rods of high-purity silver with an initial grain size $\sim$ ($\frac{1}{2}$ — 3 mm) were plated with Ag^{110} and were simultaneously twisted and diffused in the range 790-800°C. The penetration curves were obtained by sectioning. No enhancement of diffusion was observed within the estimated experimental error in the diffusivity ($\pm$ 20%). Strain rates between 1.6×10^{-5} and $14 \times 10^{-5} \; sec^{-1}$ and strains ≤ 0.5 were employed. These results are consistent with the previous data which indicate that the effects of plastic deformation are small at these relatively high temperatures. The results disagree markedly with those of Lee and Maddin who report enhancements 2 orders of magnitude larger than the present results under comparable experimental conditions. The results will be compared with those of other workers in the field. Further work at lower temperatures is continuing.

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Chicago U. [Inst. of Radiobiology and Biophysics] Ill.

STUDIES OF THE SCANNING X-RAY SYSTEM AS A MEANS OF EXAMINING STRUCTURE, by R. J. Moon. [Final rept.] Sept. 1955, 98p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-179) (AF 18(600)566) AD 249432
Unclassified

The primary goal of this research was the development of a scanning x-ray system which would effectively and in a practical way produce an x-ray image with much more information at a greatly reduced dosage than with conventional methods. Much of the projected goal was achieved, although continuous operation of the scanning x-ray tube at 100 ma and 125 kv was not accomplished, as intended. The currents and voltages at which the tube was operated indicated, however, the feasibility of achieving this level of operation. A suitable fluorescent crystal detector was developed. The electron optics of the scanning x-ray tube proved to be excellent. A pulse sorter was developed which is capable of handling 100,000,000 pps. A prototype memory tube was also constructed and used successfully. Studies were conducted

cn physical and biological specimens. The research
work was brought to a state that indicates the necessity
for the continued development of the scanning x-ray
system.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

EVALUATION OF MOLECULAR INTEGRALS BY DIGI-
TAL COMPUTER, by C. C. J. Roothaan. [1958] [3]p.
(Bound with its AFOSR-TN-60-9; AD 232111; PB 154277)
(Sponsored jointly by Air Force Office of Scientific Re-
search under AF 18(600)471, National Science Founda-
tion, and Office of Naval Research under N6ori-2009)
Unclassified

Also published in Jour. Chem. Phys., v. 28: 982-983,
May 1958.

One of the goals of this research has been the develop-
ment of a complete set of digital computer programs
for all the integrals occurring in quantum-mechanical
calculations, based on Slater orbitals. This being a
formidable task, a more restricted objective was chosen
1st, namely the 2-center integrals arising from 1s, 2s,
and 2p orbitals. A fully automatic program, using the
Remington Rand 1103 computer, was recently com-
pleted. Extensive tests have proven the integrals reli-
able to at least 7 significant figures. The total comput-
ing time for all the necessary integrals for a diatomic
molecule of 1st row atoms is 37 or 100 min for the
homopolar or heteropolar case, respectively, for each
value of R. Comparison of this program with others
indicates the need for extension of the existing pro-
grams in 2 directions: higher quantum numbers; and 3-
and 4-center integrals.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

[CORRELATED ATOMIC ORBITALS] Orbitales
atomiques corrélées, by C. C. J. Roothaan. [1958] [2]p.
incl. diagr. table. (Bound with its AFOSR-TN-60-9;
AD 232111; PB 154277) (Sponsored jointly by Air Force
Office of Scientific Research under AF 18(600)471,
National Science Foundation and Office of Naval Re-
search under Nonr-212101)   Unclassified

Published in Colloque Internat'l. sur le Calcul des
Fonctions d'Onde Moléculaire, Paris (France), Paris,
Centre National de la Recherche Scientifique, 1958,
p. 49-50.

It is pointed out that one criticism of the function of n
electrons based on the Hartree-Fock orbitals is that
the electrons situated in the same orbital and having
opposite spins must approach each other very often.
In the case of 2 electrons the curve of the function bends
abruptly toward a finite value when $\Gamma_{12} \to 0$ has been
demonstrated by Hartree-Ingman. The Hartree-Fock

cure for 2 electrons ms smooth when $\Gamma_{12} \to 0$. The for-
mula $\Phi = \varphi_{(\Gamma 1)} \varphi_{(\Gamma 2)} \mathcal{f}_{(\Gamma 12)}$ is given and calculations of
ω and $\mathcal{f}$ are made. The results show that the experi-
mental value and that calculated by the Hartree-Fock
formula to be in close agreement.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

[REPRESENTATION OF HARTREE-FOCK ATOMIC
FUNCTIONS BY ANALYTICAL DEVELOPMENTS]
Représentation des fonctions atomiques de Hartree-
Fock par des développements analytiques, by C. C. J.
Roothaan. [1958] [2]p. (Bound with its AFOSR-TN-60-
9; AD 232111; PB 154277) (Sponsored jointly by Air
Force Office of Scientific Research under AF 18(600)-
471, National Science Foundation, and Office of Naval
Research under Nonr-212101)   Unclassified

Published in Colloque Internat'l. sur le Calcul des
Fonctions d'Onde Moléculaire, Paris (France), Paris,
Centre National de la Recherche Scientifique, 1958,
p. 61-62.

A shorter and easier procedure is presented for finding
the Hartree-Fock orbitals. The method consists of
choosing a set of base functions and determining the
atomic orbitals as being the best linear combinations
possible that can be obtained from the set. The success
of this procedure depends entirely on the choice of a
good set of base functions, in order that an expression
with as few terms as possible be obtained to produce
the Hartree-Fock orbitals. As a test of this method,
the orbital of helium is determined from the formula

$$\varphi = \sqrt{\frac{\zeta^3}{\pi}} \, [a_0 + a_1\,(\zeta r) + a_2\,(\zeta r)^2]\, e^{-\zeta r}.$$ The energy

obtained from this function is E = 2.36159 which com-
pare favorably with E = 2.36167 obtained by using the
established longer expression.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

[QUANTUM MECHANICAL COMPUTATIONS OF
MOLECULAR PROPERTIES], by R. S. Mulliken, J. R.
Platt and others. Technical rept. 1957-1958, Part I,
251p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-
1073) (Sponsored jointly by Air Force Cambridge Re-
search Center under AF 19(604)1019 and AF 19(604)-
3478, Air Force Office of Scientific Research under
AF 18(600)471, Office of Naval Research under Nonr-
212101, Office of Ordnance Research under DA-11-022-
ORD-1002, and Wright Air Development Center under
AF 33(616)5608)   Unclassified

This report covers the period Jan. 1, 1957 through
May 31, 1959 for all contracts. It contains 28 technical
papers which are largely devoted to the subject of

molecular spectroscopy and related matters. It also includes a group of theoretical papers on hyperconjugation, and 3 papers on free-electron molecular orbital theory. A large number of the included papers are reproduced from published reprints.

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Chicago U. [Lab. of Molecular Structure and Spectra] Ill.

[COMPUTATIONS ON INTEGRALS IMPORTANT IN QUANTUM CHEMISTRY], by R. S. Mulliken. Final rept. [1959] 4p. (AFOSR-TR-59-139) (AF 18(600)471) AD 230388   Unclassified

The progress of the research on this project is reviewed, from its inception in Oct. 1952 through May 1959. The accomplishments of the study have included the construction of electronic digital computer programs for computing exchange integrals, the development of a single-package program consisting of a combination of several integrals programs, aimed at computing all integrals rapidly to produce a self-consistent-field (SCF) molecular wave function in the sense of Roothaan's SCF LCAO method, and the development of a program for computing the 3- and 4-center interelectronic repulsion integrals for the case of linear molecules, by a new method.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

SUMMARY OF THEORETICAL WORK ON ATOMS AND MOLECULES, by B. J. Ransil. [1959] [9]p. incl. tables. (Bound with its AFOSR-TN-60-9; AD 232111; PB 154277) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)471, National Science Foundation, Office of Naval Research under Nonr-212101, and Wright Air Development Center under AF 33(616)5608)   Unclassified

The work of this project has encompassed 4 broad areas of study: (1) improvement of existing mathematical techniques and development of new ones for calculating molecular integrals, for performing atomic and molecular variational procedures, and for atomic and molecular SCF procedures; (2) improvement and extensive development of existing methods and exploration of new ones for obtaining accurate atomic and molecular wave functions; (3) survey of selected diatomic molecules of the 1st row of the periodic table in single-determinantal LCAO-MO-SCF approximation with a basic set of Slater-type orbitals limited to inner and valence shell only; and (4) individual projects which related to 1 or all of the above. The technical papers emanating from this research, and the specific developments and results are discussed.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

SURVEY OF DIGITAL COMPUTER PROGRAMS FOR COMPUTATION OF ELECTRONIC PROPERTIES OF ATOMS AND MOLECULES, by B. J. Ransil. [1959] [6]p. incl. tables. (Bound with its AFOSR-TN-60-9; AD 232111; PB 154277) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)471 and National Science Foundation)   Unclassified

Three extensive libraries of digital computer programs for computing the electronic properties of atoms and molecules are described: (1) the library of univac scientific 1103 programs at WADC; (2) the library of univac scientific 1103A programs, also at WADC; and (3) the library of IBM 704 programs at National Bureau of Standards and Argonne National Lab. For the 1103, a molecular consistent field (SCF) program was written for computing SCF MO's approximated as linear combinations of atomic orbitals (SCF LCAO-MO's). The SCF program was then correlated with the various integrals programs and a versatile input-output format, to produce a completely automatic molecular program capable of computing the total electronic energy, ionization potentials, and wave functions of any closed-shell diatomic molecule of the 1st row of the periodic table and its hydride in a single-determinant LCAO-MO approx. For the 1103A, a generalized integrals program for computing all 1- and 2-electron molecular integrals for 2-, 3-, and 4-center linear molecules is near completion. An integrals program capable of computing atomic integrals for s orbitals only, has been completed in conjunction with a generalized SCF scheme for atoms. Three SCF routines are in various stages of progress. It is planned that the programming, now being handled by the 1103 computer will eventually be transferred completely to the 1103A, which is a faster machine than the 1103 in many aspects. A generalized integrals and SCF program for atoms has been developed for the IBM 704 at Argonne National Lab. and an SCF procedure has been coded at NBS. It is expected that a more extensive computer library will become available for the IBM 704 during 1960.

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Cincinnati U. Applied Science Research Lab., Ohio.

STUDIES OF THE DIELECTRIC PROPERTIES OF INSULATING LIQUIDS, by M. Ish-Shalom. Final rept. Feb. 20, 1959, 103p. incl. diagrs. tables, refs. (AFOSR-TR-59-31) (AF 49(638)271) AD 244645   Unclassified

Anomalous dispersion in viscous liquids was investigated. Anomalous dispersion is the phenomenon in which the dielectric constant of a substance decreases with increasing frequency of the measuring electric field. The decrease is accompanied by an increase in the loss factor. The macroscopic and microscopic aspects of the theory of dielectrics are discussed with respect to static properties, time dependent field,

derivation of a Debye-type equation, distribution of times of relaxation, the Mossotti field and molar refraction, the Debye equation for molar polarization, the Onsager equation, and the Kirkwood equation. For the dynamic properties, consideration is given to Brownian motion (Debye) and the rate process. The dielectric properties of nitrobenzene solutions in 2 types of viscous solvents were studied at various temperatures and concentrations. One solution was a mixture of terphenyls and triphenylmethane and the other a low-molecular-weight butylene polymer. The common features of both systems were a high degree of skewness of the Cole-Cole plot, relatively high free energies of activation (8 to 10 kcal/mol), and high entropies of activation of the process of dielectric relaxation. The values of the free energies of activation and the entropies of activation of the viscosity were roughly of similar magnitude. The 2 solvents differed in the actual values of entropies of activation. After extrapolation to the temperatures at which the peak of the dielectric absorption lies between 1 and 10 kc/s, the viscosities of the solvents are about 50,000 to 100,000 poises.

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Colorado U. Dept. of Mathematics, Boulder.

TWIN CONVERGENCE REGIONS FOR CONTINUED FRACTIONS $1 + K(a_n/1)$ ONE OF WHICH IS THE CIRCULAR REGION $|a_{2n-1}| \leq \rho^2$, by W. J. Thron. [1959] 61p. (AFOSR-TN-175) (AF 49(638)100) AD 211315   Unclassified

Also published in Math Zeitschr., v. 70: 310-344, Feb. 1959.

A study is made of the continued fraction, $1 + \dfrac{a_1}{1} + \dfrac{a_2}{1} + ...,$ whose elements a_n are complex numbers.

Determination of twin convergence regions, one of the regions being the circular disk $|z| \leq \rho^2$, is considered. Regions $G\rho$ are sought such that the 2 conditions, $|a_{2n-1}| \leq \rho^2$ and $a_{2n} \in G\rho$ for all $n \geq 1$, guarantee convergence of the continued fraction.

357

Colorado U. [Dept. of Mathematics] Boulder.

SEQUENCES GENERATED BY ITERATION, by W. J. Thron. [1959] [19]p. (AFOSR-TN-59-938) (AF 49(638)-100) AD 226018; PB 145442   Unclassified

Also published in Trans. Amer. Math. Soc., v. 96: 38-53, July 1960.

Let g satisfy $0 < g(x) < x$ in some interval $0 < x < c$. If x_1 satisfies $0 < x_1 < c$, the sequence $x_1, x_2, x_3, ...$ is

determined by $x_{n+1} = g(x_n)$ (n = 1, 2, 3,...). Then $x_n \to 0$ and the question as to the asymptotic behavior arises. The behavior as far as it is independent of the initial element is of primary interest. Apart from a discussion of known facts concerning the case where g'(0) exists with $0 \leq g'(0)$, all attention is devoted to the case where g'(0) = 1.

358

Colorado U. [Dept. of Mathematics] Boulder.

A TWO-PARAMETER FAMILY OF BEST TWIN CONVERGENCE REGIONS FOR CONTINUED FRACTIONS, by L. J. Lange and W. J. Thron. [1959] 34p. (AFOSR-TN-59-1301) (AF 49(638)100) AD 229596; PB 144777
                                Unclassified

Also published in Math. Zeitschr., v. 73: 295-311, 1960.

A study is presented of the continued fraction $1 + a_1/1 + a_2/1 + ...,$ whose elements a_n satisfy the conditions: (1) $a_{2n-1} = c_{2n-1}^2$ for $|c_{2n-1} \pm ia| \leq \rho$ and (2) $a_{2n} = c_{2n}^2$ for $|c_{2n} \pm i(1+a)| \geq \rho$, where a is a complex number, and a and ρ satisfy the inequality $|a| < \rho < |1 + a|$. These conditions are shown to be sufficient for the convergence of the continued fraction. The case is considered for which the elements of the continued fraction satisfy these conditions for real values of a. An elementary proof is given for the convergence of the continued fraction which establishes uniformity of convergence and gives an estimate of the speed of convergence. This proof employs only the fundamental concepts of complex variable theory. This basic theorem is shown to also hold true for complex values of a. For this case, a non-elementary proof is constructed which depends on the theory of functions of normal families.

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Colorado U. Dept. of Physics, Boulder.

LECTURES IN THEORETICAL PHYSICS. VOLUMES I AND II. LECTURES DELIVERED AT THE SUMMER INSTITUTE FOR THEORETICAL PHYSICS, COLORADO U., BOULDER, 1958-1959, ed. by W. E. Britten, B. W. Downs, and L. G. Dunham. New York, Interscience, 1959-1960, 2v. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-136) (In cooperation with Boulder Labs., Colo.) [AF 49(638)349]   Unclassified

The purpose of these conferences was to promote a free exchange of ideas and information among investigators of theoretical physics. Lectures dealing with high-energy collision theory, interactions of strange particles, multiple production of mesons, nuclear theory, pair production in the field of an atom, particles with zero-mass, and statistical-mechanical theory of irreversible processes are discussed in the 1st volume. The 2nd volume

contains articles on abstract field theory, the classical electron, hypernuclei and the Λ-nucleon interaction, invariance properties in elementary particle physics, quantum mechanical amplifiers, quantum mechanics' many body problem, symmetry laws, and the theory of beta decay.

360

Columbia U. [Columbia Radiation Lab.] New York.

MASER ACTION IN RUBY IN THE 21-CM REGION (Abstract), by F. R. Ararıs, S. Okwit, and A. A. Penzias. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-73279])
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 21, Jan. 28, 1959.

A 3-level ruby maser employing a partially superconducting fixed frequency cavity was operated at Columbia U. It employed the $1/2 \leftrightarrow -1/2$ and $3/2 \leftrightarrow -1/2$ transitions (employing the low field notation) for amplifying and pumping frequencies respectively. It was operated at low magnetic fields oriented at $67°$ relative to the crystal axis. A tunable maser was developed concurrently at Airborne Instruments Lab. Operation was obtained without the use of a superconducting cavity using the $-3/2 \leftrightarrow 3/2$ and $3/2 \leftrightarrow 1/2$ transitions at high magnetic fields oriented at $90°$ to the crystal axis. Operating parameters of the 2 masers will be given and the types of operation will be compared.

361

Columbia U. Columbia Radiation Lab., N. Y.

ANTIFERROMAGNETIC RESONANCE IN MnF_2, by F. M. Johnson and A. H. Nethercot, Jr. [1959] [12]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-73279])
Unclassified

Published in Phys. Rev., v. 114: 705-716, May 1, 1959.

Measurements of the antiferromagnetic resonance frequency, $\nu(T)$, where made on single-crystal slabs of MnF_2 in the frequency range 96 to 247.2 kmc/sec and at temperatures, T, ranging from $4.2°K$ to $64°K$ ($T_N = 67.7°K$). The results are in general agreement with the resonance relations derived for antiferromagnetic materials by Nagamiya, Keffer, and Kittel, and others. At low temperatures, values of $\nu(T)/\nu(0)$ and $\nu(0)$ are consistent with spin-wave method calculation of the sublattice magnetization and of the value and temperature

dependence of the anisotropy energy. This agreement indicates almost complete correlation of adjacent electron spins in the low-temperature range as predicted from spin-wave theory. From the antiferromagnetic resonance measurement of $\nu(0) = 261.4 \pm 1.5$ kmc/sec and Oguchi's calculation of H_A, $z|J|$ is 3.94×10^{-15} erg, in agreement with other determinations. Antiferromagnetic resonance line widths were measured from $4.2°K$ to $64°K$. The observed asymmetric line shapes are satisfactorily accounted for as arising from a mixing of absorption and dispersion and from reflections. A simplified line-width theory is given which satisfactorily accounts for the observed line widths except at the lowest temperatures, where a residual width is found. Finally, antiferromagnetic resonance measurements on 2 crystals, which where grown under different conditions, indicate no difference in resonance frequency or line width. (Contractor's abstract)

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Columbia U. [Columbia Radiation Lab.] New York.

A MASER AMPLIFIER FOR RADIO ASTRONOMY AT X-BAND, by J. A. Giordmaine, L. E. Alsop and others. [1959] [8]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research and Signal Corps under [DA 36-039-sc-73279])
Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 1062-1069, June 1959.

The design and operating characteristics of a maser radiometer for use in radio astronomy at 3-cm wavelength are discussed. The operating system which is described has a bandwidth of 5.5 mc and an input noise temperature, including background radiation into the antenna, of about $85°K$. An rms fluctuation level of about $0.04°K$ is attained using an averaging time of 5 sec. A discussion of the factors determining the sensitivity of such devices is presented. (Contractor's abstract)

363

Columbia U. Columbia Radiation Lab., N. Y.

FREQUENCY DEPENDENCE OF THE SURFACE RESISTANCE OF SUPERCONDUCTING TIN IN THE MILLIMETER WAVELENGTH REGION, by R. Kaplan, A. H. Nethercot, Jr., and H. A. Boorse. [1959] [10]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, and Signal Corps under [DA 36-039-sc-73279])
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 5, Jan. 28, 1959.

Also published in Phys. Rev., v. 116: 270-279, Oct. 15, 1959.

The ratio of the superconducting to normal surface resistance of polycrystalline tin has been measured at 7 frequencies between 17 kmc/sec and 77 kmc/sec and at temperatures from 1.5°K to 3.0°K. These data plus those of other investigators have been compared with the predictions of 2 theories: the first a calculation made by Serber (unpublished) based on the London 2-fluid model of superconductivity and the Reuter-Sondheimer theory of the anomalous skin effect, and the second a calculation based on the Bardeen-Cooper-Schrieffer theory as developed by Bardeen and Mattis. Agreement between experimental and theoretical results is only fair in the case of the two-fluid theory. The best values of the relevant parameters, Fermi velocity ν and mean free path l, were found to be, respectively, $(1.25 \pm 0.3) \times 10^7$ cm/sec and $10^{-3} - 10^{-1}$ cm. A value of ν approximately 10^8 cm/sec would be expected of tin. The surface resistance ratio from the Bardeen-Cooper-Schrieffer theory has been calculated only for the extreme anomalous limit and the calculation therefore should not apply too accurately for tin. However, a curve of the right general shape is obtained and further calculations more appropriate to tin should improve the agreement between theory and experiment.

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Columbia U. Columbia Radiation Lab., New York.

BEAM MASER SPECTROSCOPY ON FORMALDEHYDE, by P. Thaddeus, J. Loubser and others. [1959] [2]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-73279]
Unclassified

Published in Jour. Chem. Phys., v. 31: 1677-1678, Dec. 1959.

Hyperfine structures of CH_2O and $CHDO$ were made and analyzed. The former structure is due to $1 \cdot J$ and spin-spin magnetic interactions of the 2 protons. The isotopic substituted deuteron structure is compounded and is represented by $F_1 F$ where $1_D + J = F_1$, $I_H + F_1 = F$. The measured frequencies of the most intense $\wedge F_i = \Delta F = O$ transitions relative to the strongest line and the sum of the $F_1 = 3 \to 3$ are given in table form. In the investigations it was assumed that the C-H distance = 1.094A, C-O distance = 1.20A and < HCH = 118° ± 28'.

365

Columbia U. [Columbia Radiation Lab.] New York.

ATOMIC AND MOLECULAR BEAM SPECTROSCOPY, by P. Kusch and V. W. Hughes. [1959] 172p. incl.

diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-73279] and National Science Foundation)   Unclassified

Published in Handbuch der Phys., v. 37: 1-172, 1959.

The present article deals primarily with atomic and molecular beam spectroscopy. The 1st chapter on methodology includes discussions of the production, characteristics, detection, and deflection of beams of neutral particles, and of the theory and experimental technique associated with the transition process. The 2nd and 3rd chapters deal with atomic and molecular spectroscopy respectively. They include a summary of the theory of the energy levels studied, a discussion of the type of measurements that have been made and of the present limitations to the accuracy of the experiments, and a compilation of the more important data obtained. (Contractor's abstract)

366

Columbia U. Columbia Radiation Lab., New York.

RESEARCH ON PHYSICS AND CHEMISTRY OF GASES AT HIGH TEMPERATURES, by P. Kusch. Final rept. Nov. 1, 1954-Oct. 30, 1959. Nov. 1959 [2]p. incl. refs. (AFOSR-TR-59-194) (AF 18(600)1334)   Unclassified

A brief explanation of the work done under this contract is presented. The reports include those previously reviewed (COU.20:003-009, Vol. II) and are concerned with the properties of the alkali halides in the gaseous phase. Evidence was obtained of the polymerization of most of the alkali halide species. Recently, it is reported, the work has taken a new direction to the properties of the metastable stages of certain atoms. This work has been successful and will be reported in subsequent publications.

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Columbia U. Dept. of Chemistry, N. Y.

THE HYPERFINE INTERACTION AND QUADRUPOLE COUPLING CONSTANT IN THE HYDROGEN MOLECULE ION, by M. J. Stephen and J. P. Auffray. Technical status rept. nos. 17-18, May 1-Oct. 31, 1958 [17]p. incl. tables, refs. (AFOSR-TN-59-546) (AF 18(600)-1152) AD 253123   Unclassified

Also published in Jour. Chem. Phys., v. 31: 1329-1332, Nov. 1959.

An accurate calculation has been made of the interaction between the electron spin magnetic moment and a nuclear moment for the ground state of the hydrogen molecule ion. An accurate value of the electric field gradient at the nucleus was also obtained. The values are compared with values from an approximate L.C.A.O.

wavefunction. The possibility of observing the para-
magnetic resonance spectrum of this molecule is dis-
cussed. (Contractor's abstract)

368

Columbia U. [Dept. of Chemistry] New York.

PARAMAGNETIC RESONANCE ABSORPTION SPEC-
TROSCOPY, by G. K. Fraenkel. Final rept. Apr. 1,
1955-Sept. 30, 1959, 9p. (Rept. no. 16; rept. no. CU-
16-59 AF1390-Chem) (AF 18(600)1390) AD 230591;
PB 145523   Unclassified

The research performed during this study of the para-
magnetic resonance spectra of free radicals is reviewed.
Investigations have been made into the mechanisms of
proton hyperfine splitting in aromatic free radicals,
and certain theories are being tested which suggest that
the hyperfine splitting can be accounted for by a π-inter-
action and that the splitting may be related to the un-
paired electron spin density on the carbon adjacent to
the proton. Studies have been made of the electron res-
onance spectra of all the methyl- and chloro-substituted
p-benzosemiquinones and the acid-stabilized semiqui-
nones. Investigations of relaxation mechanisms, line
broadening, and saturation indicated that the peak
heights and line widths of the different hyperfine com-
ponents in the spectra of the semiquinone ions were not
the same and exhibited different degrees of saturation.

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Columbia U. Dept. of Chemistry, New York.

NUCLEAR AND PARAMAGNETIC RESONANCE, by
G. K. Fraenkel and B. [G.] Segal. [1959] [22]p. incl.
refs. [AF 18(600)1390]   Unclassified

Published in Ann. Rev. Phys. Chem., v. 10: 435-456,
1959.

The existing literature on nuclear and paramagnetic
resonance is reviewed. The discussion is restricted
almost exclusively to electron spin resonance, and is
concerned primarily with the ESR of free radicals. A
comprehensive list of 276 references is appended.

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Columbia U. Dept. of Chemistry, New York.

THEORY OF SATURATION IN ELECTRON SPIN RESO-
NANCE SPECTRA, by M. J. Stephen and G. K. Fraenkel.
Sept. 23, 1959, 1v. incl. diagrs. tables, refs. (Technical
note no. 2; rept. no. CU-2-59AF520-Chem) (AFOSR-
TN-59-745) (AF 49(638)520) AD 230214; PB 144910
                                           Unclassified

Also published in Jour. Chem. Phys., v. 32: 1435-1444,
May 1960.

A theory of saturation in electron spin resonance spec-
tra exhibiting hyperfine splitting is presented. This the-
ory is used to study the saturation of free-radical spec-
tra in solution; and several relaxation processes are in-
vestigated. It is shown that motional modulation of the
intramolecular electron-nuclear anisotropic dipole-dip-
ole interaction introduces a relation between the satura-
tion parameters and the hyperfine components that varies
symmetrically about the center of the spectrum and
causes a smaller degree of relaxation for the components
in the central portion of the spectrum than for those in
the wings. This relaxation mechanism introduces a
greater dependence on nuclear spin state for radicals
with several magnetic nuclei than for radicals with only
1 such nucleus. It is also shown that a cross-term be-
tween this intramolecular dipolar interaction and mo-
tional modulation of the anisotropic g-tensor introduces
a relaxation that varies linearly from 1 side of the spec-
trum to the other. Numerical values of the relaxation-
induced transition probabilities are estimated for the
benzene negative ion, and tables are given from which
saturation factors can be computed for a variety of con-
ditions for several different spin systems. The relation
between the spin-lattice relaxation time, T_1, and the pa-

rameters which determine saturation is discussed, and it
is pointed out that these quantities are not equivalent in
systems exhibiting cross-relaxation. (Contractor's
abstract)

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Columbia U. Dept. of Chemistry, New York.

ANOMALOUS RELAXATION OF HYPERFINE COMPO-
NENTS IN ELECTRON SPIN RESONANCE, by J. W. H.
Schreurs, G. E. Blomgren, and G. K. Fraenkel. Jan. 1,
1960, 27p. incl. table, refs. (Technical note no. 3; rept.
no. CU-3-60AF520-Chem) (AFOSR-TN-59-1326)
(AF 49(638)520) AD 233724; PB 146749 Unclassified

Also published in Jour. Chem. Phys., v. 32: 1861-1869,
June 1960.

It is shown that the different hyperfine components in
the electron resonance spectra of free radicals exhibiting
proton hyperfine splitting saturate at different rates,
and different sets of relaxation times must be used to
describe the behavior of each component. The variations
in the relaxation times (T_1 and T_2) were found to be
approx symmetric about the center of the spectrum, and
the central component is the narrowest and saturates
more readily than the outer components. A qualitative
discussion is given of the relaxation and line-broadening
mechanisms which may be responsible for the variations
in T_1 and T_2. In solutions of the p-benzosemiquinone ion
at room temperature, the values of T_1 and T_2 were found
to be approx 10^{-6} sec. An analysis is given of the exper-
imental parameters which affect saturation measure-
ments, including the effect of a non-uniform r-f field in a
rectangular cavity, and a study is made of the type of
spectra to be expected when the individual hyperfine

components have different values of T_1 and T_2. An appendix is included on the work of Jen, et al. (Phys. Rev., v. 112: 1169, 1958), on deuterium atoms trapped at liquid helium temperature, which shows that the anomalous intensities obtained as a function of r-f power is not the same as the phenomenon observed for free radicals in solution, and cannot be adequately interpreted in terms of any currently proposed mechanisms. (Contractor's abstract)

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Columbia U. Dept. of Electrical Engineering, New York.

A TRANSPORT EQUATION FOR THE SPECTRAL DENSITY OF A MULTIPLY SCATTERED ELECTRO-MAGNETIC FIELD, by D. S. Bugnolo. Nov. 19, 1959 [23]p. incl. diagrs. refs. (Technical rept. no. T-3D; rept. no. CU-8-59AF350-EE) (AFOSR-TN-59-1175) (AF 49(638)350) AD 229905; PB 145315
Unclassified

Presented in part at IRE-URSI joint meeting, San Diego, Calif., Oct. 1959.

Also published in Jour. Appl. Phys., v. 31: 1176-1182, July 1960.

The use of a first Born approximation is open to question when the path length is greater than a mean free path in the scattering region. It is therefore of interest to develop a transport equation capable of predicting the spectral density for such cases. The general theory presented in this paper is applied to the case of multiple scattering by dielectric noise. It is independent of models for the dielectric fluctuations. A method of solution is developed for the case of forward scattering. The particular case of a monochromatic plane wave incident of a half space is discussed in detail. The results are applied to a numerical example in the troposphere. (Contractor's abstract)

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Columbia U. Dept. of Electrical Engineering, New York.

ON THE QUESTION OF MULTIPLE SCATTERING IN THE TROPOSPHERE, by D. S. Bugnolo. Nov. 19, 1959 [20]p. incl. diagrs. refs. (Technical rept. no. T-4/D; rept. no. CU-9-59AF350-EE) (AFOSR-TN-59-1252) (AF 49(638)350) AD 230877; PB 145555 Unclassified

Also published in Jour. Geophys. Research, v. 65: 879-884, Mar. 1960.

A criteria is developed to serve as a measure of multiple scattering in the troposphere as a result of dielectric noise. The question to be answered is: What is the probability that any ray of the incident field will be scattered at least twice in a distance R? This is a useful criteria in that it can be used as a measure of re-

liability for the usual single scatter approximations. The criteria is developed in detail for an arbitrary dielectric noise and applied to a number of special cases. The results indicate that multiple scattering effects should be of importance in the microwave spectrum. (Contractor's abstract)

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Columbia U. [Dept. of Electrical Engineering] New York.

MEAN-SQUARED-ERROR OF A BAND-LIMITED LONG LINE-OF-SIGHT RADIO LINK AFFECTED BY ATMOS-PHERIC TURBULENCE (Abstract), by D. S. Bugnolo. [1959] [1]p. (AF 49(638)350) Unclassified

Presented at meeting of the Internat'l. Scient. Radio Union, Pennsylvania State U., University Park, Oct. 20-22, 1958.

Published in I.R.E. Trans. on Antennas and Propagation, v. AP-7: 105-106, Jan. 1959.

One possible measure of system reliability in the presence of atmospheric turbulence is the notion of fidelity in a mean-squared sense. Given an arbitrary input $x(t)$ and the output $y(t)$, the fidelity is defined as

$$v = \overline{[x(t) - y(t)]^2}.$$

This paper is concerned with the prediction of system fidelity as an application of the general theory of scattering for arbitrary inputs. The results are applied to the special case of a long line-of-sight radio link. It is shown that the fidelity in a mean-squared sense of a band-limited long line-of-sight radio link is directly proportional to the bandwidth.

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Columbia U. [Dept. of Mathematical Statistics] New York.

A NOTE ON PERFECT PROBABILITY, by G. Kallianpur. Feb. 1959 [8]p. (Rept. no. CU-46-59) (AFOSR-TN-59-210) (AF 18(600)442) AD 211664; PB 140417
Unclassified

Also published in Ann. Math. Stat., v. 30: 169-172, Mar. 1959.

A class of perfect probability spaces, called D-spaces, are defined and characterized. The triplet (Ω, Z, μ) is said to be a perfect probability space if μ is a probability over the σ algebra Z of subsets of Ω and if for every univalent, real valued, Z-measurable function f, the following is true: for every linear set A such that $f^{-1}(A) \in Z$, there exists a linear Borel set B with $B \subseteq A$ and $\mu \{f^{-1}(B)\} = \mu \{f^{-1}(A)\}$. Proof is presented of the theorem giving a necessary and sufficient criterion for a D-space.

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Columbia U. [Dept. of Mathematical Statistics] New York.

ON THE INDEPENDENCE OF A LINEAR STATISTIC
AND OF A QUADRATIC STATISTIC, by G. Kallianpur.
[1959] 23p. (AFOSR-TN-59-211) (AF 18(600)442)
AD 262094   Unclassified

Let $y_1,\ldots,y_n$ be independent, identically distributed
random variables. Consider the statistics $L = b'y$
and $Q = y'Ay + 1'y$ where A is the $n \times n$ matrix
(a_{jk}), $\underline{b} = (b_1,\ldots,b_n)'$, $\underline{1} = (1_1,\ldots,1_n)'$ and $\underline{y}$ is the
column vector with the y_j as components. In this pa-
per the following problem is studied: under what con-
ditions does the stochastic independence of L and Q
imply the normality of $\underline{y}$? Suppose the matrix A and
the vectors b and 1 are connected by the following re-
lations: $A b = o$ and $1'b = o$. (1) Let the diagonal ele-
ments of A be all of the same sign and let at least one
element a_{jj} be different from zero. Similarly let all
the components of the vector b be non-zero and of the
same sign. Suppose further that for some $\rho > o$
$E|y_1|^\rho$ is finite. If L and Q are independent statistics
then $\underline{y}$ is a normally distributed vector. (2) Let $a_{jj} =$
o for $j = 1,\ldots,n$ and suppose that the y_j are symmetric
random variables with finite second moments. Then
the independence of the statistics L and Q implies the
normality of the y_j.

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Columbia U. Dept. of Physics, New York.

GROUND STATE Λ-DOUBLING TRANSITIONS OF OH
RADICAL, by G. Ehrenstein, C. H. Townes, and M. J.
Stevenson. [1959] [2]p. incl. table. (Sponsored jointly
by Air Force Office of Scientific Research under
[AF 49(638)631], Office of Naval Research, and Signal
Corps)   Unclassified

Published in Phys. Rev. Ltrs., v. 3: 40-41, July 1, 1959.

The $F = 2 \rightarrow F = 2$ and $F = 1 \rightarrow F = 1$ transitions between
the Λ-doubling levels of the lowest rotational, te of
the $^2\pi_{3/2}$ electronic state of the OH radical, .   `
presence in interstellar space may be detectable ,y
these lines in its radiofrequency spectrum, have been
observed in the laboratory.

378

Columbia U. [Electronics Research Labs.] New York.

THE EFFECT OF POLE AND ZERO LOCATIONS ON

THE TRANSIENT RESPONSE OF SAMPLED-DATA
SYSTEMS, by E. I. Jury. [1955] [8]p. incl. diagrs.
(AFOSR-3914) (AF 18(600)677)   Unclassified

Presented at Winter General meeting of the Amer. Inst.
Elec. Engineers, New York, Jan. 31-Feb. 4, 1955.

Also published in Trans. Amer. Inst. Elec. Engineers,
v. 74 (Pt. II): 41-48, 1955.

The effect of the location of the poles and zeros of the
transfer function of a sampled-data system on the loca-
tion and magnitude of the maxima and minima of transi-
ent response resulting from a step function input is
studied. Theorems are given relating to the necessary
conditions for the production of monotonic and non-mono-
tonic time response expressed in terms of pole and zero
locations in the z-plane. It is shown that, under certain
conditions of pole and zero locations, the normalized
time-sequence response may well be approximated by a
single dominant time term. A method is presented of
ascertaining from the pole and zero location whether
these conditions exist. On the basis of dominant term
approx, the methods of synthesis applied to 2nd-order
systems can be generally extended to general systems.
The results of this investigation are directly applicable
to the design problems in the field of pulsed networks
and sampled-data control systems. (Contractor's ab-
stract)

379

Columbia U. [Electronics Research Labs.] New York.

CORRELATION BETWEEN ROOT-LOCUS AND TRAN-
SIENT RESPONSE OF SAMPLED-DATA CONTROL
SYSTEMS, by E. I. Jury. [1955] [8]p. incl. diagrs.
(AFOSR-3915) (AF 18(600)677)   Unclassified

Presented at Summer General meeting of the Amer.
Inst. Elec. Engineers, Swampscott, Mass., June 27-
July 1, 1955.

Also published in Trans. Amer. Inst. Elec. Engineers,
v. 74 (Pt. II): 427-434, 1955.

The introduction of the root-locus method in the z-
plane simplifies the investigation of sampled-data con-
trol systems, by demonstrating the correlation between
transient response and the location of the roots. It is
shown that by establishing the correlation between fre-
quency locus and the root locus, the correlation between
frequency and transient response of sampled-data sys-
tems can be demonstrated. Synthesis of sampled-data
control systems can be performed in the time domain
through the introduction of phase-angle loci as demon-
strated in examples. Finally, approx equations are
given so that transient overshoot and peak time may be
evaluated without actually working out the transient solu-
tion. (Contractor's abstract)

380

Columbia U. [Electronics Research Labs.] New York.

PULSE WIDTH MODULATED RELAY CONTROL OF
SYSTEMS SUBJECT TO SAMPLED DATA, by W. L.
Nelson. [1959] 68p. incl. diagrs. refs. (Technical rept.
no. T-34/B) (AFOSR-TN-59-282) (AF 18(600)677)
AD 212915; PB 142367   Unclassified

An investigation was conducted on the application of
pulse width modulation as a control method for relay
controlled systems with sampling. The limit cycles
which occur in relay control systems with sampling
are discussed, and 2 methods of design employing pulse
width control which eliminate these limit cycles are
developed. Experimental results are presented for a
second order system. Application and extension of
the results are discussed. (Contractor's abstract)

381

Columbia U. [Electronics Research Labs.] New York.

PULSE WIDTH CONTROL OF SAMPLED DATA SYS-
TEMS, by W. L. Nelson. July 6, 1959, 149p. incl. diagrs.
refs. (Technical rept. no. T-35/B; rept. no. CU-55-
59AF677-EE) (AFOSR-TN-59-609) (AF 18(600)677)
AD 217396; PB 143175   Unclassified

The use of pulse width control for the on-off regulation
of systems subject to sampled data is investigated in
this paper. The pulse width controller is considered to
effect control of a linear n^{th} order plant by applying to
the plant during each sampling period an input signal,
selected from the restricted class of pulse width control
signals, and based on the state of the plant at the samp-
ling instant. The basic capabilities of this type of con-
trol are investigated in relation to simple on-off (or re-
lay) control and in relation to pulse amplitude control.
General methods for achieving both stable and optimal
control are developed and practical design applications
are considered. Examples and experimental evaluation
of the design methods are also given. (Contractor's
abstract)

382

Columbia U. [Electronics Research Labs.] New York.

A DIGITAL-ANALOG CONTROLLER FOR SAMPLED
DATA SYSTEMS, by S. C. Bigelow. July 22, 1959, 47p.
incl. illus. diagrs. (Technical rept. no. T-36/B; rept.
no. CU-56-59AF677-EE) (AFOSR-TN-59-803) (AF 18-
(600)677) AD 226972; PB 143961   Unclassified

A practical digital controller is described for sampled
data control systems. The controller is a hybrid digi-
tal-analog computer programmed to solve the control
equations. The machine input and ouptut signals are
voltage analogs in the range of from -50 to +50 v.

Arithmetic operations are performed using analog com-
puter circuits, while storage is accomplished in digital
storage registers. Analog-to-digital and digital-to-ana-
log conversions are performed internally. This control-
ler serves a twofold purpose: (1) demonstrates the fea-
sibility of applying the well-developed theory of sampled
data control systems to real processes, and (2) provides
a useful tool for further study of such systems. (Con-
tractor's abstract)

383

Columbia U. [Electronics Research Labs.] New York.

A GENERAL FLOW GRAPH TECHNIQUE FOR THE
SOLUTION OF MULTI-LOOP SAMPLED SYSTEMS,
by R. Ash, W. H. Kim, and G. M. Kranc. July 31, 1959
[30]p. incl. diagrs. refs. (Technical rept. no. T-37/B;
rept. no. CU-57-59-677-EE) (AFOSR-TN-59-824)
(AF 18(600)677) AD 223400   Unclassified

A flow-graph approach for analyzing multi-loop sam-
pled-data systems is presented. Two techniques for
finding the sampled output are examined; these are:
(1) construction of a sampled signal flow-graph from
the original system; and (2) a general gain formula
which can be directly applied to the original system.
The theorems necessary to establish the formula are
rigorously proven. The 1st technique allows 2 possi-
ble modes of solution. The sampled output can be
found directly from the sampled flow graph by the use
of Mason's formula, or in case of a more complicated
multi-loop system, the problem of enumerating non-
touching feed-back loops can be simplified by the use
of topological matrices. Techniques developed are
also applied to the solution of multirate systems.
(Contractor's abstract)

384

Columbia U. [Electronics Research Labs.] New York.

OPTIMUM MULTIRATE CONTROLLER FOR A SAM-
PLED FEEDBACK SYSTEM, by G. M. Kranc. Oct. 1,
1959, 24p. incl. diagrs. (Technical rept. no. T-38/B;
rept. no. CU-59-59AF677-EE) (AFOSR-TN-59-1095)
(AF 18(600)677) AD 229686; PB 145100 Unclassified

An extension is made of optimum design procedures to
sampled-data systems with a multirate controller used
as a discrete compensator. The multirate controller is
a discrete network which in response to input samples
at time $t = 0, T, 2T, \ldots$ produces output samples at time
$t = 0, T/n, 2T/n, \ldots$ (where n is an integer), any output
sample being a linear combination of the past and pres-
ent inputs and outputs. It is shown how to design this
controller to achieve a least mean square continuous er-
ror with random inputs or a least integral continuous er-
ror with known test input functions. The advantages of
the multirate controller over the single-rate compensa-
tor are demonstrated. (Contractor's abstract)

385

Columbia U. [Electronics Research Labs.] New York.

SAMPLED DATA CONTROL SYSTEMS CONTAINING PERIODICALLY VARYING MEMBERS, by B. Friedland. Nov. 12, 1959, 25p. incl. diagrs. (Technical rept. no. T-39/B; rept. no. CU-60-59AF677-EE) (AFOSR-TN-59-1215) (AF 18(600)677; AD 230744; PB 145553 Unclassified

Presented at First Internat'l. Cong. of the Internat'l. Federation of Automatic Control, Moscow (USSR), 1960.

Also published in Automatic and Remote Control, v. 1: 361-368, 1960.

The Z-transform method is extended to sampled-data systems containing periodically varying members. Every member is characterized by an $N \times N$ "transfer matrix" $H(z)$ whose elements are pulse transfer functions. The input-output relation for every member is given by $\underline{Y}(z) = \underline{H}(z) \underline{X}(z)$ where $\underline{X}(z)$ and $\underline{Y}(z)$ are $1 \times N$ matrices (vectors) whose elements are the "skip-sampled Z-transforms" of the input and output, respectively. By the use of matrix algebra, the transfer matrices of the members are combined to obtain the overall transfer matrix of the system, from which the response of the system may be determined. The method is illustrated by application to the following problems: (1) multirate sampled systems; (2) systems in which samples are periodically omitted, and holding circuit with periodically varying hold time is employed; and (3) use of a periodically varying amplifier to achieve deadbeat performance.

386

Columbia U. [Electronics Research Labs.] New York.

LINEAR MODULAR SEQUENTIAL CIRCUITS AND THEIR APPLICATION TO MULTIPLE CODING, by B. Friedland and T. E. Stern. [1959] [9]p. incl. diagr. table. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)677 and Office of Naval Research under Nonr-26660) Unclassified

Presented at I.R.E. National Convention, New York, Mar. 23-26, 1959.

Also published in I.R.E. National Convention Record, Pt. 2: 40-48, 1959.

A linear modular sequential circuit (LMSC) is characterized by the relations (1) $y(n) = Cs(n) + Dx(n)$; (2) $s(n + 1) = As(n) + Bx(n)$ in which $y(n)$, $x(n)$, and $s(n)$ are the input, output, and state vectors, respectively and A, B, C, D are matrices defined over the modular field $GF(p)$ (p = prime). Such circuits are useful in various types of sequential machines, and in particular in coding and decoding systems. Utilizing LMSC's systematic procedures for the construction of single error-correcting close-packed multiple level codes, in the manner of

D. A. Huffman, are given. The proper operation of the decoder is seen to depend upon certain periodic properties of powers of the matrix A. These properties are explored through the use of the theory of finite fields, and appropriate synthesis procedures are derived. (Contractor's abstract)

387

Columbia U. Inst. of [Air] Flight Structures, New York.

VIBRATIONS AND STABILITY OF PLATES UNDER INITIAL STRESS, by G. Herrmann and A. [E.] Armenakas. Feb. 1959 [51]p. incl. diagrs. table, refs. (Technical note no. 1; rept. no. CU-2-59AF430-CE) (AFOSR-TN-59-189) (AF 49(638)430) AD 211220; PB 140061 Unclassified

Several linear theories of motion of elastic plates are established which in addition to initial membrane forces take into account initial moments and transverse shear forces. The equations of motion are obtained by linearizing the appropriate nonlinear plate equations and, in the absence of initial stresses, they are reduced, depending upon the order of approximation, to either the classical (elementary) or the Mindlin plate theory (classical theory including the effects of shear deformation and rotatory inertia). These equations are applied to the solution of particular problems, and the effect of uniform initial compression, bending moment and transverse shear force on the frequencies of the flexural, longitudinal, thickness-shear and the first 2 face-shear models are discussed. In the course of this investigation it was found that a plate may buckle under a uniform initial transverse shear force in a similar fashion as under initial compression. (Contractor's abstract)

388

Columbia U. Inst. of [Air] Flight Structures, New York.

ENERGY METHODS FOR THE ANALYSIS OF TEMPERATURE DISTRIBUTIONS AND THERMAL STRESSES IN STRUCTURES, by G. Herrmann. May 1959, 12p. (Technical note no. 2; rept. no. CU-4-59AF-430-CE) (AFOSR-TN-59-327) (AF 49(638)430) AD 213675; PB 140994 Unclassified

Some well-known energy theorems of structural analysis are generalized for the case when a part of the stresses is due to thermal effects. These methods assume that the temperature distribution is known. It is shown further that the temperature distribution in the structure itself may be determined by the use of analogous energy theorems, which can be established for both steady-state and transient conditions. (Contractor's abstract)

389

Columbia U. Inst. of [Air] Flight Structures, New York.

SHEAR BUCKLING OF BARS, by G. Herrmann and A.
E. Armenakas. Oct. 1959 [11]p. incl. diagrs. (Techni-
cal note no. 3; rept. no. CU-7-59 A F430-CE) (AFOSR-
TN-59-1016) (AF 49(638)430) AD 228828; PB 144762
Unclassified

Also published in Jour. Appl. Mech., v. 27: 455-457,
Sept. 1960.

It is shown that a perfectly straight bar, subjected to a
state of uniform shear stress will buckle, in a manner
similar to a column under compression, if the shear
stress exceeds a certain critical value. The buckling
equations are obtained by the Newtonian approach, and
also by the application of the principle of minimum po-
tential energy. In order to provide additional insight
into this buckling mechanism, a simple model is intro-
duced and analyzed. (Contractor's abstract)

390

Columbia U. [School of Engineering] New York.

TWINNING IN ZINC SINGLE CRYSTALS, by H. D.
Guberman. Aug. 31, 1958, 27p. incl. diagrs. tables.
(AFOSR-TN-59-269) (AF 18(600)898, Task I)
AD 212703; PB 142023   Unclassified

Resolved shear stresses for the nucleation of twins in
the range 892 gr/mm^2 to 2317 gr/mm^2 have been
found for clean surfaced zinc single crystals. For
coated crystals the resolved shear stresses lay in the
range 962 gr/mm^2 to 2568 gr/mm^2. The results are
interpreted as supporting the views of Bell and Cahn
(Proc. Roy. Soc. (London), v. 239A: 494, 1957) concern-
ing the nucleation of twins in zinc single crystals.
(Contractor's abstract)

391

Columbia U. [School of Engineering] New York.

[AN INVESTIGATION OF THE NATURE OF FRACTURE
IN METALS] by D. N. Beshers. [Final rept.] Aug. 31,
1958, 7p. (AFOSR-TR-59-90) (AF 18(600)898; Task I)
Unclassified

A summary and evaluation of work completed under
this contract is presented. The results include the veri-
fication that twin interfaces and incoherent surface
coatings greater than 300A are effective barriers to dis-
locations, producing pileups that can lead to fracture.
One way in which twins can affect the fracture proper-
ties of zinc is demonstrated. Also studied was a deter-
mination of whether the absolute grain size or the num-
ber of grains in a cross sectional area is controlling
factor in determining flow and fracture stresses of
metals at low temperatures.

392

Columbia U. [School of Engineering] New York.

INTERNAL FRICTION STUDY OF COLD WORKED IRON
CONTAINING NITROGEN, by D. Petarra. [1959] 28p.
incl. diagrs. tables. (AFOSR-TN-59-270) (AF 49(638)-
408) AD 212704; PB 142004   Unclassified

A mechanism explaining the complex behavior 220°C
peak height as a function of annealing temperature has
been advanced. It has been shown that the recovery proc-
ess directly affects the height of the 220°C internal fric-
tion peak, and indirectly affects the height of the room
temperature internal friction peak. The intimate rela-
tionship between these 2 peaks is brought out. (Contrac-
tor's abstract)

393

Columbia U. [School of Mines] New York.

GRAIN BOUNDARY SLIDING AND INTERCRYSTAL-
LINE CRACKING, by J. Intrater and E. S. Machlin.
[1959] [4]p. incl. illus. diagrs. [AF 18(600)965]
Unclassified

Published in Acta Metall., v. 7: 140-143, Feb. 1959.

The results of this study concerned with grain boundary
sliding and intercrystalline cracking are as follows:
(1) Grain boundary sliding along stationary grain bound-
aries will lead to the formation of voids situated along
these grain boundaries. (2) The number of voids pro-
duced increases monotonically with the amount of grain
boundary sliding independent of the temperature. (3) Va-
cancy condensation and any other thermally activated
process, as a mechanism for the primary nucleation
and growth of voids, is unimportant under these experi-
mental conditions. (4) Upon testing of hydrogen the
voids are isolated. With a vacuum of 5×10^{-4} mm Hg
the voids are better described as cracks. (5) The num-
ber of voids produced per unit of grain boundary area is
sensitive to the grain boundary morphology and jog popu-
lation.

394

Columbia U. [School of Mines] New York.

A METHOD FOR GROWING BICRYSTALS OF COPPER,
by J. Intrater and E. S. Machlin. [1959] [2]p. incl. diagrs.
[AF 18(600)965]   Unclassified

Published in Trans. Metall. Soc. AIME, v. 215: 471-472,
1959.

The method reported in this technical note explains its
availability for a study on grain boundary sliding in
superpure copper using bicrystals of a specific shape.
The bicrystals are comprised of single crystals of 2

different orientations grown from the melt in 1/2 of a split graphite mold. The 2 crystals were remelted starting 2 in. from the top to insure that the whole top portion of the crystal was maintained molten. A bicrystal was obtained by moving the induction coil vertically upward at a speed of 1 in./hr. It was found that tapered inserts were necessary to minimize the strain at the contracted section of the bicrystals during solidification.

395

Combustion and Explosives Research, Inc., Pittsburgh, Pa.

COMBUSTION, FLAMES AND EXPLOSIONS OF GASES, by B. Lewis and G. von Elbe. New York, Academic Press, 1961, 731p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-209) (AF 49(638)307) Unclassified

The mass of material concerned with combustion research is accumulated for presentation, interpretation and authoritative application of theoretical aspects pointing the way to the solution of many problems. Particular emphasis is placed on the modification of combustion wave propagation due to heat loss to the unburned medium and to localized changes of mixture composition by diffusional processes.

396

Combustion Inst., Pittsburgh, Pa.

SEVENTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, Oxford U., London (Gt. Brit.) (Aug. 28-Sept. 3, 1958), London, Butterworths Scientific Publications, 1959, 959p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)316], Office of Naval Research, and Office of Ordnance Research) Unclassified

This symposium was the 1st in the series (see also item nos. PIT.01:001, Vol. I and CIP.01:001, Vol. II) to be held outside of the United States and the 1st at which preprints of accepted papers were supplied to participants. There were 18 technical sessions, each lasting about 100 minutes. Approximately 120 papers were presented, covering topics such as detonation, the spectroscopy and structure of flames, the mechanism of combustion reactions, ionization in flames, the interaction of flames with surfaces, the mechanism of flame propagation, turbulence in flames, ignition and limits of inflammability, combustion in practical flowing system, special fuels, and instrumentation. Twenty countries were represented at the symposium.

Committee on Mathematical Biology, Chicago, Ill. see Chicago U. Committee on Mathematical Biology, Ill.

397

Compagnie Generale de Telegraphie Sans Fil, Paris (France).

RESEARCH ON RECOMBINATION PROCESSES IN SEMICONDUCTOR. Final technical rept. [1959] 8p. incl. diagr. (AFOSR-TR-59-37) (AF 61(052)100) AD 230185; PB 145039 Unclassified

A summary is given of the experiments based on the emission of infra-red radiation from the recombination of hole-electron pairs in the semi-conductors germanium and silicon, especially at low or very low temperatures.

398

Copenhagen U. Inst. of Neurophysiology (Denmark).

CENTRAL NERVOUS MECHANISMS IN COLOR VISIONS, by M. A. Lennox. [1959] [2]p. incl. diagrs. (AFOSR-TN-59-298) (AF 61(514)1194) AD 213082 Unclassified

Also published in Danish Med. Bull., v. 5: 164-165, June 1958.

Studies were carried out on cats to determine what happens in the brain when the color of a light is changed. Responses from the cortex were recorded when the eye was flashed with blue, green, yellow, and red light. At high intensities the response occurred earlier when the light was red, later when yellow, and latest when blue or green. It was also found that 2 mechanisms were at work: (1) the red light caused a faster photochemical reaction in the eye, and (2) the red-sensitive receptors were connected with large fibers which conducted the impulse faster in the central nervous system.

399

Copenhagen U. Inst. of Neurophysiology (Denmark).

STUDY OF THE ORGANIZATION OF THE VISUAL SYSTEM IN RESPECT TO COLOR, by M. A. Lennox. Final technical rept. Jan. 1-Dec. 31, 1958, 9p. (AFOSR-TP-59-34) (AF 61(514)1194) AD 213037; PB 142099 Unclassified

An attempt was made to test the hypothesis that conduction velocity might be the central basis of color discrimination. Flashes of 5 different colors at equal intensity were delivered to the eye of a monkey. The color filters transmitted broadly, 50 mμ at 1% transmission, and had peak transmissions at above 600, at 580, 560, 510 and 450 mμ. Three types of cortical cells were found; those with selective spectral sensitivity responding to 1 or at most 2 colors; those responding to all colors; and cells responding not at all to light whether the eye were dark adapted or in light. The response to optic nerve stimulation was of 2 types. Some cells responded with 1 or 2

spikes with no significant change in latency irrespective of the stimulus, indicating that these cells were fired by 1 radiation fiber. Other cells responded with a burst of spikes and the latency of this burst decreased with increasing stimulus intensity, which indicated overlap or convergence of a number of radiation fibers on the single cell. These cells tended to respond to all colors. A few cells responded to optic nerve stimulation, but not to any of the colors used. One cell responded to changes in background illumination and to optic nerve stimulation but not to color flash.

400

Copenhagen U. Inst. of Neurophysiology (Denmark).

SINGLE UNIT OFF RESPONSES TO BRIEF FLASHES IN CAT'S OPTIC TRACT, by M. A. Lennox. [1959] [10]p. incl. diagrs. tables, rets. (Technical scientific note no. 1) (AFOSR-TN-59-674) (Sponsored jointly by Air Force Office of Scientific Research under AF 61-(052)189 and Danish State Research Foundation)
AD 218386   Unclassified

Also published in Jour. Neurophysiol., v. 22: 88-97, Jan. 1959.

In cats a microelectrode was used to record from single fibers in the optic tract when the opposite eye was flashed with blue or red light and when the optic nerve was stimulated electrically. Three types of off unit were found. (1) Intensity sensitive units. The number of spikes was determined by the amount of light, whether this was altered by changing the intensity or the duration of the flash. (2) Units not sensitive to intensity in which the number of spikes after cessation of the flash either in off or on-off units was not regulated by the amount of light. (3) Mixed forms. There was no correlation between the off discharge and the color of the light, nor with conduction velocity along the fiber. (Contractor's abstract)

401

Copenhagen U. Inst. of Neurophysiology (Denmark).

RESPONSES TO MONOCHROMATIC FLASHES OF SINGLE CELLS IN MONKEY CORTEX, by M. A. Lennox. [1959] 9p. (AFOSR-TN-59-1318) (AF 61(052)-189)   Unclassified

Presented at meeting of the Society for Experimental Biology, Copenhagen (Denmark), Aug. 14, 1959.

A study designed to see what correlations there may be between fiber size, that is conduction velocity in the optic nerve and radiations, and response to color is reported. It is pointed out that the anesthesia used on the adult Mangabeys from Africa raises their threshold to light and that certain quantitative adjustments might have to be made. Half the cells encountered responded to light flash or optic nerve stimulation. Certain cells

responded only to light at 589 mμ flashes, yet there are no known retinal cells with such a narrow spectral sensitivity. This suggests that the nervous interaction at some point along the visual pathway makes the differentiation. Single cortical cells which respond reliably to 1 and only 1 of the colors used were found. There are also cells which respond to 2 or 3 spectrally adjacent colors when there is a background illumination on the eye. In the dark, cells respond to all colors with increasing vigor and diminishing threshold as the dark period becomes more prolonged. This supports the common assumption that the activity of the rods is inhibited in the presence of light, and also suggests that the activity of the cones may be inhibited in the dark.

402

Cork U. Coll. (Ireland).

CURVE FITTING AND INTEGRAL CURVES FOR NON-LINEAR DIFFERENTIAL EQUATIONS. A GENERALISED STEP-FUNCTION APPROACH, by P. M. Quinlan. Sept. 1958, 37p. incl. tables. (Technical note no. 5) (AFOSR-TN-59-65) (AF 61(514)1163)
AD 209609; PB 139604   Unclassified

Generalized step-functions are used to give a curve of any specified degree of continuity passing through specified points. The method is extended so that the slope and ordinate of the fitting curve are equal to those of a given curve. A calculus is developed for matching both ordinate-slope and curvature at all points of regular subdivision by a generalized step function expression. The necessary calculus for differentiation, integration, including repeated integration, and interpolation is developed. An estimate of the accuracy of the various fits is obtained by evaluating the standard integral cos x, and it is shown that the ordinate-slope method is unaffected by either points of inflection or critical points. The ordinate-slope and the ordinate-slope-curvature methods are used as the basis of a new method of finding integral curves for differential equations, including non-linear equations. (Contractor's abstract, modified)

403

Cork U. Coll. (Ireland).

VIBRATION OF BEAMS - A RECURRENCE APPROACH, by P. M. Quinlan. Sept. 1958, 35p. incl. diagrs. tables. (Technical note no. 6) (AFOSR-TN-59-118) (AF 61(514)-1163) AD 210423; PB 139617   Unclassified

A new method is presented for obtaining the frequencies of vibration of a loaded beam. The usual frequency determinant is by-passed, and the frequency equation is obtained by the multiplication of 2 sets of polynomials. Thus the higher critical frequencies can be obtained as readily as the lowest frequency, an advantage not possessed by any existing method. The method is developed in 4 stages by the aid of graded examples, beginning with the simple case of a light beam under a concentrated

central load, then going onto a beam under 2 loads when
the avoidance of a frequency determination is possible
due to successive elimination. Next application is made
to a non-uniform beam, in which the necessary calculus
is developed, and then in the 4th example, an aircraft
wing, the development culminates in a systematic self-
checking tabular method based on a recurrence relation
between the amplitudes v_r at point x_r. In the concluding
section application is made to the torsional oscillations
of a shaft under 6 masses. (Contractor's abstract)

404

Cork U. Coll. (Ireland).

HYPERCIRCLE METHOD APPLIED TO THE SOLUTION
OF THE BIHARMONIC EQUATION. II, by V. G. Hart.
Dec. 1958, 20p. incl. diagrs. (Technical note no. 7)
(AFOSR-TN-59-296) (AF 61(514)1163) AD 213040;
PB 142019   Unclassified

The approximate solution of the biharmonic equation is
considered in a plane multiply connected region. The
boundary conditions correspond to the problem of a
perforated elastic plate clamped at both interior and ex-
terior boundaries and subjected to transverse loading.
The method used is that of the hypercircle, and it pro-
vides upper and lower bounds on a functional (the
strain-energy) involving the solution of the biharmonic
boundary-value problem. Pointwise bounds are not
considered here, but can be obtained by use of a suitable
Green's function. Estimates of the deflection of the
plate and bending moments in it are also given. As an
illustration of the method, the problem of an elastic
plate in the shape of a hollow square is considered. A
preliminary and a higher approximation are described.
Unfortunately due to the poor condition of the digital
computer available, only 1 bound could be supplied in
the latter approximation. (Contractor's abstract)

405

Cork U. Coll. (Ireland).

RESEARCH ON TORSION AND PLATE PROBLEMS, by
P. M. Quinlan. Annual summary rept. no. 1, Dec. 1,
1956-Nov. 30, 1958. Jan. 6, 1959, 8p. (AFOSR-TN-59-
297) (AF 61(514)1163) AD 213081; PB 140814
                                              Unclassified

A synopsis is given of the research on torsion and plate
problems with special reference to conformal mapping
and the hypercircle method. The research is reported
in a series of 7 technical notes. The mathematical solu-
tion is investigated for the hexagon, eccentric circular
cylinder, oblate and prolate, and semi-elliptical sections
using conformal mapping. The application of Fourier
integral method and the hypercircle method are investi-
gated for a semi-infinite plate, fixed horizontally along
its edges, and for plates with holes, respectively. The
hypercircle method is applied to multiply connected
plates and the skew-bridge problem. Problems in elas-

ticity are investigated with special reference to problems
having aeoloptropic elasticity. The problem of program-
ming is investigated for resulting nonlinear equations.
(ASTIA abstract, modified)

406

Cork U. Coll. (Ireland).

FOURIER SERIES FOR TWO-POINT BOUNDARY-
VALUE PROBLEMS, by P. M. Quinlan. Nov. 1959, 1v.
incl. diagrs. tables, refs. (Technical note no. 8)
(AFOSR-TN-59-744) (AF 61(514)1163) AD 233280
                                             Unclassified

The general solution of the differential equation $F(D^2)z = g(x)$ is obtained in the form of a Fourier Sin or Cos Ser-
ies. The result is expressed in terms of Fourier-Sum
Functions, involving 2 parameters K and Θ which are
tabulated for K,O(.1)2; Θ/π, O(.1), 1. The method is
illustrated by numerical application to an 8 order dif-
ferential equation. (Contractor's abstract)

407

Cork U. Coll. (Ireland).

A PROPERTY OF BOUNDED REGULAR FUNCTIONS,
by P. B. Kennedy. [1959] 15p. (Technical note no. 4)
(AFOSR-TN-59-669) (AF 61(514)1399) AD 218381;
PB 143168   Unclassified

Also published in Proc. Roy. Irish Acad., v. 60A: 7-14,
1959.

For a bounded regular function $f(z)$ in the unit circle
$|z| < 1$, an investigation is made of the relation be-
tween the growth of the Nevanlinna characteristic of
the derivative of f and the angular measure of the set
of singularities of f on $|z| = 1$.

408

Cork U. Coll. (Ireland).

ON A CLASS OF FUNCTIONS REGULAR AND
BOUNDED IN THE UNIT CIRCLE, by P. B. Kennedy.
[1959] 16p. (Technical note no. 5) (AFOSR-TN-59-
670) (AF 61(514)1399) AD 218382; PB 143167
                                             Unclassified

Examples are constructed to shed light on the "good-
ness" of the hypothesis under which $f \in Q$ implies
$f' \in Q$. The condition essential to the truth of Hayman's
theorem is shown. It is also pointed out that some
"order-of-contact condition" occurring in the definition
of "properly contains" is needed.

409

Cork U. Coll. (Ireland).

THE ABSOLUTE CONVERGENCE OF CERTAIN LA-
CUNARY FOURIER SERIES, by S. O'Shea. [1959] [12]p.
(Technical note no. 6) (AFOSR-TN-59-883) (AF 61-
(514)1399) AD 226388; PB 146100   Unclassified

Also published in Proc. Roy. Irish Acad., v. 61A: 1-8,
1960/61.

Let $f(x)$ be measureable and periodic with period 2π,
and satisfy a uniform Lipschitz condition of order
α $(0 \leq \alpha \leq 1)$ in every finite interval. Let the Fourier

series of f be $\frac{1}{2}a_0 + \sum_{1}^{\infty} (a_n \cos nx + b_n \sin nx)$. Results

for the cases $0 < \alpha \leq \frac{1}{2}$ are interpolated between the
following 2 theorems: (1) if $\alpha > \frac{1}{2}$, then $\sum (|a_n| + |b_n|)$
$|b_n|) < \infty$; and (2) if $\alpha = 0$ and $a_n = b_n = 0$ except possi-
bly for $n = n_k$, where $\{n_k\}$ is a sequence of positive

integers satisfying $\lim_{k \to \infty} \inf \frac{n_{k+1}}{n_k} > 1$, then $\sum (|a_n| +$

$|b_n|) < \infty$ is true. (ASTIA abstract)

410

Cork U. Coll. (Ireland).

RESEARCH ON PROPERTIES OF THE COEFFICIENTS
IN FOURIER SERIES WITH GAPS, by P. B. Kennedy.
Final technical rept. June 15, 1959 [7]p. incl. refs.
(AFOSR-TR-59-115) (AF 61(514)1399) AD 226390;
PB 145276   Unclassified

Size of coefficients in lacunary Fourier series of func-
tions with certain continuity properties are presented;
some questions of convergence of such series are
raised; applications in regular-function theory are
suggested.

411

Cork U. Coll. (Ireland).

ON A DIVERGENT TRIGONOMETRICAL SERIES
GIVEN BY STEINHAUS, by S. O'Shea. [1959] [3]p.
(AF 61(514)1399)   Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 68-70,
Feb. 1959.

Steinhaus gave the series

$$(*) \sum_{n=2}^{\infty} (\log n)^{-1} \cos n (x - \log \log n)$$

as an example of an everywhere divergent trigonomet-
ric series with coefficients tending to zero. The author
shows that a condition on $u(n) \uparrow \infty$ and $c_n \downarrow 0$ sufficient

that $\sum_{n=1}^{\infty} c_n \cos (nu(n)) \cos nx$ should diverge for all

real x is the existence of a sequence of positive integers
p_n such that $\lim_{n \to \infty} \sup (n + p_n)[u(n + p_n)-u(n)] < \frac{1}{2}$ and

$\lim_{n \to \infty} \inf \sum_{m=n+1}^{n+p_n} c_m > 0$. The special case $u(n) =$

$\log \log n$, $c_n = (\log n)^{-1}$, $n \geq 2$, gives the "cosine part"
of (*). The condition is also sufficient that

$\sum_{n=1}^{\infty} c_n \sin(nu(n)) \sin nx$ should diverge for all $x \neq 0$

(mod π). (Math. Rev. abstract)

412

Cork U. Coll. (Ireland).

ON A THEOREM OF HAYMAN CONCERNING QUASI-
BOUNDED FUNCTIONS, by P. B. Kennedy. [1959] [8]p.
(AF 61(514)1399)   Unclassified

Published in Canad. Jour. Math., v. 11: 593-600, 1959.

Let $f(z)$ be regular in $|z| < 1$. If $m(r,f) =$
$(2\pi)^{-1} \int_{-\pi}^{\pi} \log^+ |d(re^{i\theta})| d\theta$ is bounded for $0 < r < 1$,

$f(z)$ is called quasi-bounded. Hayman (Rend. Circ. Mat.
Palermo, Series 2, v. 2: 346-392, 1953) has given condi-
tions that $f'(z)$ be also quasi-bounded. A domain D is
said to properly contain a sequence of non-overlapping

open arcs (1) $z = e^{i\theta}$, $\theta_n < \theta < \theta_n + \delta_n$ $(n = 1,2,3,\cdots)$, if
the distance $d(\theta)$ from $e^{i\theta}$ to the boundary of D satisfies

$d(\theta) > A \{(\theta - \theta_n)(\theta_n + \delta_n - \theta)\}^B$, $(A > 0, B > 0$ constants).
Hayman showed that if D contains $|z| < 1$ and properly
contains the sequence of arcs (1) such that

$(2) \sum_{1}^{\infty} \delta_n = 2\pi$, $\sum_{1}^{\infty} \delta_n \log \frac{1}{\delta_n} < \infty$, and if $f(z)$ is regular

and bounded in D, then $f'(z)$ is quasi-bounded in $|z| < 1$.
The author shows that if the inequality in (2) is replaced

by (3) $\lim_{n \to \infty} \sup (\sum_{n}^{\infty} \delta_j) \log \frac{1}{\delta_n} = \infty$, then $m(r,f') \to \infty$ as

$r \to 1$. In particular, the inequality in (2) cannot in gen-
eral be replaced by (4) $\sum_{1}^{\infty} \delta_n (\log \frac{1}{\delta_n})^\gamma < \infty$, for any $\alpha < 1$.
(Math. Rev. abstract)

413

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

THE TAILORED-INTERFACE HYPERSONIC SHOCK
TUNNEL, by C. E. Wittliff, M. R. Wilson, and A.
Hertzberg. Mar. 1958, 1v. incl. illus. diagrs. refs.
(AFOSR-TN-59-31) (AF 18(603)10) AD 209203
    Unclassified

Presented at ASME-ARS Aviation Conf., Dallas, Tex.,
Mar. 16-20, 1958.

Also published in Jour. Aero/Space Sci., v. 26: 219-
222, Apr. 1959.

During recent years, the shock tunnel has come into
widespread use as a hypersonic test facility. It has
been found that strong shock waves in large length-to-
diam ratio shock tubes undergo severe attenuation re-
sulting in unsteady flow conditions in the test section.
A new design, termed the "tailored-interface" shock
tunnel, has been developed which increases the testing
time up to 25 times that of the conventional shock tunnel
of the same length alleviating the attenuation problem.
The results of heat transfer experiments on a hemi-
sphere-cylinder model are presented and compared with
theory, wind-tunnel and free flight data. (Contractor's
abstract)

414

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

BOUNDARY-LAYER DISPLACEMENT AND LEADING-
EDGE BLUNTNESS EFFECTS IN HIGH TEMPERA-
TURE HYPERSONIC FLOW, by H. K. Cheng, J. G. Hall
and others. Jan. 1960 [81]p. incl. illus. diagrs. tables,
refs. (Rept. no. AD-1052-A-9) (AFOSR-TN-59-1193)
(AF 18(603)10) AD 233867; PB 146370
Unclassified

Presented at Twenty-eighth annual meeting of the
Inst. Aeronaut. Sci., Hypersonic Phenomena Session,
New York, Jan. 25-27, 1960.

Also published in Jour. Aero/Space Sci., v. 28: 353-
382, May 1961.

Two important features of hypersonic flow over
slender or thin bodies are given; these are: (1) the dis-
placement effect of the boundary layer and (2) the large
downstream influence of leading-edge bluntness. New
theoretical and experimental results on this problem
are given. The interaction of the 2 effects is treated
theoretically by extending the basic shock-layer con-
cept. A detached shock layer is introduced to account
for bluntness. In the boundary-layer, the approximate
solution is found to be governed by local similarity.
For the specific heat ratio α close to unity, the leading
approximation for flat-plate afterbodies yields a solu-
tion agreeing with blast-wave theory at 1 limit and
strong-interaction theory at the other. Similarly, flow
over a blunted wedge is treated. A hypersonic similitude
involving strong shocks, but not requiring α close to 1
is also given. The solutions obtained in the leading ap-
proximation provide a natural comparison with experi-
mental data correlated on the basis of this similitude.
(Contractor's abstract)

415

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

GASDYNAMICS OF A WAVE SUPERHEATER FACILI-
TY FOR HYPERSONIC RESEARCH AND DEVELOP-
MENT, by R. C. Weatherston, W. E. Smith and others.
Feb. 1959, 133p. incl. diagrs. tables, refs. (Rept. no.
AD-1118-A-1) (AFOSR-TN-59-107) (AF 18(603)141)
AD 210220; PB 142603   Unclassified

The fundamental principles of wave superheater design
and operation are developed. The gasdynamic and heat
transfer aspects of one version, which is designed to
generate 9000°R in uncontaminated air, are discussed.
A prototype wave superheater was built and operated
successfully at its designed conditions of 3000°R in air
and 5500°R in Ar, starting from room temperature
(COA.02:003, Vol. II). The 9000°R superheater utilizes
preheated He driver and preheated test gases, and can
superheat 4.3 lb of uncontaminated air/sec at 200 atm
stagnation pressure. Ar can readily be substituted for
air as a test gas and superheated to 17,000°R at the ra
of 12 lb/sec. Cooling of the superheater structure and
the effects of heat transfer within the superheated air
are examined. Certain shock tube experiments were
performed to test the nonsteady heat transfer theory.
(Contractor's abstract, modified)

416

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

ENGINEERING DESIGN OF A WAVE SUPERHEATER
FACILITY FOR HYPERSONIC RESEARCH AND DE-
VELOPMENT, by J. E. Carpenter. Feb. 1959, 1v. incl.
illus. diagrs. tables, refs. (Rept. no. AD-1118-A-2)
(AFOSR-TN-59-108) (AF 18(603)141) AD 210224;
PB 145085   Unclassified

The engineering problems associated with the develop-
ment of the 9000°R Wave Superheater are presented in
considerable detail. Included are the approaches that
were pursued to attain a sound solution and the reasons
for selecting the final engineering configurations. The
major portion of the report is concerned with equipment
selection and the background of engineering information
required to perform the selection. Several appendices
are included which report in detail the results of vari-
ous analytical and experimental studies. Specifications
for the major items of purchased equipment are also
included. (Contractor's abstract)

417

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

BOUNDARY-LAYER TRANSITION AND HEAT
TRANSFER IN SHOCK TUBES, by R. A. Hartunian,
A. L. Russo, and P. V. Marrone. May 1959, 31p. incl.
illus. diagrs. refs. (Rept. no. AD-1118-A-3) (AFOSR-
TN-59-564) (AF 18(603)141) AD 234728; PB 146973
Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 587-594, Aug. 1960.

An experimental study was made of the wall boundary layer in a shock tube operated over a wide range of shock Mach numbers and pressure levels in air, including those for which real gas effects exist. Transition distances are determined, and correlated in terms of the transition Reynolds number based on a characteristic length for this boundary layer. Data from independent shock-tube studies are also included in this correlation. The results indicate a weak dependence of transition Reynolds number on shock strength up to moderate values of shock Mach number, followed by a larger stabilizing tendency. Comparison of these data with transition data obtained in the same manner in argon indicate that the increased cooling rates are largely responsible for the stabilization. A dependence of transition Reynolds number on the unit Reynolds number is found at the lower shock strengths. Specifically, higher transition Reynolds numbers are achieved at larger unit Reynolds numbers. The phenomenon of transition reversal does not appear within the range of the experiments reported. Laminar and turbulent flow heat transfer rates to the walls of the shock tube are determined experimentally. The results of the heat transfer measurements substantiate existing theories in both the laminar and turbulent flow regimes. (Contractor's abstract)

418

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

THE HYPERSONIC AERODYNAMICS OF SLENDER AND LIFTING CONFIGURATIONS, by F. K. Moore and H. K. Cheng. [1959] [47]p. incl. diagrs. refs. (AFOSR-TN-59-599) (AF 16(603)141) AD 221896
Unclassified

Also published in Inst. Aerospace Sci. First Award Papers, 1959, p. 59-125.

A review is made of the theory of hypersonic aerodynamics, having in mind application to slender and lifting configurations. Within the framework of hypersonic small-perturbation theory, the effects of leading edge bluntness and shock-layer-boundary-layer interaction are discussed, and the limitations of the theory are described. New experimental results for the interaction process on a cold flat plate at $M = 12$ are cited. The idea of local boundary-layer similarity is discussed in terms of application to slender configurations. The consistent development of shock-layer theory assuming a ratio of specific heats near 1 and a very strong shock is described, incorporating the local-similarity theory of the laminar boundary layer. The special case of a cone at angle of attack is discussed in some detail, and an explicit description of the entropy sublayer which is a general feature of such problems is included. The secondary flow in the hypersonic boundary layer is evaluated, and is found to be important for slender cones. In the light of information obtained concerning the cone at angle of attack, the corresponding shock-layer theory for more general pointed bodies is outlined. (Contractor's abstract)

419

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

THE PERFORMANCE OF THIN-FILM THERMOMETERS IN PARTIALLY IONIZED SHOCK-TUBE FLOWS, by P. V. Marrone and R. A. Hartunian. Nov. 1959 [7]p. incl. diagrs. (Rept. no. AD-1118-A-5) (AFOSR-TN-59-1046) (AF 18(603)141) AD 229133
Unclassified

Also published in Phys. Fluids, v. 2: 719-721, Nov.-Dec. 1959. (Title varies)

In shock-tube study of the processes of boundary layer transition and heat transfer at high temperatures conducted with thin-film resistance thermometers, it was found that the presence of very small degrees of ionization in the shocked gas induced spurious electrical signals in the output of the thin-film gauge. The techniques employed in overcoming this difficulty are discussed. The use of a thin insulative coating of SiO_2 proved to be the most successful of the several techniques investigated. SiO was evaporated directly over the Pt element to a thickness of 800-1000 A. The gauge was then fired in an oven for approximately 9 hr at 1000°F to convert the SiO to SiO_2. Results show that: (1) the SiO_2 coated gauge performed satisfactorily in highly ionized gases, permitting studies of heat transfer in high temperature flow, (2) the increase in rise time due to the SiO_2 layer is very small, the total rise time being approximately $2\mu sec$, and (3) this technique makes it possible to apply foils over the SiO_2 coating, with small increase in rise time, permitting the study of surface chemistry effects on heat transfer.

420

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

PRELIMINARY RESEARCH ON A MOLECULAR BEAM FOR THE 1-10 EV RANGE, by G. T. Skinner and C. E. Treanor. Dec. 1959, 61p. incl. illus. diagrs. table, refs. (Rept. no. AD-1118-A-9) (AFOSR-TN-59-1086) (AF 18-(603)141) AD 236369; PB 147406
Unclassified

An interim discussion is given of the design and construction of a molecular-beam apparatus for the production of atomic and molecular beams in the 1-10 ev energy range. A shock tube is used as the source of high-temperature, high-pressure gas, and a hypersonic expansion is used to obtain a high-energy, nearly-mono-energetic beam. Use of a two-center potential for the treatment of atom-molecule collisions is discussed. (Contractor's abstract)

421

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

HEAT TRANSFER FROM DISSOCIATED GASES IN A
SHOCK TUBE, by R. A. Hartunian and P. V. Marrone.
Nov. 1959, 72p. incl. diagrs. tables, refs. (Rept. no.
AD-1118-A-7) (AFOSR-TN-59-1087) (AF 18(603)141)
AD 234379   Unclassified

Measurements of the heat transfer from dissociated
oxygen to the side-wall of a shock tube were made over
a wide range of operating conditions using the methods
of thin-film thermometry. Numerical solutions of the
equilibrium shock-tube wall boundary-layer equations
for several values of the Lewis number were obtained.
Results show the heat transfer to be very weakly de-
pendent upon the Lewis number. This indicates the
shock-tube wall boundary layer to be a source for ex-
perimental determinations of the viscosity coefficient
of dissociated gases. Experimental data obtained in
the equilibrium boundary-layer regime agree with the
theory at the low temperatures, and rise above the
theoretical curves at the higher temperatures. This
difference between theory and experiment is attributed
to the uncertainty in the calculated viscosity coeffi-
cient used in the theory. The experiments were then
used to determine new values for the viscosity coeffi-
cient of high temperature, dissociated oxygen. These
values are considerably higher than those predicted
theoretically using a Lennard-Jones potential or
Sutherland's formula. Techniques are described by
which thin-film thermometers can be used to meas-
ure heat transfer from ionized gases and, also, to
study the effects of surface catalytic efficiency on the
heat transfer from dissociated gases. The results of
exploratory experiments using the latter technique are
discussed. The results of calculations are presented
which illustrate the reductions in heat transfer to the
stagnation point of re-entering vehicles that may be
achieved through the use of a noncatalytic surface.
(Contractor's abstract)

422

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

A GRAPHICAL SOLUTION OF SHOCK EQUATIONS,
by C. E. Treanor and M. J. Williams. Nov. 1959, 32p.
incl. diagrs. (Rept. no. AD-1118-A-4) (AFOSR-TN-
59-1088) (AF 18(603)141) AD 230216; PB 144909
                                            Unclassified

A rapid graphical method for calculating the conditions
behind a normal shock is described. The method ap-
plies to any gas for which the enthalpy is known as a
function of pressure and density. The accuracy is lim-
ited only by that of the available graph of the gas prop-
erties. The necessary working graphs for air, O_2 and

N_2 (complete thermodynamic equilibrium) and for NO
(without chemical reaction) are included, along with a
template for use in attaining the solution (Contractor's
abstract)

423

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

SPECTROSCOPIC TECHNIQUE FOR TEMPERATURE-
DENSITY MEASUREMENTS IN OXYGEN-BEARING
FLOWS, by W. H. Wurster and C. E. Treanor. Dec.
1959, 40p. incl. illus. diagrs. table, refs. (Rept. no.
AD-1118-A-10) (AFOSR-TN-59-1089) (AF 18(603)141)
AD 239050; PB 148773   Unclassified

The absorption spectrum of shock-heated molecular
oxygen has been measured photoelectrically in the
wavelength range 2280 to 2870A. Four wavelength
bands were used, each about 20A wide. The oxygen
temperatures ranged from 1500 to 4000°K, and the den-
sity from 0.01 to 2.0 atmospheres. The photoelectric
results for the 20A bands were correlated with previ-
ous high-dispersion photographic measurements of
transition probabilities and line widths for O_2. This

correlation is shown in graphical form, and the use of
this absorption technique to determine a temperature-
density parameter for oxygen bearing flows is dis-
cussed. (Contractor's abstract)

424

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

STUDIES OF CHEMICAL NONEQUILIBRIUM IN HYPER-
SONIC NOZZLE FLOWS, by J. G. Hall and A. L. Russo.
Feb. 1959 [59]p. incl. diagrs. refs. (Rept. no. AD-1118-
A-6) (AFOSR-TN-59-1090) (AF 18(603)141) AD 229131;
PB 144945   Unclassified

Published in Conf. on Kinetics, Equilibria, and Per-
formance of High Temperature Systems, Los Angeles,
Calif. (Nov. 2-5, 1959), Pacific Palisades, Combustion
Inst., 1959. p. 59-13-1 — 59-13-61.

Analyses have been made of chemical nonequilibrium
effects in pseudo-one-dimensional nozzle flows where
the working fluid is a mixture of a dissociating species
and inert diluent. Numerical examples computed on a
high-speed digital machine are given for the critical
flow of pure oxygen at a reservoir temperature of
5900°K over a wide range of reservoir pressures. A
characteristic feature of all solutions is rapid freezing
of the oxygen composition downstream of the nozzle
throat. Freezing is considerably delayed by increase
in reservoir pressure, and to a lesser degree by in-
crease in recombination rate. The temperature depend-
ence of the recombination rate has relatively small in-
fluence on freezing. Approximate methods are given
for analyzing such flows on the basis of infinite

reaction-rate solutions. Applications of the approximate methods have been made to nonequilibrium airflow in hypersonic wind tunnel nozzles and to nonequilibrium hydrogen flow at conditions relevant to spaceflight propulsion. From the examples discussed it appears that high reservoir pressures are essential to avoid significant nonequilibrium effects in hypersonic wind tunnel test flows of air and in rocket nozzle flows employing hydrogen-like propellants. For the rocket nozzle, the net effect of nonequilibrium is to make the specific impulse for infinite expansion ratio only weakly dependent on chamber pressure for a given chamber temperature. (Contractor's abstract)

425

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

CHEMICAL NONEQUILIBRIUM EFFECTS IN HYDROGEN ROCKET IMPULSE AT LOW PRESSURES, by J. G. Hall, A. Q. Eschenroeder, and J. J. Klein. Nov. 1959 [10]p. incl. diagrs. (Rept. no. AD-1118-A-8) (AFOSR-TN-59-1192) (AF 18(603)141) AD 229134; PB 146541   Unclassified

Also published in ARS Jour., v. 30: 188-190, Feb. 1960.

Calculations of nonequilibrium hydrogen flows were investigated for a lower range of pressures as well as a wider range of temperatures and nozzle geometry than previously considered. The calculations were made by using an approximate method of analysis (item no. 424) for such flows. The method involves a local relaxation length criterion for determination of the freezing of gas composition; the criterion is evaluated on the basis of corresponding equilibrium flow solutions. A comparison with exact numerical solutions show the criterion to give an accurate prediction of the frozen dissociation level. The approximate method is particularly convenient for determining the limiting specific impulse I_∞, attained by expansion to infinite area and zero pressure. Since the specific total enthalpy, h_0, is constant, I_∞ is given in terms of

h_0 and the final, frozen degree of dissociation

α_f by, $I_\infty = \dfrac{u_\infty}{g} = \dfrac{1}{g} \sqrt{2(h_0 - \dfrac{E_D \alpha_f}{M})}$ where u_∞ is the

velocity at infinite area, g is the standard gravitational acceleration, E_D is the molar dissociation energy of diatomic species, and M is the diatomic molecular weight.

426

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

DYNAMICAL FEYNMAN'S THEOREM, by E. H. Kerner. [1959] [2]p. (Bound with its AFOSR-TN-59-1086) [AF 18(603)141]   Unclassified

Published in Phys. Rev. Ltrs., v. 2: 152-153, Feb. 15, 1959.

A simple dynamical extension of Feynman's theorem allowing for a calculation of the forces on nuclei in motion is discussed. The conservation of energy and the definition of the nuclei motion is found by use of the formula:

$$M\ddot{X} = -\dfrac{\partial W}{\partial X} - \int |\psi|^2 \dfrac{\partial V}{\partial X}\, dx$$

and a scheme is presented for management of this equation. Essentially what is done in the formulation of this equation is the breaking up of the conservative motion of the whole molecular system into two individual nonconservative parts, of which one part, the nuclear motion, is surveyed in abstraction from the rest.

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

PROPAGATION OF WEAK DISTURBANCES IN A GAS SUBJECT TO RELAXATION EFFECTS, by F. K. Moore and W. E. Gibson. [1959] [8]p. [AF 18(603)141]
                                           Unclassified

Published in Inst. Aero. Sci. Awards Papers, p. 57-64, 1959.

A generalized wave equation is derived for sound disturbances in a gas when relaxation efforts are present. Solutions involving discontinuous wave fronts are presented, and under certain assumptions, the complete wave equation reduces to the telegraph equation. Solutions are given for a wavy wall in subsonic and supersonic flow and a simple wedge in supersonic flow. The study is relevant to hypersonic shock waves.

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

SPECTROSCOPIC MEASUREMENT OF THE TEMPERATURE OF SHOCK-HEATED OXYGEN, by W. H. Wurster. [1959] [4]p. incl. diagrs. [AFOSR-614] (AF 18(603)141)   Unclassified

Published in Proc. Conf. on Phys. Chem. in Aerodynam. and Space Flight, Pennsylvania U., Philadelphia, (Sept. 1-3, 1959), New York, Pergamon Press, 1961, p. 158-161. (AFOSR-TR-60-106)

Also published in Planetary Space Sci., v. 3: 158-161, Feb. 1961.

Preliminary findings are presented of experiments currently in progress in which the ultra-violet absorption of the Schumann-Runge band system of oxygen has been exploited as a means of determining the vibration temperature of heated oxygen. The apparatus is described and results obtained to date are presented. These

results demonstrate the usefulness of this device in measuring temperatures between 1500° and 3500°K for a limited range of optical thickness. Current work on the measurements to other densities and on the applicability of this technique to the temperature of air is discussed. (Contractor's abstract)

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

MOLECULAR INTERACTIONS AT HIGH TEMPERA-
TURES, by C. E. Treanor and G. T. Skinner. [1959]
[5]p. incl. illus. diagrs. [AF 18(603)141]
Unclassified

Published in Proc. Conf. on Phys. Chem. in Aerodynam. and Space Flight, Pennsylvania U., Philadelphia (Sept. 1-3, 1959), New York, Pergamon Press, 1961, p. 253-256. (AFOSR-TR-60-106)

Also published in Planetary and Space Sci., v. 3: 253-256, Feb. 1961.

An experimental and theoretical program concerning the interaction between gas particles having energies in the 1 to 10 ev range is discussed. A molecular beam has been constructed for the experimental work, using a shock tube as the source of high-energy atoms and molecules. In particular, the interest centers around those interactions characteristic of high-temperature air where considerable dissociation has occurred. The atom-molecule interactions, about which least is known, have been given 1st consideration because of their importance in estimating transport properties. A 2-center potential has been used for preliminary investigation of the diatomic molecule as seen by an approaching atom. (Contractor's abstract)

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

THE STUDY OF HIGH TEMPERATURE GASDYNAMIC PHENOMENA BY MEANS OF THE SHOCK TUBE (Abstract), by A. Hertzberg. [1958] [1]p. [AF 49(638)269]
Unclassified

Presented at Fifty-fifth meeting of the Amer. Acoustical Soc., Washington, D. C., May 7-10, 1958.

The ability of the shock tube to simulate the temperatures and velocities of hypersonic flight has recently spurred its application to the study of high-temperature phenomena in gases. This paper reviewed the application of the shock tube to the study of high-temperature phenomena in gases and discusses some of the more important experiments and investigations that have recently been carried out at Cornell Aeronautical Lab. In particular, the application of the shock tube and its modified forms were discussed in connection with the

study of hypersonic flight, high-temperature chemical kinetics, and high-temperature gas physics. (Contractor's abstract)

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

MEASURED TRANSITION PROBABILITIES FOR THE SCHUMANN-RUNGE SYSTEM OF OXYGEN, by C. E. Treanor and W. H Wurster. [1959] [34]p. incl. diagrs. refs. (AFOSR-TN-59-946) (AF 49(638)269)
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 68, Jan. 28, 1959. (Title varies)

Also published in Jour. Chem. Phys., v. 32: 758-766, Mar. 1960.

Transition probabilities for the Schumann-Runge system of O_2 have been measured in absorption in the wavelength region 2650 - 3900A. Oxygen was heated in a shock tube to temperatures up to 4500°K, thereby populating high vibrational and rotational levels. Absorption spectra were photographed using a high-speed flash lamp and a large Littrow quartz spectrograph. Transition probabilities for the bands of 3 sequences, associated with the zero, 1st and 2nd vibrational levels of the excited electronic state, yield an f value of 0.048 ± 0.008 which, when corrected for wavelength dependence, is about 1/3 that determined in the vacuum ultraviolet. This corresponds to a decrease in transition probability with increasing internuclear separation. Line width variations with temperature and density have also been measured. The optical diameter for O_2 - O_2 collisions was determined as 6A and for O_2 - O collisions as 10A. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

ENTROPIES AND ENERGIES OF DIMERIZATION OF ALKALI METAL HALIDES, by S. H. Bauer, R. M. Diner, and R. F. Porter. [1959] [5]p. incl. diagrs. tables, refs. (AFOSR-TN-59-148) (AF 18(603)1)
AD 264285
Unclassified

Also published in Jour. Chem. Phys., v. 29: 991-995, Nov. 1958.

Calculated entropies of dimerization for a number of gaseous alkali metal halides, assuming the rhombic planar model for the dimer, fall in the range -31.0 ± 1.5 entropy units. Entropies of dimerization deduced from experimental data for several species diverge appreciably from the calculated values. The differences

can be attributed to uncertainties in the graphical determination of dimerization energies. Energies of dimerization recalculated by combining experimental values of free energy (dimerization) with theoretical values of entropy (dimerization) correlate well with the interionic separations in the dimers. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

MASS SPECTROMETRIC STUDY OF ALKALI HYDROX-IDE VAPORS, by R. C. Schoonmaker and R. F. Porter. [1959] [4]p. incl. tables, refs. (AFOSR-TN-59-243) (AF 18(603)1) AD 230886   Unclassified

Also published in Jour. Chem. Phys., v. 31: 830-833, Sept. 1959.

A mass spectrometer has been used to analyze the vapors effusing from the orifice of a Knudsen cell containing pure and mixed alkali hydroxide condensed phases. Monomeric and dimeric species are detected in all cases except for LiOH in the temperature range 650-900°K. Thermochemical data are reported for the reactions $2MOH(g) = M_2(OH)_2(g)$, and $M_2(OH)_2(g) + N_2(OH)_2(g) = 2MN(OH)_2(g)$, where M and N represent constituent alkali metals. The analogous behavior of the vaporization processes of alkali fluorides and hydroxides is discussed. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

A MASS SPECTROMETRIC AND THERMODYNAMIC STUDY OF GASEOUS TRANSITION METAL (II) HAL-IDES, by R. C. Schoonmaker, A. H. Friedman, and R. F. Porter. [1959] 14p. incl. tables, refs. (AFOSR-TN-59-668) (AF 18(603)1)   Unclassified

Also published in Jour. Chem. Phys., v. 31: 1586-1589, Dec. 1959.

Mass spectrometric and Knudsen effusion techniques were used to study the vaporization of several transition metal (II) halides. The systems studied include FeI_2 and the chlorides and bromides of Cr, Mn, Co and Ni. The overall temperature range was between 440 and 700°C. For all systems the monomer is the major species in the temperature range studied. Dimeric species were also detected in the vapor phase for all systems except $NiCl_2$ and $NiBr_2$. Vapor pressure data were combined with mass spectrometric and entropy data to give heats for the dimerization reaction: $2 MX_2(g) = M_2X_4(g)$. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

MASS SPECTROMETRIC STUDY OF HIGH TEMPERA-TURE REACTIONS OF $H_2O(g)$ AND $HCl(g)$ WITH Na_2O AND Li_2O, by R. C. Schoonmaker and R. F. Porter. [1959] [21]p. incl. diagrs. tables, refs. (AFOSR TN-59-1043) (AF 18(603)1)   Unclassified

Also published in Jour. Phys. Chem., v. 64: 457-461, Apr. 1960.

The gaseous products formed by reactions of $H_2O(g)$ and $HCl(g)$ with condensed Li_2O and Na_2O phases at high temperatures have been identified mass spectrometrically. At low water pressures the major species produced by reaction of $H_2O(g)$ with $Li_2O(s)$ is LiOH(g). In Na_2O-$H_2O(g)$ experiments, NaOH(g) and $Na_2(OH)_2(g)$ are formed. An estimate of the relative heats of dimerization of LiOH and NaOH was obtained from the results of experiments with the Na_2O-Li_2O-$H_2O(g)$ system. In the systems Na_2O-NaCl-$H_2O(g)$ and Na_2O-$HCl(g)$ the mixed anion dimer, $Na_2(OH)Cl(g)$, is formed in addition to $Na_2(OH)_2(g)$ and $Na_2Cl_2(g)$. Because of ambiguities due to the ion fragmentation patterns of $Na_2(OH)_2$, Na_2Cl_2, and $Na_2(OH)Cl$ the existence of the latter species is necessarily inferred from the dependence of ion current intensities on flow rate of the reactant gas. Similar behavior was noted for the system Na_2O-NaF-$H_2O(g)$. Comparison of ion fragmentation patterns obtained in studies with pure LiCl and with the Li_2O-$HCl(g)$ system indicates that Li^+ ions are formed from both LiCl(g) and $Li_2Cl_2(g)$ molecules at high electron energies. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

STABILITIES OF THE GASEOUS MOLECULES BiSe, BiTe, AND SbTe, by R. F. Porter. [1959] [5]p. incl. table. (AFOSR-TN-59-1226) (AF 18(603)1 and AF 49-(638)480)   Unclassified

Also published in Jour. Chem. Phys., v. 32: 943-944, Mar. 1960.

An investigation was made to gather thermochemical data from which dissociation energies of the molecules studied could be obtained. The experiment utilized a mass spectrometric identification of the vapor species escaping from an effusion cell in which condensed-vapor equilibrium was maintained. In the Bi-Se and Bi-Te systems ion currents of Bi^+, Bi_2^+, BiX^+, X_2^+ were

observed. These formations were thought to be due to processes of simple ionization by electron impact. Experimental values for K' for several systems were calculated and presented in table form along with ΔH and ΔS values. The Sb-Se and Sb-Te systems were found to be very complicated in their vaporization due to polyatomic species in high concentration.

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

MEAN-FIRST-PASSAGE TIMES AND THE COLLISION THEORY OF BIMOLECULAR REACTIONS, by B. Widom. [1959] [8]p. (AFOSR-TN-59-51) (AF 18(603)-111) AD 231831   Unclassified

Presented at Symposium on Absolute Reaction Rates, Madison, Wis., Mar. 1959.

Also published in Jour. Chem. Phys., v. 31: 1387-1394, Nov. 1959.

A general collison theory is outlined for the kinetics of reaction of molecules which are dilutely dispersed in an inert gas, the reaction being the result of binary collisions between the reacting molecules and the inert gas molecules. It is assumed that the products of reaction are instantaneously removed from the system. The mean-first-passage time for the transition from reactant to product states is expressed in terms of the solution of an integral equation in which the kernal is the transition probability per unit time between 2-states of the reacting molecule. When a rate constant exists, it is the reciprocal of the mean-first-passage time. In a 1-dimensional system, or in a system of 2 or 3 dimensions where the interaction between colliding molecules has a finite range, there exists a finite collision number Z which is independent of the internal state of the reacting molecule. In such a case there is a Liouville-Neumann solution of the integral equation which allows the mean-first-passage time to be expressed as a sum of contributions corresponding to failure to react after no collisions, after 1 collision, after 2 collisions, etc. The equilibrium hypothesis is analyzed, and it is seen what the precise nature of that approximation is. (Contractor's abstract, modified)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

COLLISION THEORY OF THE KINETICS OF DISSOCIATION OF DIATOMIC MOLECULES, by B. Widom. [1959] [3]p. (AFOSR-TN-59-250) (AF 18(603)111) AD 229673   Unclassified

Also published in Jour. Chem. Phys., v. 31: 1027-1029, Oct. 1959.

A collision theory is developed for the rate of dissoci-

ation of diatomic molecules dilutely dispersed in an inert gas, the theory being identical in its basic structure to the collision theory of Rice but differing from the latter in some of its details. The rate constant is found to be

$$K = C(\mu^{\frac{1}{2}} A^{\frac{1}{2}}/\hbar r_0^2) \, Z \, \exp(-D/kT),$$

where Z is the collision number, D the dissociation energy, μ the reduced mass of the diatomic molecule, r_0 its equilibrium internuclear distance, A the magnitude of the coefficient of the attractive r^{-6} term in the long-range interaction energy of its 2 atoms of its diatomic molecule, and c a dimensionless constant estimated to be 0.27. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

ROTATIONAL RELAXATION OF ROUGH SPHERES, by B. Widom. [1959] [11]p. incl. tables. (AFOSR-TN-59-984) (AF 18(603)111) AD 236291   Unclassified

Also published in Jour. Chem. Phys., v. 32: 913-923, Mar. 1960.

A theory of rotational relaxation of spherical top molecules in an inert gas is given, under the assumption that the molecules and the atoms collide as rough spheres. Some general aspects of relaxation theory are first discussed and a theorem is presented which, under some circumstances, allows the problem to be greatly simplified. The rotation relaxation problem is then solved both for two- and three-dimensional systems. If I is the moment of inertia of the rotating molecule, M the reduced mass of the atom-molecule system, and α the sum of the atomic and molecular radii, and if $b = I/M\alpha^2$, then the most important result of the three-dimensional theory is that $Z_{eff} = 3/8(1 + b)^2/b$, where Z_{eff} is the number of collisions suffered by each molecule in a time equal to the relaxation time. This is the analog of a result previously derived by Wang Chang and Uhlenbeck for self-relaxation in the pure molecular gas. Values of Z_{eff} are calculated for a variety of mixtures of spherical top molecules with inert gases. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

THALLIUM TUNGSTEN BRONZE: A NEW DEFECT STRUCTURE, by M. J. Sienko. July 1, 1959 [21]p. incl. diagrs. (AFOSR-TN-59-504) (AF 49(638)191) AD 215929; PB 143000   Unclassified

Presented at meeting of the Inorg. Chem. Div. of the Amer. Chem. Soc., Boston, Mass., Apr. 5-10, 1959.

Abstract published in 135th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1959, p. 3-M.

Also published in Jour. Amer. Chem. Soc., v. 81: 5556-5559, Nov. 5, 1959.

Thallium tungsten bronzes, Tl_xWO_3, were prepared ranging in composition from $x = 0.19$ to $x = 0.36$. Preparation methods included: (1) heating Tl_2WO_4, WO_3, and W; (2) vapor phase reaction of Tl and WO_3; (3) electrolysis of Tl_2CO_3 and WO_3 mixtures. Products were crystallized and powder diagrams could be indexed in the hexagonal system with a = 14.53A and c = 7.27A. Electrical resistance measurements using a potential probe method on single crystals indicated metallic conduction with specific resistivity varying from 6.0 x 10^{-3} ohm - cm at 25°C to 9.0 x 10^{-3} ohm - cm at 240°. Thermoelectric power at room temperature was -20 microvolts per degree referred to platinum, suggesting 1 free electron per thallium atom. A general model is proposed for the tungsten bronzes M_xWO_3 where M is viewed as an interstitial atom giving rise to local energy levels in the forbidden gap between the conduction and valence bands of WO_3. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

THE TEMPERATURE DEPENDENCE OF RAMAN INTENSITIES, by G. W. Chantry. [1959] 7p. incl. table. (AFOSR-TN-59-743) (AF 49(638)279) AD 227604; PB 143997   Unclassified

Also published in Jour. Chem. Phys., v. 32: 222-223, Jan. 1960.

The temperature dependence of the intensity of the Raman lines of a polyatomic molecule was investigated. It is shown that, when account is taken of all possible "hot" band transitions as well as fundamental transitions, the temperature dependence of each band is the same as that found for the single band of a diatomic molecule. Degenerate vibrations are also considered and likewise shown to have the same temperature dependence. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

RAMAN INTENSITIES OF THE A_1 LINES OF OXY-ANIONS, by G. W. Chantry and R. A. Plane. Aug. 11, 1959, 10p. incl. tables, refs. (AFOSR-TN-59-807) (AF 49(638)279) AD 227607; PB 144013 Unclassified

Also published in Jour. Chem. Phys., v. 32: 319-321, Feb. 1960.

The trace of the derived polarizability tensor has been measured on an absolute scale for the ions CO_3^{-2}, NO_3^-, PO_4^{-3}, SO_4^{-2} and ClO_4^- in aqueous solution. From these and the known normal coordinate matrix elements, the values of the derivative with respect to bond length have been calculated. Results are interpreted in terms of bond order and indicate appreciable π bonding in the ions NO_3^-, SO_4^{-2} and ClO_4^-. In these cases, as opposed to hydrocarbons, a π electron makes a larger contribution to the derived bond polarizability than does a σ electron. (Contractor's abstract)

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Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

MARKOFF PROCESSES A POTENTIALS I, by G. A. Hunt. [1957] [50]p. incl. refr. [AF 18(600)685]
                              Unclassified

Published in Illinois Jour. Math., v. 1: 44-93, Mar. 1957.

This article establishes close connections between the general potential theory and the homogeneous Markov processes. A precise and general treatment of the relations between the Newtonian theory and the Brownian movement is given. Regularity hypothesis are assumed with the following properties: if the P_t are the probabilities of the path of a homogeneous Markov process, the "kernel" $U = \int_0 P_t dt$ satisfies the fundamental principals of the potential theory, such as the maximum principles. A semi-group of probabilities corresponds inversely to a kernel satisfying these principles. $\mathcal{K}$ is taken to be a locally compact separable space. The entire family $\{K_r\}_{r \in \mathcal{K}}$ of positive Radon measures on $\mathcal{K}$ is studied, such that the charge K(r,A) of K_r on the Borelean $A \subset \mathcal{K}$ can be a measurable function of r for all Radon measures.

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Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

MARKOFF PROCESSES AND POTENTIALS II, by G. A. Hunt. [1957] [54]p. [AF 18(600)685] Unclassified

Published in Illinois Jour. Math., v. 1: 316-369, Sept. 1957.

This report shows the relative general potential theory to be, in a sense, complete. Terminal time S is replaced by one defined in terms of a function a and a set A. Excessive functions, defined as a positive function φ if it is measurable over the field A and if $K\tau\varphi$ increases to φ as τ decreases to 0 are discussed. Various theorems on associated functions and measures

are developed. The creation of mass is discussed from the standpoint that it can be postulated on the basis of the hypothesis that the paths behave well for all time.

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Cornell U. Dept. of Mathematics, Ithaca, N. Y.

CONVERGENCE OF ORTHOGONAL SERIES, by R. P. Agnew. Mar. 1959, 8p. (Rept. no. 81) (AFOSR-TN-59-206) (AF 18(600)685) AD 211660; PB 140025
Unclassified

Also published in Duke Math. Jour., v. 27: 127-131, 1960.

The following theorem is proved: if a_0, a_1, a_2, ... is a sequence of real or complex constants for which $\sum |a_k|^2 = \infty$, and if I is a real 1-dimensional interval, then there is a set φ_0, φ_1, ... which is orthonormal over I and is such that $0 = a_0 \varphi_0(x) + a_1 \varphi_1(x) + a_2 \varphi_2(x) + ...$ for each x in I.

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Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

THE EQUIVALENCE OF TWO EXTREMUM PROB-LEMS, by J. Kiefer and J. Wolfowitz. [1959] [4]p. (AFOSR-TN-59-255) (AF 18(600)685) AD 244073
Unclassified

Also published in Canad. Jour. Math., v. 12: 363-366, 1960.

Let $f_1,..., f_k$ be continuous, real, linearly independent functions on a compact space X. Consider any convex set of probability measures ξ on a Borel field of sub-sets of X, which includes the measures with finite sup-port, and for which $m_{ij}(\xi) = \int f_i(x)f_j(x) \xi (dx)$ is de-fined. Let $M(\xi) = \| m_{ij}(\xi) \|$, and $[M(\xi)]^{-1} = \| m^{ij}(\xi) \|$ if $M(\xi)$ is nonsingular. Write $f(x)$ ($f(x')$) for the column (row) vector with components $f_i(x)$. It is shown that the following 3 criteria are equivalent: (1) ξ^* maximizes det $M(\xi)$; (2) ξ^* minimizes $\max_x f(x)'[M(\xi)]^{-1}f(x)$; (3) $\max_x f(x)'[M(\xi^*)]^{-1}f(x) = k$. A corollary is that there al-ways exists a measure ξ such that, for suitable con-stants a_{ij}, the functions $g_i = \sum_j a_{ij} f_j$ are orthonormal with respect to ξ and $\max_x \sum_i g_i^2(x) = k$. Analogous re-sults hold if one assumes only that the f_i are bounded and linearly independent. The results have applica-tions to the determination of optimum statistical de-signs.

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Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

ASYMPTOTIC EXPANSIONS IN GLOBAL CENTRAL LIMIT THEOREMS, by R. P. Agnew. [1959] [17]p. (AF 18(600)685)
Unclassified

Published in Ann. Math. Stat., v. 30: 721-737, Sept. 1959.

Consider the distribution function (d.f.) $F_n(x)$ of the nor-malized sum $(\xi_1 + \xi_2 + .. + \xi_n)_n^{1/2}$ where the ξ's are in-dependent random variables with the same d.f., $F(x)$, hav-ing zero mean and unit variance. This paper studies the asymptotic behavior of constants $C_n(p) = \int_{-\infty}^{\infty} | F_n(x) - \Phi(x) |^p dx$, $\Phi(x)$ being the Gaussian d.f. Primary interest is focused on the case p = 2, for which conditions are presented under which there exists constants D_i such that $C_n(2) = C_n = \sum_{i=1}^{k} D_i n^{-i} + O(n^{-k-1})$. Different approaches are required depending on whether or not the magnitude of the characteristic function (c.f.) of $F(x)$ is periodic. It is shown that $D_i = A_i = B_i$, where B_i is needed only when the c.f. is periodic. Methods extending the results to k > 2 are indicated. Specific results are presented for a uniform d.f. (non-periodic and a binomial d.f. (peri-odic). Extensive computations are made for the symmet-ric binomial d.f., with results for $k \leq 5$. Values of C_n are presented for n < 10 and a very good approximation is available for $n \geq 5$. (Math. Rev. abstract)

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Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

ON THE GROWTH OF MEROMORPHIC FUNCTIONS WITH SEVERAL DEFICIENT VALUES, by A. Edrei and W. H. J. Fuchs. [1959] [37]p. incl. refs. [AF 18(600)-685]
Unclassified

Published in Trans. Amer. Math. Soc., v. 93: 292-328, Nov. 1959.

The possibility of proving analogous theorems for mero-morphic functions possessing deficient values was in-vestigated. The results obtained give a partial answer to the question of under which conditions are deficien-cies invariant under a change of origin. It is shown that under the conditions of letting $f(x)$ be an entire function of finite order λ and letting $M(r)$ denote its maximum modulus in the region $|z| \leq r$, assertion (i) of the fol-lowing theorem cannot hold for all meromorphic func-tions satisfying the inequality $K(f) < 1$. If some value τ ($\neq \infty$) is exceptional in the sense of Borel, then (i) λ is a positive integer; (ii) log $M(r) \sim \alpha r \lambda$ for positive value of α. However, the following theorem shows that some connection exists between the order λ, of $f(x)$ and the numerical value of $K(f)$. Let $k(\lambda) = \inf (K(f))$ where

f ranges over all meromorphic functions of order λ. Then $k(\lambda) = 0$, $(\lambda = 1,2,3,...)$. For all other λ, $k(\lambda) > 0$. Proof of the following theorem is presented. Let $f(x)$ be a meromorphic function of finite order λ. Then $K(\rho) \geq \dfrac{|\sin \pi\lambda|}{2.2\lambda + 1/2 |\sin \pi\lambda|}\lambda$, which gives the correct order of magnitude of $k(\lambda)$.

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[Cornell U. Dept. of Mathematics, Ithaca, N. Y.]

[DEFICIENT AND ASYMPTOTIC VALUES OF MERO-MORPHIC FUNCTIONS] Valeurs déficientes et valeurs asymptotiques des fonctions mémorphes, by A. Edrei and W. H. J. Fuchs. [1959] [38]p. (AF 18(600)685)
Unclassified

Published in Comment. Math. Helvetici, v. 33: 258-295, 1959.

The following questions are raised by the theorem of meromorphic functions. (1) If an entire function $f(z)$, of infinite order, admits an exceptional value, its order is of necessity whole, positive, and perfectly regular. Is this valid if it is assumed that $f(z)$ is meromorphic and the sum of the deficients excedes unity? (2) It is known that meromorphic functions exists, even for entire functions of finite order, for those values which are deficient without being asymptotic. When are deficient values also asymptotic values, or does this signify that the above must be completely denounced in order to establish a liason between the 2 exceptional values? (3) How does the presence of deficient values influence the gap of the Taylor expansion of an entire function? In this report particular attention is directed at the latter 2 questions. The methods of giving a good approx of log $|f(z)|$ in the function $T(|z|,f)$ are shown. This leads to showing that if the order of the entire function $f(x)$ is finite, and the sum of the deficiencies is sufficiently great, there exist deficient values which are also asymptotic.

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Cornell U. Dept. of Mathematics, Ithaca, N. Y.

CONVERGENCE OF THE EMPIRIC DISTRIBUTION FUNCTION ON HALF SPACES, by J. Wolfowitz. [1959] [4]p. (AFOSR-TN-59-454) [AF 49(638)296]
AD 214943　　　　　　　　　　　　Unclassified

Also published in Contributions to Probability and Statistics, Stanford, Stanford U. Press, 1960, p. 504-507.

Let (X_1, Y_1), (X_2, Y_2),..., be a sequence of independent chance variables with the same distribution function (d.f.) as (X, Y). Let p be a real parameter, $F(x|p)$ be the d.f. of $pX + Y$, and $F_n(x|p)$ be the empiric d.f. of $(pX_1 + Y_1)$,..., $(pX_n + Y_n)$. The author proves under no restric-

tions on the d.f. of (X,Y), that $P\left\{ \lim\limits_{n\to\infty} \sup\limits_{-\infty < p < \infty} \sup\limits_{-\infty < x < \infty} |F_n(x|p) - F(x|p)| = 0 \right\} = 1$. This result was proved by Fortet and Mourier (Ann. Ecole Normale Super, v. 60, (1953) under the assumption that the d.f. of (X,Y) is absolutely continuous, and by the author (Ann. Math. Stat., v. 25, 1954) under the assumption that X and Y are independent. It is possible to extend this result to more complex regions than half-spaces, and to sequences which are not independent. (Contractor's abstract)

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Cornell U. Dept. of Mathematics, Ithaca, N. Y.

LOTOTSKY AND HAUSDORFF METHODS FOR EVALUATION OF SERIES (Abstract), by R. P. Agnew. [1959] [1]p. (AFOSR-TN-59-792) [AF 49(638)226]
Unclassified

A continuation is presented of the development of properties of the new and powerful Lototsky method L for evaluation of series (COR.05:043, Vol. I). The principal new result is the fact that L is consistent with each regular Hausdorff method H. Relations are given involving L and other new methods introduced by Vuckovic in Yugoslavia in 1958 and by Herlestam in Sweden in 1959. (Contractor's abstract)

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Cornell U. [Dept. of Physics] Ithaca, N. Y.

USE OF SYNCHROTRON ORBIT-RADIATION IN X-RAY PHYSICS, by L. G. Parratt. [1959] [3]p. incl. diagr. table. (AFOSR-4021) (AF 18(600)300)
Unclassified

Also published in Rev. Scient. Instr., v. 30: 297-299, Apr. 1959.

This report makes a comparison of the prospective usefulness of the intense x-radiation emitted by the centripetally accelerated electrons in the orbit of a high-energy synchrotron in the range of wavelengths 0.1 to 20A. The results, presented in table form, indicate that at wavelengths in the range of 1A, the synchrotron shows no advantage over the conventional tube. However, with a 1-bev beam at wavelengths of 10A, the synchrotron beam demonstrates a great advantage over the conventional tube. It is also shown that with a beam of 6-bev, the synchrotron beam is better, even at a distance on 1A. It is concluded that the great advantage of the synchrotron beam is in emission spectroscopy (1) for those materials that cannot be fabricated easily into x-ray tube targets or that, as targets, cannot dissipate many watts of power, (2) in minimizing contamination, physical or chemical changes, etc., of the emitting material, (3) in controlling and knowing the temperature of the emitting material, and (4) in reducing the relative intensity of the ubiquitous bremsstrahlen background radiation.

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Cornell U. Dept. of Physics, Ithaca, N. Y.

STUDIES OF THE MORPHOLOGY AND STRUCTURE OF
COPPER FILMS DEPOSITED BY VACUUM EVAPORA-
TION, by B. M. Siegel. Dec. 15, 1958 [61]p. incl. illus.
diagrs. refs. (Technical rept. no. 9) (AFOSR-TN-59-7)
(AF 18(600)674, Task I) AD 203303; PB 139654
Unclassified

A study was made on thin copper films deposited by
vacuum evaporation on mica at temperatures from
room temperatures to above 400°C. These films, rang-
ing in thickness from 50 to 1000 A were examined by
transmission and replica electron microscopy, and by
electron diffraction. The investigation characterized
the crystallite size and orientation. It was also possi-
ble to demonstrate stacking faults in individual crys-
tallites. (Contractor's abstract)

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Cornell U. Dept. of Physics, Ithaca, N. Y.

A STUDY OF REFLECTED XENON IONS FROM
PLATINUM, by D. S. Beers. Mar. 1, 1959 [63]p. incl.
diagrs. tables, refs. (Technical rept. no. 10) (AFOSR-
TN-59-151) (AF 18(600)674, Task I) AD 210985;
PB 140620   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series
II, v. 4: 221, Apr. 30, 1959. (Title varies)

A study was undertaken to determine the character-
istics of Xe ions reflected from a Pt surface to im-
prove understanding of the nature of reflected ions.
The apparatus and procedure used were previously de-
scribed (COR.08:017, Vol. II). Results indicated that
(1) the measured yield of reflected ions is independent
of the incident-ion current and the energy of the inci-
dent-ions, (2) the energy of the reflected ions is ap-
proximately 0, (3) the variation of the yield of reflected
ions with ambient Xe pressure and target temperature
approximately satisfies an empirical equation, and (4)
the estimated true yield of reflected ions is of the or-
der of 10^{-4} (infinite Xe pressure). The experimental
results are in agreement with previous studies of re-
flected inert-gas ions, but are in disagreement with
previous studies of reflected alkali ions. Several ten-
tative mechanisms are discussed to account for the
ionization and ejection of the adsorbed Xe atoms.

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Cornell U. Dept. of Physics, Ithaca, N. Y.

STUDIES ON THE NUCLEATION, GROWTH AND OXI-

DATION OF EVAPORATED COPPER FILMS WITH A
HIGH VACUUM ELECTRON DIFFRACTION CAMERA,
by B. M. Siegel and C. C. Peterson. [1959] [11]p. incl.
illus. diagrs. tables, refs. (Technical rept. no. 14)
(AFOSR-TN-59-1195) (Also bound with its AFOSR-TR-
59-212) (AF 18(600)674, Task I)   Unclassified

Also published in Proc. Internat'l. Conf. on Structure
and Properties of Thin Films, Bolton Landing, N. Y.
(Sept. 9-11, 1959) New York, John Wiley and Sons, p.
97-107.

A study is made of the behavior of very thin deposits of
copper (less than 30A average thickness) under varied
conditions of heat treatment and oxidation with an ultra-
high vacuum electron diffraction camera that studies the
crystallographic structure of the deposited films and
follows the reactions on the surface of the "clean" films.
The 3 phase study included: (1) The changes of very
"thin" copper deposits under heat treatment. (2) The
character of the oxidation of these copper deposits and
the heat treatment of the oxide. (3) The reduction of the
oxide. The most surprising observation is that the cop-
per deposit disappears upon heat treatment at 350°C.
Possible explanations of this are presented. An elec-
tron micrograph of a copper deposit after heat treatment
and partial oxidation is explained pointing out the copper
particles and the cuprous oxide.

456

Cornell U. Dept. of Physics, Ithaca, N. Y.

A STUDY OF A PLATINUM SURFACE USING A MASS
SPECTROMETER, by R. C. Bradley and A. Arking.
May 1, 1959 [56]p. incl. diagrs. tables, refs. (Technical
rept. no. 11) (AFOSR-TN-59-271) (AF 18(600)674, Task
II) AD 212705; PB 144215   Unclassified

The mass spectrometric analysis of particles ejected
from a metal surface by the impact of inert gas ions
provides information on sputtering, on surface and bulk
compositions, and on surface and bulk kinetics. The
present paper describes some experiments on platinum,
using this technique. In particular the formation of PtO_3
on the Pt surface and its subsequent removal, either by
evaporation or by ion bombardment was described. This
is presented in detail in Section IV. Section II describes
the experimental arrangements and techniques, and
Section III pertains to sputtered particles other than
PtO_3.

457

Cornell U. Dept. of Physics, Ithaca, N. Y.

INVESTIGATION OF AN ALLOY SURFACE WITH
THE FIELD EMISSION MICROSCOPE, by R. C.
Bradley and L. A. D'Asaro. [1959] [8]p. incl. illus.

diagrs. tables, refs. (Technical rept. no. 12)
(AFOSR-TN-59-480) (AF 18(600)674, Task II)
AD 215733   Unclassified

The field emission microscope has been used to investigate the surface of an alloy of a few % zirconium in molybdenum. The field emission patterns indicate that a high-temperature flash (2000°K) reduces the surface concentration of zirconium to zero. Subsequent heat treatment at 1000°K brings Zr to the emitting surface where it adsorbs preferentially in small clusters on the lattice steps of the (100) planes. These clusters are easily observed because of their high electron emission. Their emission characteristics reveal them to be smooth layers of low work function (2.94 ± 0.01 ev) rather than protruding crystallites. When the bulk concentration of zirconium in the alloy is increased from 1% to 5%, the emission patterns change markedly, but there is little effect on the adsorption characteristics of the surface. Surface migration, desorption, and bulk diffusion of zirconium were found to proceed rapidly at temperatures above 1200°K, 1500°K, and 2000°K, respectively. Measurements of activation energies for surface migration and desorption gave 2.7 ± 0.3 ev and 4.15 ± 0.15 ev, respectively. (Contractor's abstract)

458

Cornell U. Dept. of Physics, Ithaca, N. Y.

DIFFUSION AND DESORPTION OF METAL IMPURITIES IN PLATINUM, by R. C. Bradley. Oct. 1, 1959 [17]p. incl. diagrs. tables, refs. (Technical rept. no. 13) (AFOSR-TN-59-1004) (AF 18(600)674, Task II) AD 233154; PB 145868   Unclassified

Also published in Phys. Rev., v. 117: 1204-1207, Mar. 1, 1960.

Activation energies for the volume diffusion of certain impurities in polycrystalline platinum samples have been obtained by studying the ions released from their surfaces at temperatures above 1000°C. For one Pt sample these energies were 4.7 ± 0.2 ev for K, and 3.7 ± 0.2 ev for Ca. For a second sample, however, all the energies were 10 - 15% higher. After periods of inert gas ion bombardment at room temperature,

burst of K^+ and Na^+ ions were released at temperatures of about 600°C and 700°C, respectively. Activation energies associated with this release were 1.9 ± 0.1 ev

for K^+ and 2.6 ± 0.1 ev for Na^+. In this case there was close agreement between the two different samples. (Contractor's abstract)

459

Cornell U. Dept. of Physics, Ithaca, N. Y.

PRECISE WAVELENGTH OF A WIDE SPECTRAL LINE AND PRECISE LATTICE PARAMETER OF A CRYSTAL,

by J. O. Porteus and L. G. Parratt. May 1, 1959, 17p. incl. diagrs. refs. (Technical rept. no. 3) (AFOSR-TN-59-305) (AF 49(638)402) AD 213089; PB 142063
Unclassified

In precision determinations of crystal lattice parameters, crystallographers recently pointed out that certain advantages accrue if the centroid of the diffraction pattern and of the x-ray line are used as reference angle (or wavelength) positions. Certain disadvantages are also pointed out: (1) the lattice parameter so determined refers necessarily to the centroid of the crystal pattern, (2) in order to keep the Bragg law simple and to avoid double-valued lattice parameters, the centroid proposal implies that x-ray wavelengths in general should refer to the centroid of the respective lines, and (3) there is an inherent experimental imprecision in the determination of the centroid of any line or pattern having long tails that fade gradually into the ubiquitous background. The 3rd point is argued qualitatively in terms of the general signal-to-noise ratio. This inherent imprecision is largely avoided if the peak position of the line is used as the reference position (defined as the intersection of the line profile with the curve drawn through the bisecting points of the horizontal chords of the line) and if the parameter position of the crystal pattern is taken as the bisector of the chord. These reference positions also avoid the Bragg law complication. (Contractor's abstract)

460

Cornell U. Dept. of Physics, Ithaca, N. Y.

PROBABILITY FOR AN INNER TWO-ELECTRON TRANSITION: X-RAY $K\beta'$ SATELLITE, by M. Sawada, T. Watanabe, and L. G. Parratt. May 14, 1959, 15p. incl. diagr. tables. (Technical rept. no. 4) (AFOSR-TN-59-459) (AF 49(638)402) AD 215264; PB 142156
Unclassified

An explanation was recently proposed by Parratt for the rather intense radiation observed on the low-energy side of each of many x-ray emission lines. This explanation, in terms of excitation states, is based on a fundamental departure from the conventional type of x-ray energy level diagram. In some important cases the emission in question, e.g., the so-called $K\beta'$ lines of the elements of the first transition group, had previously been interpreted by Sawada as a 2-electron transition type of x-ray satellite. This interpretation was based on wavelength positions, and in regard to intensity it was purely qualitative. Because of the fundamental nature of the excitation state proposal, the theoretical relative intensity of the 2-electron-jump type of satellite is explored in the present paper; it is found to be too low. Accordingly, this model for at least the bulk of the $K\beta'$ line is untenable.

461

Cornell U. Dept. of Physics, Ithaca, N. Y.

LINE ASYMMETRY AND SATELLITES IN X-RAY
SPECTRA: EXCITATION STATES, by M. H. Skolnick
and L. G. Parratt. May 20, 1959, 38p. incl. diagrs.
table, refs. (Technical rept. no. 5) (AFOSR-TN-59-
505) (AF 49(638)402) AD 215930; PB 142181
Unclassified

Calculations are presented for the K spectra of solid
metallic manganese. This many-electron model is
able to explain satisfactorily the observed asymmetries
of the $K\alpha_{1,2}$ lines and the origin of the $K\beta'$ satellite
lines for elements in the first transition group. (Con-
tractor's abstract)

462

Cornell U. Dept. of Physics, Ithaca, N. Y.

AN OPTIMIZED METHOD FOR CORRECTING FOR
SMEARING ABERRATIONS: COMPLEX X-RAY SPEC-
TRA, by J. O. Porteus and L. G. Parratt. Sept. 1,
1959, 1v. incl. diagrs. tables, refs. (Technical rept.
no. 7) (AFOSR-TN-59-754) (AF 49(638)402)
AD 226880, PB 143952   Unclassified

Also published in Jour. Appl. Phys., v. 33: 700-707,
Feb. 1962.

The true spectrum $T(\nu)$ is desired from the observed
spectrum $0(\nu_n)$ which has been recorded with a spec-
trometer whose smearing or "spectral window" func-
tion is $M(\nu_n-\nu)$, i.e., we seek to correct $0(\nu_n)$ for the
smearing effect of $M(\nu_n-\nu)$. The correction involves
the convolution or folding integral

$$0(\nu_n) = \int_{-\infty}^{\infty} T(\nu) \ M(\nu_n-\nu) \ d\nu.$$

This problem, with appropriate terminology, arises in
almost every facet of experimental science. A mathe-
matically unique solution exists only in case $0(\nu_n)$ and
$M(\nu_n-\nu)$ are exactly known for all ν. Many investiga-
tors have attacked this problem and many different
"practical solutions" have been proposed. The prob-
lem is re-examined from the point of view of correct-
ing x-ray spectra for resolving power, and previous
solutions are found to be inadequate. A new optimized
solution is proposed. The errors in this solution are
discussed in detail. The specific spectral examples to
which the new method is applied are the K emission
and absorption of crystalline potassium chloride.
(Contractor's abstract)

463

Cornell U. Dept. of Physics, Ithaca, N. Y.

X-RAY REFLECTION STUDIES OF THE ANNEAL
AND OXIDATION OF SOME THIN SOLID FILMS, by
N. Wainfan and L. G. Parratt. Aug. 25, 1959 [20]p. incl.
diagrs. refs. (Technical rept. no. 6) (AFOSR-TN-59-
755) (AF 49(638)402) AD 226979; PB 143951
Unclassified

Also published in Jour. Appl. Phys., v. 31: 1331-1337,
Aug. 1960.

The technique of the total reflection of x-rays has been
applied to the study of thin vacuum-deposited films of
Cu, Ni, Ge, and Se on polished glass substrates. Start-
ing with fresh films "smooth" enough to exhibit pro-
nounced x-ray interference fringes in the region just
beyond the critical angle, the effects of vacuum anneal
and oxidation were studied. Changes in the reflection
curves are interpreted in terms of possible structural
changes in the films. These reflectivity changes are
examined in the light of results obtained from the study
of x-ray reflection from layers of particles of carbon
or polystyrene latex deposited onto "smooth" substrates.
(Contractor's abstract)

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Cornell U. [Dept. of Physics] Ithaca, N. Y.

THE STRUCTURE OF VACUUM-DEPOSITED FILMS
AS DETERMINED FROM THE TOTAL REFLECTION
OF X-RAYS (Abstract), by N. Wainfan, R. Sviedrys
and others. [1959] [1]p. [AF 49(638)402]
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
265, Apr. 30, 1959.

A vacuum x-ray reflectometer has been constructed
to allow measurement of the coefficient of reflection
of optically flat surfaces at small glancing angles while
the mirror is contained in a temperature-controlled
vacuum chamber. This instrument has been applied to
the study of metal films vacuum-deposited onto opti-
cally flat glass and Pyrex substrates. The x-ray wave-
length used in this work is 1.54A. A measurement of
the x-ray reflection coefficient as a function of glancing
angle yields information about the density, the density
distribution and thickness of the metal film. The new
instrument extends previous investigations to the study
of the oxidation-reduction and annealing processes.
Data will be presented illustrating the effects of the
oxidation, reduction, and anneal on copper films in the
thickness range between 400 and 1200A. X-ray reflec-
tion curves will be interpreted in terms of possible
film structures.

465

Cornell U. Graduate School of Aeronautical Engineering,
Ithaca, N. Y.

THE RESPONSE OF LAMINAR BOUNDARY LAYER
TO IMPULSIVE MOTIONS, by M. L. Rosenzweig.
Feb. 1959, 96p. incl. diagrs. tables, refs. (AFOSR-
TN-59-92) (AF 18(600)1523) AD 210182; PB 146843
Unclassified

An investigation was conducted on the response of the
laminar boundary layer in 2-dimensional, incompres-
sible flow to impulsive changes in velocity. In particu-
lar, the problem of stagnation-point flow against a wall
which moves impulsively in its own plane is considered.
A method is developed for the solution of this problem.
Applications of this method are then made to the case
of linearized, unsteady, laminar boundary-layer flow.
Detailed calculations are carried out to determine the
oscillatory response of the laminar boundary layer
when the basic steady flow is that given by the potential
velocity distribution. The results of these calculations
are then used to find the response to impulsive changes
of velocity. (Contractor's abstract)

466

Cornell U. Graduate School of Aeronautical Engineering,
Ithaca, N. Y.

ON THE MOTION OF THIN AIRFOILS IN FLUIDS OF
LARGE BUT FINITE ELECTRICAL CONDUCTIVITY, by
by J. E. McCune. [1959] [39]p. incl. diagrs. (AFOSR-
TN-59-456) (AF 18(600)1523) AD 215030
Unclassified

A 2-dimensional, small-perturbation theory for the
steady motion of thin lifting airfoils in an incompres-
sible conducting fluid, with the uniform applied mag-
netic field perpendicular to (and in the plane of) the un-
disturbed, uniform flow field, is described. The con-
ductivity of the fluid is assumed to be such that the
magnetic Reynolds number ($\equiv R_m$) of the flow is large
but finite. Within this assumption, a theory based on
superposition of sinusoidal modes is constructed and
applied to some simple thin airfoil problems. It is
shown that with this particular field geometry the
Alfvén wave mechanism is important in making possible
very deep penetration into the flow field of currents
and their associated vorticity. It is also shown that
the current penetration for an airfoil is much larger
than for a wavy wall of wave length equal to the air-
foil chord. A value of R_m = 5 is found to be a good ap-
proximation to infinity; use of the present technique for
values of R_m on the order of unity is permissible.

These results provide an indication of what is meant
by large magnetic Reynolds number in 2-dimensional
magneto-aerodynamics. (Contractor's abstract)

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Cornell U. Graduate School of Aeronautical Engineering,
Ithaca, N. Y.

FLUTTER ANALYSIS OF A SUPERSONIC RING WING,
by P. Crimi. June 1959, 32p. incl. diagrs. table, refs.
(AFOSR-TN-59-685) (AF 18(600)1523) AD 227075
Unclassified

Also published in Jour. Aero/Space Sci., v. 29: 578-
582, May 1962.

The possibility of flutter of a supersonic ring wing is
investigated by using linearized equations. The elastic
system is limited to flexural deformations and piston
theory is employed for aerodynamic pressures. By
means of Lagrange's equations, the equations of motion
are derived, and expressions for critical Mach number
and flutter frequency obtained. Results are restricted
to wings of moderately high aspect ratio by the simpli-
fied aerodynamics. A representative airfoil cross-
section is chosen and flutter quantities calculated for
various values of geometric parameters and mode num-
ber. Both analytical and numerical results seem to
indicate that the system investigated is highly stable.
(Contractor's abstract)

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[Cornell U. Graduate School of Aeronautical Engineering,
Ithaca, N. Y.]

THEORY OF THE MAGNETIC BOUNDARY LAYER,
by V. N. Zigulev, tr. by W. J. Rae. [1959] 5p. incl.
diagrs. (AFOSR-TN-59-872) (AF 18(600)1523)
AD 236059 Unclassified

Trans. from Dokl. Akad. Nauk SSSR, v. 124: 1001-1004,
1959.

Examples are cited which illustrate the phenomenon
that a moving plasma is shielded from an external mag-
netic field and from the electric currents that flow in it.
The thickness of the shielding layer, called a magnetic
boundary layer, has the order $1/\sqrt{Re_m}$ for motions at
large magnetic Reynolds numbers.

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Cornell U. Graduate School of Aeronautical Engineering,
Ithaca, N. Y.

ON THE TURBULENT BOUNDARY LAYER WITH
FLUID INJECTION, by D. L. Turcotte. July 1959 [7]p.
incl. diagr. (AFOSR-TN-59-874) (AF 18(600)1523)
AD 256963; PB 147634 Unclassified

By introducing a sublayer region in which the intensity
of turbulence grows at a prescribed rate, the reduction
in wall shear stress due to fluid injection is found for

a turbulent boundary layer. With the decrease in wall shear stress expressed as a function of the ratio of the injection velocity to the friction velocity, the form of the solution is particularly simple. The theory provides a free parameter which can be determined such that the available experimental data are excellently correlated. (Contractor's abstract)

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Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

ON THE RESPONSE OF THE LAMINAR BOUNDARY LAYER TO SMALL FLUCTUATIONS OF THE FREE-STREAM VELOCITY, by N. Rott and M. L. Rosenzweig. [1959] [27]p. incl. diagr. (AFOSR-TN-59-885) (AF 18-(600)1523)   Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 741-747; 787, Oct. 1960.

The linearized treatment of small time-dependent disturbances of a laminar boundary layer, initiated by Lighthill, is extended in several ways. In particular, the high-frequency expansion is continued beyond the leading (Stokes) term, which was the only one considered so far. Several interesting questions of "joining" occur, which are discussed but left unsolved. Also, a practical method for obtaining the response to an impulsive change in velocity is given. The application of the methods to the case when the basic flow belongs to the Falkner-Skan family is discussed. (Contractor's abstract)

471

Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

AN INVISCID BOUNDARY LAYER OF MAGNETOHY-DRODYNAMICS, by W. S. Lewellen. [1959] 46p. incl. diagrs. table. (AFOSR-TN-59-927) (AF 18(600)1523) AD 229791; PB 144767   Unclassified

A boundary-layer approximation for fluids with large electrical conductivities is applied to the 2-dimensional, steady, inviscid, incompressible magnetohydrodynamic equations for the case of a uniform magnetic field parallel to the free stream. Two approaches to the solution of the magnetic boundary layer are used: (1) the approximate integral method is used to derive equations analogous to the von Kármán integral momentum equation of viscous theory. These equations are integrated for flow of the type $U_1 = C x^n$; (2) the exact magnetic-boundary-layer equations are transformed, for similar flows, into a system of ordinary differential equations. The solution of these equations is found in the form of a power-series expansion in a parameter equal to the Alfvén speed divided by the free-stream velocity. Numerical results are given for several cases of similar

flow. In sub-Alfvénic flow, evidence points to a boundary layer growing in the direction opposite to the flow. (Contractor's abstract)

472

Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

MAGNETOHYDRODYNAMIC EFFECTS IN AERODY-NAMIC FLOWS, by W. R. Sears. [1959] [10]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1523] and Office of Naval Research)   Unclassified

Presented at Thirteenth annual meeting of the Amer. Rocket Soc., New York, Nov. 17-21, 1958.

Published in ARS Jour., v. 29: 397-406, June 1959.

A review of the phenomena that appears in fluid motions if the fluid is a conductor and there are electric and/or magnetic fields present is discussed. Body forces, their origin, induced electromotive forces, and Joule heating are among the subjects discussed. Application of magnetohydrodynamics to aeronautical problems are suggested including the lift and drag of flying bodies, the transfer of heat from hot gas streams to adjacent bodies, and thrust production and augmentation. Areas of future investigation are also indicated.

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Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

ELECTROMAGNETIC INTERACTION WITH AERODY-NAMIC FLOWS, by E. L. Resler, Jr. and J. E. McCune. [1959] [17]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)-1523] and Office of Naval Research) AD 241663   Unclassified

Published in Proc. Third Symposium on Magnetohydro-dynamics, Lockheed Research Lab., Palo Alto, Calif. (Nov. 21-22, 1958), Stanford, Stanford U Press, 1959, p. 120-136.

For steady flow past sinusoidal walls complete solutions to the linearized magneto-aerodynamic equations can be found for arbitrary values of the conductivity σ. From these the magnitude of the effects of current diffusion and Alfvén wave mechanism on the flow can be discerned. In general, both of these mechanisms are present in the flow; which of them dominates the forces on bodies depends on the geometry of the magnetic field. Therefore the criterion for whether or not a fluid will behave as a good conductor depends not only on the magnetic Reynolds number but also on the configuration. These mechanisms also appear in the theory of thin airfoils; in addition, they are modified importantly by compressibility effects. For the geometries considered,

airfoil performance characteristics can be obtained in closed form for the general case. These solutions are analogous to the Prandtl-Glauert and Ackeret theories in conventional aerodynamics. (Contractor's abstract)

474

Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

SOME SOLUTIONS OF THE MACROSCOPIC EQUA-TIONS OF MAGNETOHYDRODYNAMICS, by W. R. Sears. [1959] [13]p. incl. diagrs. refs. (AF 18(600)-1523) Unclassified

Published in Proc. Third Biennial Gas Dynamics Symposium on Dynamics of Conducting Gases, Evanston, Ill. (Aug. 24-26, 1959), Evanston, Northwestern U. Press, Mar. 1960, p. 51-63. (AFOSR-TR-60-87)

A report is made on three different theoretical investigations concerning magnetohydrodynamics of inviscid incompressible fluids. These three studies concern the following cases: (1) Thin airfoils and slender bodies in fluids of modern conductivity; this to flows having uniform parallel magnetic and velocity fields in the undisturbed region. (2) An inviscid magnetic boundary layer; this is a nonlinear treatment for fluids of large but finite conductivity and also involves the case of uni-

form, parallel fields in the free stream. (3) Some flows involving tensor conductivity; here some flows previously studied, namely steady flow past a corrugated wall and one-dimensional wave propagation (Alfvén waves) are generalized for a fluid in which the Hall effect is appreciable.

475

Cornell U. Sibley School of Mechanical Engineering, Ithaca, N. Y.

A MULTIPLICATIVE MODEL FOR ANALYZING VARI-ANCES WHICH ARE AFFECTED BY SEVERAL FAC-TORS, by R. Bechhofer. July 10, 1959, 41p. incl. tables, refs. (Technical rept. no. 14) (AFOSR-TN-59-798) (AF 49(638)230) AD 226887 Unclassified

A multiplicative model is proposed for analyzing multi-factor experiments which are conducted to study the effect of changes in the levels of the factors on the variance of a chance variable. The model is a direct analogue of the additive model for means. Univariate and multivariate applications to factorial experiments, experimental designs, and multiplicative response surfaces for variances are discussed. (Contractor's abstract)

Cruft Lab., Cambridge, Mass. see Harvard U. Cruft Lab., Cambridge, Mass.

476

Delaware U. Dept. of Chemical Engineering, Newark.

TURBULENT FLOW AND HEAT TRANSFER RATES
IN NON-NEWTONIAN FLUIDS, by A. B. Metzner.
Final rept. Dec. 1959 [6]p. incl. diagrs. tables, refs.
(AFOSR-TR-59-143) (AF 18(603)115) AD 230229
Unclassified

This research has been concerned with the analysis of
the flow characteristics of non-Newtonian systems flow-
ing through smooth round tubes, and the application of
this knowledge to the prediction of heat transfer rates
by means of the analogy between heat and momentum
transfer. The results are summarized for turbulent
flow pressure drop relationships, turbulent velocity
profiles, and heat transfer rates. Item no. 477 is also
bound with this report.

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Delaware U. [Dept. of Chemical Engineering] Newark.

HEAT TRANSFER TO TURBULENT NON-NEWTONIAN
FLUIDS, by A. B. Metzner and P. S. Friend. [1959]
[4]p. incl. diagrs. tables, refs. [AF 18(603)115]
Unclassified

Published in Indus. and Eng. Chem., v. 51: 879-882,
July 1959.

An analysis of turbulent heat transfer rates to fluids
flowing in smooth round tubes is made. Extensive ex-
perimental data on slurries and polymer solutions are
presented, covering the range of Prandtl numbers
from 6.3 - 190, and of Reynolds numbers up to 71,000.

478

Delaware U. Dept. of Chemical Engineering, Newark.

THE EFFECTS OF HIGH HYDROSTATIC PRESSURE
ON SUBSEQUENT PHYSICAL PROPERTIES OF
METALS, by J. R. Ferron. Dec. 11, 1959, 25p. incl.
diagrs. tables. (AFOSR-TR-59-199) (AF 49(638)84)
AD 272011 Unclassified

Studies were made of the changes in the physical prop-
erties of metals after the metals were treated at high
hydrostatic pressure (200,000 psi maximum) for peri-
ods up to 3 wk. Treated and untreated samples of
polycrystalline Mg and Al were tested in tension. No
observable changes in strength properties occurred in
either metal as a result of pressure treatment. Duc-
tility of Mg was reduced slightly, but the effect is at-
tributed to slight plastic deformation rather than to the
pressure treatment itself. X-ray diffraction was used
to study changes in single crystals of Al. No definite
conclusions were drawn from the results because of
low precision in the data. The x-ray studies are being
continued to obtain more consistent results.

479

Delaware U. Dept. of Physics, Newark.

[INTERMOLECULAR FORCE MEASUREMENTS BY
MICROWAVE LINE WIDTHS], by H. F. Feeny. Final
summary rept. Aug. 31, 1957 [6]p. incl. table. (Rept.
no. PAR-19) (AFOSR-TR-59-96) (AF 18(600)449)
Unclassified

Measurements on the broadening of the $J = 6 \rightarrow 6$ line of
ammonia by H_2, O_2, N_2, and CO_2 have been completed.

The molecular quadrupole moments of the various
broadeners were calculated from the measured collision
diameters and are compared to the quadrupole moments
obtained from the $J = 3 \rightarrow 3$ line width data. (Contrac-
tor's abstract)

480

Detroit U. [Research Inst. of Science and Engineering]
Mich.

DEVELOPMENT OF A MATHEMATICAL THEORY OF
PLASTICITY BASED ON THE CONCEPT OF SLIP II, by
H. Payne and S. J. Czyzak, and N. Bow. Oct. 1, 1959,
22p. incl. tables. (AFOSR-TN-59-1030) (AF 18(600)-
1466) AD 229095; PB 144773 Unclassified

The model developed by H. Payne (Jour. Mech. and Phys.
Solids, v. 7: 126, 1959) was used to solve the problem of
a thin wall cylinder which is subjected to a torsional
strain following a plaster tensile strain and the results
of this work are described in detail. The study of the
Bauschinger effect was started and the work contained
in this report deals with the 1st phase of this study.
The method for calculating the plastic behavior for a
reversal of a uniaxial strain was developed and is dis-
cussed. (Contractor's abstract)

481

Detroit U. [Research Inst. of Science and Engineering]
Mich.

THE SLIP THEORY OF PLASTICITY FOR CRYSTAL-
LINE AGGREGATES, by H. Payne. [1959] [9]p. incl.
tables. (AF 18(600)1466) Unclassified

Published in Jour. Mech. and Phys. Solids, v. 7: 126-
134, Mar. 1959.

The model for predicting the plastic behavior of a crys-
talline aggregate under uniaxial stress from empirical
data on slip in the single crystal which has been devel-
oped by Taylor and modified by Bishop and Hill, and by
Lin is presented in a mathematical form which provides
for the case in which the stress is not uniaxial. (Con-
tractor's abstract)

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[Documentation, Inc., Washington, D. C.].

THE IBM 9900 SPECIAL INDEX ANALYZER, by R.
W. Murphy. Nov. 17, 1958, 24p. incl. illus. diagrs.
table. (AFOSR-TN-59-157) (In cooperation with
International Business Machines Corp., Poughkeepsie,
N. Y.) [AF 49(638)91]   Unclassified

The IBM Special Index Analyzer is a machine designed
to facilitate reference to cataloged information. It is
composed of 3 units: a card punch which is used pri-
marily for reading cards, a storage unit containing
both the control equipment and a paper tape punch and
reader for retaining the intermediate results of opera-
tions, and a typewriter for automatically printing the
results of the search. An information retrieval system
employing the Special Index Analyzer is set up on the
basis that a document can be categorized by a set of
terms. When items are entered into the system, each
is analyzed to find which terms are pertinent to it, and
records are made associating the item with significant
items. The terms are drawn from a pre-established
glossary. These records are then rearranged into an
index consisting of subdivisions called term files, each
of which includes all the references to which an indi-
vidual term is pertinent. In this arrangement the term
files are ready for use by the researcher, employing
the IBM 9900 Special Index Analyzer to select out sig-
nificant references automatically and accurately. The
operations and applications of the machine are dis-
cussed in detail.

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Dublin Inst. for Advanced Studies (Ireland).

[HIGH-DENSITY HIGH-ENERGY ELECTRON SHOW-
ERS AT SEA LEVEL]. Final technical rept. Dec. 1,
1956-Nov. 30, 1958, 16p. incl. tables, refs. (AFOSR-
TR-59-54) (AF 61(514)1164) AD 216623; PB 143031
                                        Unclassified

Experimental work on cosmic ray showers was carried
out at stations in Dublin, Ireland, and Mona, Jamaica.
The effects investigated were: (1) the variation in rate
of local penetrating showers of the cosmic radiation
with solar time; (2) the variation in rate of dense ex-
tensive air showers with solar time, together with re-
lated studies of shower size and structure; and (3) the
variation in rate of penetrating extensive showers with
sidereal time and the measurement of shower direc-
tions. The effect originally discovered in Dublin of the
variation of rate with solar time was confirmed, and the
results appear to be in reasonable agreement with the
theory of Bassi and Ferrari. The variation in rate of
showers with solar time was confirmed in Dublin and
in Jamaica. The size of the showers producing the ef-
fect was shown to be between 10^6 and 10^7 particles at
sea level. The hypothesis was introduced that the im-
mediate cause of the effect is a change in the structure
of the showers at sea level. The variation with side-

real time was confirmed in Dublin and a somewhat
similar variation in rate of the penetrating extensive
showers was found in Jamaica.

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Dublin Inst. for Advanced Studies (Ireland).

FURTHER EVIDENCE FOR A VARIATION IN THE
RATE OF DENSE EXTENSIVE AIR SHOWERS WITH
SOLAR TIME, by C. B. A. McClusker, D. E. Page, and
R. A. Reid. [1959] [2]p. incl. diagr. refs. (AFOSR-TN-
59-897) (AF 61(052)163) AD 225631   Unclassified

Also published in Phys. Rev., v. 113: 712-713, Jan. 15,
1959.

The variation in the rate of dense extensive air showers
with solar time previously found in Dublin, Ireland, has
been confirmed using a similar apparatus situated in
Mona, Jamaica. It is suggested that this and other vari-
ations in rate with solar time may possibly be due to a
periodic change in the structure function of the showers.
(Contractor's abstract)

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Duke U. [Dept. of Mathematics] Durham, N. C.

ON THE STEADY-STATE THERMOELASTIC PROB-
LEM FOR THE HALF-SPACE AND THE THICK
PLATE, by I. N. Sneddon and F. J. Lockett. Mar. 1959
[11]p. incl. diagrs. (AFOSR-TN-59-301) (AF 18(600)-
1341) AD 213085; PB 140460   Unclassified

Also published in Quart. Appl. Math., v. 18: 145-153,
July 1960.

An attempt was made to determine the steady-state
thermal stresses in a semi-infinite elastic medium and
a thick elastic plate. The problem is treated as one in
the classical theory of elasticity. The method of solu-
tion employed is that of multiple Fourier transforms,
double transforms in this case. A general solution,
corresponding to an arbitrary temperature field, is ob-
tained in the form of 2-dimensional Fourier integrals,
and it is confirmed that the stress field is plane and
parallel to the boundary of the medium. The particular
solution corresponding to axially symmetrical tempera-
ture fields is deduced. A solution is found for the prob-
lem in which the surface temperature is uniform over a
circular region of exposure and is zero outside. In this
special case an expression is given for the difference of
the principal stresses in terms of tabulated integrals,
and the 3-dimensional analogue of the constructed iso-
chromatic lines. The corresponding analysis of the
steady-state displacements and stresses produced by
arbitrary distributions of temperature on the surfaces
of a thick plate is given. To illustrate the use of the
thick-plate formulae, the isochromatic surfaces within
the plate are constructed for a special distribution of
surface temperatures. (ASTIA abstract)

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Duke U. [Dept. of Mathematics] Durham, N. C.

A NOTE ON THE AXIALLY SYMMETRICAL PUNCH
PROBLEM, by I. N. Sneddon. Mar. 1959, 30. (AFOSR-
TN-59-362) (AF 18(600)1341) AD 213672; PB 140534
Unclassified

The object of this report is to show that it is a simple
matter to derive the form of the kernel function $K(\mu)$
appropriate to any prescribed displacement function
$f(r)$. The results are in agreement with those of
Segedin (Mathematika, v. 4: 156-161, Dec. 1957) who
arrives at his solution by avoiding the use of dual inte-
gral equations and the introduction of an awkward system
of curvilinear coordinates.

487

Duke U. [Dept. of Mathematics] Durham, N. C.

THE ELEMENTARY SOLUTIONS OF SOME DUAL
INTEGRAL EQUATIONS, by I. N. Sneddon. Mar. 1959,
5p. (AFOSR-TN-59-363) (AF 18(600)1341) AD 213673;
PB 140535 Unclassified

Also published in Proc. Glasgow Math. Assoc., v. 4: 108-
110, 1960.

A simple solution is given of the pairs of equations
which arise most frequently in physical applications.
The dual integral equations considered are of the type:

$$\int_0^\infty \xi^\alpha \psi(\xi) J_\nu(\xi \rho) d\xi = f(\rho), \ 0 < \rho < 1: \text{ and}$$

$$\int_0^\infty \psi(\xi) J_\nu(\xi \rho) d\xi = 0, \ \rho > 1, \text{ where } \alpha \text{ and } \nu \text{ are prescribed}$$

constants and $f(\rho)$ is a prescribed function of ρ. (ASTIA
abstract)

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Duke U. [Dept. of Mathematics] Durham, N. C.

ON THE NUMERICAL SOLUTION OF A NON-LINEAR
FIRST-ORDER DIFFERENTIAL EQUATION, by J.
Douglas, Jr. Mar. 1959, 27p. incl. refs. (AFOSR-TN-
59-403) (AF 18(600)1341) AD 214523; PB 142147
Unclassified

Also published in Proc. Rome Symposium on the
Numerical Treatment of Partial Differential Equations
with Real Characteristics, Rome (Italy) (Jan. 28-30,
1959), Rome, Libreria Eredi Virgilio Veschi, 1959,
p. 12-16.

The initial value problem for the equation $u_t = g(u)v_x$
for $-\infty < x < \infty$, $t > 0$, where $u(x,0) = f(x)$, $-\infty < x < \infty$, is
treated numerically. Under suitable assumptions on f

and g proof is presented of the convergence of a simple
explicit finite difference scheme for the case in which
the solution is discontinuous. (Math. Rev. abstract)

489

Duke U. [Dept. of Mathematics] Durham, N. C.

PROPAGATION OF THERMAL STRESSES IN A
SEMI-INFINITE MEDIUM, by F. J. Lockett. Apr. 1959,
13p. incl. table, refs. (AFOSR-TN-59-498) (AF 18(600)-
1341) AD 215923; PB 142359 Unclassified

Solutions are derived, using the classical theory of
thermoelasticity, to the problem of the semi-infinite
medium subjected to any physically possible combination
of body forces, heat sources, surface tractions and
thermal boundary conditions. The solutions are obtained
in the form of multiple integrals over an infinite range,
and in the general case they would have to be reduced
by numerical procedures. A particular example is given
in which the solutions reduce to a simple form. Results
show that a stress component of physical importance
differs from the classical value by a maximum amount
of 5%. (Contractor's abstract)

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Duke U. [Dept. of Mathematics] Durham, N. C.

SOME PROPERTIES OF THE FUNDAMENTAL SOLU-
TION OF THE PARABOLIC EQUATION, by S. M.
Robinson. July 1959, 28p. incl. diagrs. refs. (AFOSR-
TN-59-789) (AF 18(600)1341) AD 227717; PB 144374
Unclassified

Also published in Duke Math. Jour., v. 27: 195-220,
June 1960.

The existence of a fundamental solution in both un-
bounded and bounded domains is proved for the para-
bolic equation: $L(u) = \Sigma a_{ij}(x_1,...,x_n,t) \partial^2 u/\partial x_i \partial x_j +$
$\Sigma a_i(x_1,...,x_n,t) \partial u/\partial x_i + a(x_1,...,x_n,t)u - \partial u/\partial t =$
$0, \ (i,j = 1,...,n)$. Let the coefficients a_{ij}, a_{ji}, a_i, and a
be bounded and continuous functions of the variables
$x_1,...,x_n$, t and satisfy uniform Holder conditions with
respect to the space variables $x_1,...,x_n$. Assume that
the quadratic form $\Sigma a_{ij} x_i x_j \ (i,j = 1,...,n)$ is uniformly
positive definite. In a domain Ω of Euclidean n-space,
a fundamental solution of the parabolic equation is con-
structed. The domain need not be bounded, but may in-
clude all of Euclidean n-space. Several properties are
derived, in particular, the fundamental solution is
proved to satisfy the Chapman-Kolmogorov relation and
also the equation adjoint to $L(u)$. (ASTIA abstract)

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Duke U. [Dept. of Mathematics] Durham, N. C.

THE STEADY-STATE THERMOELASTIC PROBLEM
FOR THE ELASTIC LAYER RESTING ON A RIGID
FOUNDATION, by I. N. Sneddon and F. J. Lockett.
Sept. 1959 [11]p. incl. diagrs. (AFOSR-TN-59-1291)
(AF 18(600)1341) AD 231226; PB 145508
Unclassified

Also published in Ann. Math. Pura et Appl., v. 50: 309-
317, 1960.

A determination is made of the steady-state thermal
stresses in an elastic layer which is resting on a
rigid frictionless foundation. The layer occupies the
region $0 \leq z \leq d$, the surface $z = 0$ being free from
stress and the surface $z = d$ being in contact with the
foundation. This problem is unique in that the surfaces
of the layer are not always completely free from stress.
The condition $\sigma_3 = 0$ on $z = d$ is not, in general, true,

but is replaced by the condition that the normal displace-
ment w should be zero at that surface. (It is assumed
that the layer is prevented from separating from the
foundation). The free surface of the layer is supposed
to be subjected to a known temperature distribution
$\varphi_1(x,y)$, while the rate of change of temperature

$(\partial\theta/\partial z = \omega_2(x,y))$ is known across the surface in con-

tact with the foundation.

492

[Duke U. Medical Center, Durham, N. C.]

THE MEASUREMENT OF HUMAN ADAPTATION TO
STRESSFUL ENVIRONMENTS, by S. I. Cohen, A. J.
Silverman, and B. M. Shmavonian. [1959] [11]p. incl.
diagrs. (AFOSR-TN-59-142) (Sponsored jointly by
Air Force Office of Scientific Research under AF 49-
(638)354, Duke U. Regional Center for the Study of
Aging, and Public Health Service) AD 264191
Unclassified

Presented at Thirteenth annual meeting of the Amer.
Rocket Soc., New York, Sept. 15-18, 1958.

Also published in Gen. Systems, v. 4: 231-241, 1959.

The arousal state is ascertained by use of skin resist-
ance measurements for the purpose of showing that the
arousal state is related to psychophysiologic functions
(particularly those which are associated with the capa-
bility to perform physical and psychological tasks). This
relationship is, in fact, demonstrated; and in addition it
is pointed out that those subjects who show the highest
tolerance for stimuli, exhibit the least arousal before
the stress, and those who, before stress application,
show the higher level of arousal, cannot tolerate as high
a level of stimuli. In addition to establishing the above
relationship, it is also shown that skin resistance is re-

lated to other physiological changes, for instance hor-
monal and vascular changes. These observations, con-
cerning water, mecholyl, and adrenalin injections, show
that the skin resistance measurements clarify the other-
wise paradoxical results. Finally, the subject's own
personal meaning of the stimuli (in the case of verbal
stimuli) is taken into consideration, and the results show
that the largest responses are given to those expressions
which appear to be more meaningful to the subject. The
implications drawn from these results indicate the need
to consider a much broader evaluation of operational
systems than just during stress periods. Furthermore,
any complete analysis of behavior would have to include
pre-stress conditions as well as comparison between
response and average response for the same subject.

493

[Duke U. Medical Center, Durham, N. C.]

HALLUCINATIONS IN SENSORY DEPRIVATION, by
A. J. Silverman, S. I. Cohen and others. [1959] [10]p.
incl. refs. (AFOSR-TN-59-143) (AF 49(638)354)
AD 221902 Unclassified

Also published in Proc. APA-AAAS Symposium on
Hallucinations, Washington, D. C. (Dec. 27-28, 1958),
New York, Grune and Stratton, 1962, p. 125-134.

A systematic multi-disciplined investigation was ini-
tiated in order to study the response dissimilarities to
various low sensory input environments. The experi-
mental design included both the control of and variation
of a number of factors considered relevant to response
dissimilarities. Subjects exposed to isolation and sen-
sory deprivation were questioned concerning their visual
auditory, and kinesthetic sensations. The reports illus-
trated the difficulty encountered in differentiating ideas
from fantasies, from visual imagery associated with
fantasy, from illusory phenomena due to extraneous
stimuli, or from visual imagery produced by body sen-
sations.

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Duke U. Medical Center, Durham, N. C.

PRACTICAL AND THEORETIC DIFFICULTIES IN
"ISOLATION" STUDIES, by S. I. Cohen, A. J. Silverman
and others. [1959] [21]p. incl. refs. (AFOSR-TN-59-
144) (Sponsored jointly by Air Force Office of Scientific
Research under AF 49(638)354, Duke U. Regional Center
for the Study of Aging, and Public Health Service)
AD 253126 Unclassified

Also published in Proc. Symposium on Sensory Depriva-
tion, Harvard Medical School, Cambridge, Mass. (June
20-21, 1958), Cambridge, Harvard U. Press, 1961,
p. 114-129).

Sensory deprivation and isolation involves a large num-
ber of variables related to (1) the subject, (2) the

experimenter, and (3) the experimental situation. These variables are listed and described. Some examples are presented which suggest the kind of difficulties which may be created if these variables are not assessed. The variety of effects which may occur when one is exposed to the stress of isolation and sensory deprivation suggests that systematic interdisciplinary studies may be essential to fully realize the impact of the stress upon the subject and the kind of changes which may occur. The findings of 2 preliminary studies involving 14 subjects exposed to isolation and sensory deprivation are presented with the kind of theoretical problems which were provoked by the results of these studies. A multi-disciplined approach to the problems raised may permit a detailed investigation of the mechanisms mediating psychophysiologic relationships, and also clarify the factors responsible for the various responses which occur in this stressful environment.

495

Duke U. Medical Center, Durham, N. C.

SELECTION TECHNIQUES FOR SPACE CREWS, by A. J. Silverman, S. I. Cohen, and B. Shmavonian. [1959] [6]p. (AFOSR-TN-59-145) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-354 and National Institute of Mental Health)
AD 253128   Unclassified

Presented at Regional Research meeting of the Amer. Psychiat. Assoc., Miami, Fla., Dec. 1-3, 1958.

Also published in Amer. Jour. Psychiat., v. 115: 1110-1112, June 1959.

The criteria for crew selection is discussed including the problems of personality, motivation, and attitude. Of prime concern is the selection of those who will not respond with excessive startle and hyperalerting or panic to sudden emergencies. Thus a method of assessing CNS arousal and psychomotor functioning is important. Certain types of persons are considered undesirable, such as those with rebellious histories. It is pointed out that in the final analysis, concern with the ability of the central nervous system to rally and compensate to a stress and for the individual to maintain an ability to perceive and integrate external and internal stimuli and perform appropriate goal directed tasks is very important.

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Duke U. Medical Center, Durham, N. C.

INVESTIGATION OF PSYCHOPHYSIOLOGIC RELATIONSHIPS WITH SKIN RESISTANCE MEASURES, by A. J. Silverman, S. I. Cohen, and B. M. Shmavonian. [1959] [23]p. incl. diagrs. tables, refs. (AFOSR-TN-59-875) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)354, Public Health Service, and Wright-Patterson Air Force Base, Ohio under AF 18(600)1750) AD 233606   Unclassified

Also published in Jour. Psychosomat. Research, v. 4: 65-87, 1959.

Using a newly designed, highly sensitive and stable galvanic skin resistance (GSR) meter, basal resistance was found to be inversely related to arousal. Surgery on a dog showed an intact sympathetic nervous system is important, but blood volume shifts are not, in causing resistance drops. Moderate arousal (GSR) yielded the best tracking performance under hypotensive stress (human centrifuge). Heightened arousal had the greatest responsiveness to threshold electrical stimulation. Affectively charged words evoked arousal to the degree they had been psychiatrically judged most personally meaningful. GSR measures of arousal agreed with measured venous tone (12 Ss), blood pressure changes (15 Ss), and rises of adrenaline and noradrenaline in 15 Ss under verbal chastisement.

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Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE STUDIES OF RADIATION DAMAGE TO THE NUCLEIC ACIDS AND THEIR CONSTITUENTS, by H. Shields and W. Gordy. [1959] [31]p. incl. diagrs. (AFOSR-TN-59-53) (Bound with its Quarterly progress rept. no. 24, Nov. 1, 1958-Feb. 1, 1959; AD 212052) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)497 and Office of Ordnance Research) AD 209424
                                            Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 269-281, Feb. 1959.

As evidenced by the resonance signals, the radicals produced by irradiation of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) were different from those of any of their constituents. This suggested that radiation effects on the nucleic acids cannot be predicted from studies of mononucleotides. At room temperature the efficiency for production of detectable, long-lived radicals in the nucleic acids by ionizing radiations was low. The sharp peaking of the resonance of DNA and RNA indicated possible electron mobility or semiconductivity in the ionized acids. An 0 after-effect was absent. The resonance signal decreased with increase of temperature, indicating that thermal motions could assist electron recombination. The strong resonances obtained for the nucleic acids irradiated and observed at 77°K indicated that there was a high potential damage "frozen in."

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Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE STUDIES OF RADIATION DAMAGE TO CERTAIN LIPIDS, HORMONES, AND VITAMINS, by H. N. Rexroad and W. Gordy. [1959] [18]p. incl. diagrs. (AFOSR-TN-59-54) (Bound with its

Quarterly progress rept. no. 24, Nov. 1, 1958-Feb. 1, 1959; AD 212052) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)497, and Office of Ordnance Research) AD 209425

Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 256-269, Feb. 1959.

Microwave electron-spin resonance was used to study radiation damage (Co^{60} γ-radiation) to certain lipids, hormones, and vitamins. Compounds irradiated included cholesterol, sitosterol, cholic acid, stigmasterol, ergosterol, progesterone, testosterone propionate, pregnenolone, hexestrol, parathyroid, thyroid, calciferol, biotin, riboflavin, riboflavin 5-phosphate Na, vitamin K-5, folic acid, ascorbic acid, Ca ascorbate, testosterone, and nicotinic acid.

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Duke U. Microwave Lab., Durham, N. C.

ABSORPTION AND DISPERSION OF MICROWAVES IN FLAMES, by J. Schneider and F. W. Hofmann. [1959] [34]p. incl. diagrs. table, refs. (AFOSR-TN-59-248) Bound with its Quarterly progress rept. no. 25, Feb. 1-May 1, 1959; AD 219115) (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(600)497, California Research Corp., and Office of Naval Research) AD 212228   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 236, Apr. 30, 1959. (Title varies)

Also published in Phys. Rev., v. 116: 244-249, Oct. 15, 1959.

The dependence of the high-frequency electric conductivity and the optical constants of a weakly ionized gas on the microwave frequency, the electron-molecule collision frequency, the electron concentration, and an external magnetic field are discussed. Measurements of the electric conductivity between 23.10 and 92.96 kmc/sec indicate that the effective electron-molecule collision frequency in an actelyene-air flame is independent of the electron velocity within the limits of error. Cyclotron resonance of free electrons has been found in low-pressure flames at 24 kmc/sec. This effect can be used to determine both the concentration of free electrons and the electron collision frequency.

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Duke U. Microwave Lab., Durham, N. C.

MILLIMETER-WAVE ROTATIONAL SPECTRUM OF NO IN THE $^2\pi_{3/2}$ STATE, by P. G. Favero, A. M. Mirri,

and W. Gordy. [1959] [15]p. incl. diagrs. tables, refs. (AFOSR-TN-59-249) (Bound with its Quarterly progress rept. no. 25, Feb. 1-May 1, 1959; AD 219115) (AF 18-(600)497) AD 212229   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 290, Apr. 30, 1959.

Also published in Phys. Rev., v. 114: 1534-1537, June 15, 1959.

The J = 3/2 → 5/2 rotational transition of NO in the $^2\pi_{3/2}$ electronic state has been measured in the 1.17 mm wave region. Theory applied to these measurements combined with previous measurements on transitions of the ground $^2\pi_{1/2}$ state lead to the following values for the characteristic constants of $N^{14}O^{16}$: The rotational constant, B_0 = 50, 848.42 mc/sec, and the spin orbit coupling constant A = 122.094 cm^{-1}. The N^{14} nuclear magnetic couplings a = 83.82 mc/sec, b = 68.49 mc/sec, c = 86.34 mc/sec, and the N^{14} nuclear quadrupole couplings eQq_1 = -2mc/sec, eQq_2 = 22 mc/sec. The Λ-doubling constants p_Λ = 175.15 mc/sec, q_Λ = 1.15 mc/sec. (Contractor's abstract)

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Duke U. [Microwave Lab.] Durham, N. C.

STIMULATED EMISSION OF RADIATION BY ELECTRONS IN A MAGNETIC FIELD: RELATIVISTIC EFFECTS, by J. Schneider. [1959] 8p. (AFOSR-TN-59-862) (Bound with its Quarterly progress rept. no. 26, May 1-Aug. 1, 1959) (AF 18(600)497) AD 235439   Unclassified

The proof of the equation:

$$W_j = m_0 c^2 \left(1 + 2(j + 1/2 \frac{\hbar \omega_c}{m_0 c^2})^{1/2} - m_0 c^2 \right.$$

representing the energy levels of a relativistic electron in a magnetic field is shown. Summarily, monoenergetic electrons in a magnetic field can undergo stimulated emission of radiation if the width of the cyclotron resonance line is very small.

502

Duke U. [Microwave Lab.] Durham, N. C.

STIMULATED EMISSION OF RADIATION BY ELECTRONS IN A MAGNETIC FIELD, by J. Schneider. [1959] [8]p. incl. diagr. (AFOSR-TN-59-863) (Bound with its Quarterly progress rept. no. 26, May 1-Aug. 1, 1959) (AF 18(600)497) AD 235439   Unclassified

Monoenergetic electrons in a magnetic field undergoing absorption and emission are discussed. If the relaxation time is independent of the energy, the electrons will always absorb electromagnetic energy; however, if the relaxation time is energy dependent, the electrons undergo stimulated emission.

503

Duke U. [Microwave Lab.] Durham, N. C.

STIMULATED EMISSION OF RADIATION BY RELATIVISTIC ELECTRONS IN A MAGNETIC FIELD, by J. Schneider. [1959] [4]p. incl. diagr. (AFOSR-TN-59-864) (Bound with its Quarterly progress rept. no. 26, May 1-Aug. 1, 1959) (AF 18(600)497) AD 235439
Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 504-505, June 15, 1959.

A formula is deduced for the cyclotron resonance curve for relativistic electrons. For small collision frequency a portion of the curve may lie below the frequency axis, i.e., there may be stimulated emission rather than absorption. The use of this effect in a new type of maser is mentioned.

504

Duke U. [Microwave Lab.] Durham, N. C.

MILLIMETER WAVE SPECTRUM AND STRUCTURE OF FORMYL FLUORIDE, by P. [G.] Favero, A. M. Mirri, and J. G. Baker. [1959] [5]p. incl. tables. (AFOSR-TN-59-865) (Bound with its Quarterly progress rept. no. 26, May 1-Aug. 1, 1959) (AF 18(600)-497) AD 235439
Unclassified

Also published in Jour. Chem. Phys., v. 31: 566-567, Aug. 1959.

The rotational spectrum of formyl fluoride was studied in the frequency range 90-160 kmc/sec. The spectrum observed indicates a planar molecule having parameters in good agreement with those obtained by electron diffraction.

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Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF ALANINE: SECOND-ORDER EFFECTS IN FREE RADICAL RESONANCES, by I. Miyagawa and W. Gordy. [1959] [48]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1208) (Bound with its [Quarterly progress] rept. no. 27, Aug. 1-Nov. 1, 1959) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)497] and Office of Ordnance Research)
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 260, Apr. 30, 1959. (Title varies)

Also published in Jour. Chem. Phys., v. 32: 255-263, Jan. 1960.

The electron spin resonance of single crystals of l- and d-alanine has been observed at $T = 300°K$ and analyzed for different orientations of the crystal in the magnetic field and at several microwave frequencies ranging from 9 kmc/sec to 34 kmc/sec. The stable free radical produced by the irradiation is proved to be of the form CH_3CHR, where R is a group which has no nuclei with detectable coupling. The hydrogens of the CH_3 group of the radical are shown to have equivalent, isotropic coupling of 26 gauss each, essentially independent of the frequency of observation. This CH_3 group coupling is interpreted as arising from s orbital spin density of the hydrogens, via hyperconjugation. The hydrogen of the CH group has both an isotropic, Fermi term, $A_f = 20$ gauss, arising from s orbital density on the hydrogen, and an anisotropic term $A_\mu = 7$ gauss arising from dipole-dipole interaction of the proton moment with the electron spin density, ρ_C, on the carbon. Although the signs of A_f and A_μ could not be learned, they are shown to be of opposite sign. Hence the spin density is negative on either H or C. Principal values of the CH coupling are $A_1 = 7$ gauss, $A_2 = A_3 = 27$ gauss. The value of ρ_C is shown to be 0.75 approx. For certain orientations of the crystal the CH coupling becomes equal to the CH_3 coupling, and a quintet pattern is observed. Interesting second-order transitions are observed which for the [001] orientation become in the region of 24 kmc/sec as strong as the normal first-order transitions. A general theory is developed which accounts satisfactorily for these second-order effects which are probably of consequence in the electron spin resonance patterns of numerous other free radicals trapped within solids. (Contractor's abstract)

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Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE STUDIES OF MECHANISMS FOR CHEMICAL PROTECTION FROM IONIZING RADIATION, by W. Gordy and I. Miyagawa. [1959] [48]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1209) (Bound with its [Quarterly progress] rept. no. 27, Aug. 1-Nov. 1, 1959) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)497] and Office of Ordnance Research)
Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 384, Aug. 27, 1959. (Title varies)

Also published in Radiation Research, v. 12: 211-229, Mar. 1960.

Small concentrations of the sulfur-containing chemical protectors - cysteine, cysteamine, AET, glutathione, $Na_2S_2O_4$ - in solid solution in certain proteins are found to alter completely the form of the electron spin resonance produced by ionizing radiations in the proteins. For example, solutions of only 1/2 of 1% by weight of cysteine or $Na_2S_2O_4$ in zein (or 2 molecules of solute per protein molecule) produced resonances when γ-irradiated which are entirely different from that of pure zein when γ-irradiated. It is believed that these sulfur protectors form complexes with the proteins they protect and thus absorb the ionization or damage that would occur in the "unprotected" protein. The results indicate that an electron hole or electron spin density can migrate through certain segments of polypeptide chains of proteins. (Contractor's abstract)

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Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE OF FREE RADICALS FORMED BY IRRADIATION OF AMINO ACIDS AND PROTEINS AT 77°K (Abstract), by F. Patten and W. Gordy. [1959] [1]p. [AF 18(600)497]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 290, Apr. 30, 1959.

When γ irradiated and observed at 77°K, many amino acids, peptides, and proteins were found to give electron spin resonance patterns which differ markedly from those obtained when the samples were irradiated at 300°K and then cooled to 77°K. When certain of these samples irradiated at 77°K were allowed to warm, their patterns at 300°K were found to become like those obtained by irradiation at 300°K. When these samples were cooled again to 77°K, they did not regain their original patterns. From these results it is concluded that temperature often influences strongly the kind of radicals produced or stabilized in organic solids and that the radicals observed at room temperature are often not the primary ones produced by the irradiation.

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Duke U. [Microwave Lab.] Durham, N. C.

HYPERFINE STRUCTURE IN THE ROTATIONAL SPECTRA OF FREE RADICALS (Abstract), by J. G. Baker. [1959] [1]p. [AF 18(600)497]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 290, Apr. 30, 1959.

A classical approach is used to derive the Hamiltonian for hyperfine interactions between rotation, unpaired electronic spins and nuclear spins in molecules of the free radical type. The method of Van Vleck is then applied in order to insert these interactions into the secular determinant giving the rotational energy levels. A slight modification in the normal diagonalization of the asymmetric rotor energy levels results in determinants of order up to $(2S + 1)$ for the hyperfine energy splittings corresponding to each value of the total angular momentum F. It is also possible to determine the Stark and Zeeman effects in the presence of this hyperfine structure. This theory has been used to give a partial explanation of the published microwave spectrum of NO_2, and also in microwave studies of ClO_2, the only remaining stable free radical for which no accurate structural determination exists. Further work on these 2 gases is now in progress in the millimeter wave region to obtain more detailed information about their molecular structure.

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Duke U. [Microwave Lab.] Durham, N. C.

DETERMINATION OF THE COLLISION FREQUENCY OF FREE ELECTRONS IN FLAMES BY MICROWAVE ABSORPTION MEASUREMENTS, by F. W. Hofmann, H. Kohn, and J. Schneider. [1959] 3p. (Bound with its Quarterly progress rept. no. 28, Nov. 1, 1959-Feb. 1, 1960) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)497] and Office of Naval Research under Nonr-118105)   Unclassified

Also published in Zeitschr. Naturforsch., v. 14A: 998, Nov. 1959.

In order to determine the concentration of free electrons in flame gases from microwave attenuation measurements it is necessary to know the collision frequency ν of the electrons. A new determination of the electron collision frequencies in flames of different temperatures has been made. The frequency dependence of the attenuation was measured in the range between 23,100 and 92,960 mc, using 7 different frequencies. These measurements resulted in an electron frequency of 26 x 10^{10} sec^{-1}. The shape of the dispersion curve indicated that, within the experimental error, the electron collision frequency is independent of the electron velocity. Subsequent measurements at 24,665 mc and at 48,250 mc with flames of various temperatures and compositions showed that ν does not depend strongly on the flame conditions. In a propane-air flame of 2100°K, ν was found to be 27 x 10^{10} sec^{-1}. In acetylene flames of 2500°K and 2750°K a value of ν = 20 x 10^{10} sec^{-1} resulted in both cases.

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Duke U. School of Medicine, Durham, N. C.

[BASIC MECHANISMS INVOLVED IN VASODEPRES-
SOR FAINTING], by J. V. Warren. Final rept. [1959]
10p. incl. refs. (AFOSR-TR-59-102) (AF 18(600)1542)
AD 225127; PB 143505   Unclassified

A comprehensive study of the nature of vasodepressor
syncope (the common faint) was undertaken. A critical
review of the available information regarding this phe-
nomenon was carried out. In addition, experimental
studies aimed primarily at the circulatory nature of
vasodepressor syncope and, in particular, dealing with
the precipitating and predisposing factors, has lead to
observations on the effects of various humoral sub-
stances such as norepinephrine on the vascular sys-
tem, as well as the effect of drugs such as atropine
and isoproterenol. Additional observations were made
on the nature of abnormal heart sounds in a variety of
clinical conditions. (Contractor's abstract)

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Duke U. School of Medicine, Durham, N. C.

THE EFFECT OF ATROPINE ON THE FLOW-TIME-
PRESSURE RELATIONSHIPS IN THE CENTRAL AND
PERIPHERAL VENOUS CIRCULATIONS, by R. J.
Gorten, A. M. Weissler, and J. C. Gunnels. [1959]
[2]p. [AF 18(600)1542]   Unclassified

Published in Clin. Research, v. 7: 237-238, Apr. 1959.

Flow-time relationships in venous and central circula-
tion before and after atropine administration were
studied. Time concentration curves were determined
from brachial arterial samples in supine, post-absorp-
tive, young adult male subjects, following the simultane-
ous injections of indicator substances into the superior
vena cava (T-1824) and an antecubital vein (iodinated
I-131 albumin) before and 2 to 4 min after atropine
sulfate (2 mg intravenously). Simultaneous outputs
and mean circulation times (MCT) from central and
peripheral venous sites were calculated. In 7 studies,
in which simultaneously determined outputs from 2 in-
jection sites agreed within 10%, atropine-induced aug-
mentation averaged 46% (range 24 to 74%) over an a

average control index of 3.3 L/mm/M^2 (range 3.1 to
3.8) at a time when CVP diminished an average 2.0 mm
Hg (range 0.3 to 3.4). When indicator was injected into
antecubital vein, atropine shortened the MCT out of
proportion to the increased cardiac output; with central
injection, these 2 factors changed to the same degree.
The amount of shortening of the MCT from the ante-
cubital vein correlates well (r = 0.73) with accompany-
ing falls in CVP. This finding indicates either a de-
crease in venous volume between the 2 injection sites
or an uneven effect of atropine on the circulation, so
that the rate of flow at the site of injection is increased
out of proportion to the actual measured flow. If this

effect is a true volume shift, values in our study indicate
this to be a decrease of 474 cc (range 260 to 710). (Con-
tractor's abstract)

512

Duke U. School of Medicine, Durham, N. C.

REFLEX VENOMOTOR ALTERATIONS DURING
EXERCISE AND HYPERVENTILATION, by F. L.
Merritt, Jr. and A. M. Weissler. [1959] [1]p. [AF 18-
(600)1542]   Unclassified

Published in Clin. Research, v. 7: 238, Apr. 1959.

The vascular system of a forearm was isolated from
the general circulation by a pneumatic cuff on the
brachium inflated to suprasystolic levels. Simultaneous
observations of pressure in such an isolated forearm
venous segment and in the opposite antecubital vein and
brachial artery were made in 14 normal subjects during
a 15 to 30 sec interval of leg exercise on a bicycle
ergometer. In each subject, an immediate pressor re-
sponse in the isolated vein segment was noted with the
beginning of exercise, reaching a peak level of 5 to 23
cm water (average -10 cm) in 10 to 30 sec and continu-
ing 10 to 30 sec after completion of exercise. Venous
pressure changes in the opposite unisolated antecubital
vein were of similar direction but lesser magnitude.
To separate the effects of some of the known components
of exercise, observations of venomotor changes were
made during hyperventilation, single deep inspiration,
passive leg motion, emotional anticipation of exercise,
and reactive hyperemia of the lower extremities. Only
hyperventilation and single deep inspiration elicited
consistent veno-constrictor activity, the magnitude of
which approached but did not equal that seen during
exercise. In 3 subjects an infusion of a ganglionic block-
ing agent (Arfonad) resulted in marked attenuation or
complete obliteration of the reflex responses. (Con-
tractor's abstract)

513

Duke U. School of Medicine, Durham, N. C.

VASODEPRESSOR SYNCOPE, by .. M. Weissler and
J. V. Warren. [1959] [9]p. [AF 18(600)1542]
          Unclassified

Published in Amer. Heart Jour., v. 5: 786-794, May
1959.

It was concluded in this report that vasodepressor (the
common faint) is an acute episode characterized by a
sudden loss of consciousness. It is associated with a
fall in arterial pressure which may be attributed to a
sudden decrease in peripheral resistance secondary to
generalized vascular dilatation and occurring in a
setting in which the heart fails to compensate normally
by an increased output. As a consequence, there is an
inadequate cerebral blood flow, leading to loss of

consciousness. In apparent attempts to re-establish circulatory equilibrium, a marked but ineffectual autonomic display ensues, the afferent stimuli for which are as yet uncertainly known. The predominant picture is one of discoordinated circulatory responses which might best be termed "acute circulatory disorganization." (Contractor's abstract)

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Duke U. School of Medicine, Durham, N. C.

CIRCULATORY AND ELECTROENCEPHALO-GRAPHIC CHANGES ASSOCIATED WITH LOSS OF CONSCIOUSNESS IN VASODEPRESSOR SYNCOPE (Abstract), H. R. Karp, A. M. Weissler, and A. Heyman. [1959] [1]p. [AF 18(600)1542]   Unclassified

Presented at Fifty-first annual meeting of the Amer. Soc. for Clinical Invest., Atlantic City, N. J., May 4, 1959.

Published in Jour. Clin. Invest., v. 38: 1016, June 1959.

Recent interest in circulatory adaptation to rapid acceleration has led to a reinvestigation of the changes in arterial pressure, pulse rate and the electroencephalogram (EEG) as predictive indices of loss of consciousness in posturally induced vasodepressor syncope. Vasodepressor syncope was induced in 10 normal young male subjects by sodium nitrite (180 mg orally) combined with 60° head-up tilt. Continuous EEG recordings were made simultaneously with pulse and direct arterial blood pressure determinations. Before onset of syncope, the blood pressure showed a progressive reduction associated with autonomic dysfunction, e.g., sweating, pallor and nausea. Overt disturbances of mental function were a late phenomena and coincided with the appearance of sporadic low voltage theta waves in the EEG. Loss of consciousness developed 4 to 10 sec later and was accompanied by a profound reduction in mean arterial pressure to an average of 31 mm Hg (range, 22 to 42) and by high voltage delta waves in the EEG. At this time the mean arterial pressure had fallen approx 70% from control levels to a mean of 25 mm Hg and the cerebral blood flow, as estimated by cerebral arteriovenous oxygen differences, showed a 50% reduction. The development of bradycardia was a late but inconsistent finding. These studies demonstrate a remarkable adaptability of the central nervous system of normal subjects to withstand severe hypotension. The most reliable indices for predicting loss of consciousness appeared to be the appearance of theta activity in the EEG and a fall in mean arterial pressure below 45 mm Hg. (Contractor's abstract)

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Duke U. School of Medicine, Durham, N. C.

THE HEMODYNAMIC EFFECTS OF ISOPROTERE-NOL IN MAN WITH OBSERVATIONS ON THE ROLE

OF THE CENTRAL BLOOD VOLUME, by A. M. Weissler, J. J. Leonard, and J. V. Warren. [1959] [5]p. [AF 18(600)1542]   Unclassified

Published in Jour. Lab. and Clin. Med., v. 53: 921-925, June 1959.

The cardiac output responses to a constant infusion of isoproterenol (Isuprel, isopropyl norepinephrine) were studied in normal subjects in the recumbent and passive head-up tilt postures. Significant elevations in cardiac output and stroke volume associated with slight increases in pulse rate were observed in recumbent subjects. In tilted (head-up) subjects the minute and stroke volume responses to isoproterenol infusions were of significantly less magnitude, while the pulse rate increases were of similar degree. These data are consistent with the view that as a consequence of the peripheral pooling of blood and depletion of the thoracic reservoirs in the upright posture, there is limitation on cardiac output and stroke volume responsiveness. This effect is less, however, with an agent (isoproterenol) having a positive inotropic action than with one acting predominantly on heart rate (atropine). (Contractor's abstract)

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Duke U. School of Medicine, Durham, N. C.

PULMONARY BLOOD VOLUME DETERMINED BY A RADIOACTIVE TRACER TECHNIQUE, by A. M. Weissler, B. H. McGraw, and J. V. Warren. [1959] [4]p. [AF 18(600)1542]   Unclassified

Published in Jour. Appl. Physiol., v. 14: 531-534, July 1959.

In the present study, a semi-quantitative technique for assaying shifts in intrapulmonary blood volume is described. The method consists of the external monitoring of radioactivity over the anterior thorax after the intravenous administration of radioactive iodinated albumin utilizing a sensitive scintillation counter with a focussing collimator attachment. While this method does not yield the quantitative data of the indicator dilution and body plethysmographic techniques, it offers the advantage of confining observations to the intrapulmonary rather than the intrathoracic blood volume. Employing this technique the effects of the upright posture, peripheral venous pooling and the Vaisalva maneuver have been studied. A fall in estimated pulmonary blood volume was noted with each procedure averaging 28%, 9% and 11%, respectively, below control levels. (Contractor's abstract)

517

Duke U. School of Medicine, Durham, N. C.

CARDIOVASCULAR RESPONSES IN EXPERIMEN-TALLY INDUCED ALTERATIONS OF AFFECT, by M.

D. Bogdonoff, J. J. Combs, Jr. and others. [1959] [7]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1542 and National Institutes of Health)   Unclassified

Published in Circulation, v. 20: 353-359, Sept. 1959.

Although alterations in emotional arousal have long been associated with changes in cardiovascular dynamics, the precise quantitative relationship has not been fully detailed. Independent assessment of the emotional change was felt to be a necessary component of a quantitatively oriented study. The variously described responses for "anxiety" and "anger" might better be re-explored in such a manner. The emotional arousal was experimentally produced in the laboratory. Measures of pulse, arterial blood pressure, and cardiac output were conducted both before and during the change in affect evoked by the laboratory stimulus. (Contractor's abstract)

Enrico Fermi Inst. for Nuclear Studies, Chicago, Ill.
    see Chicago U. Enrico Fermi Inst. for Nuclear Studies,
    Ill.

518

Experiment, Inc., Richmond, Va.

THE SPARK IGNITION OF DUST CLOUDS, by L. E.
Line, Jr., H. A. Rhodes, and T. E. Gilmer, Jr. [1959]
[5]p. incl. diagrs. table, refs. (AF 18(600)1508)
                                                    Unclassified

The spark ignition of lycopodium dust clouds suspended
in oxygen-nitrogen mixtures has been studied under con-
trolled conditions. Unlike homogeneous fuel-air mix-
tures, the spark ignition of lycopodium cannot be char-
acterized solely by a minimum spark ignition energy as
determined in the usual way for gases. This energy ap-
pears to be strongly dependent upon the electrical char-
acteristics of the spark circuit that affect the discharge
time. As the discharge time increases, the ease of ig-
nition (measured by the min oxygen concentration or
min stored condenser energy for ignition) goes through
a max. A tentative explanation for the increase in ease
of ignition is put forward in terms of the disturbance
of the dust cloud by the spark discharge prior to ignition.
Data comparing the ease of igniting confined and uncon-
fined dust clouds also are presented and discussed.

A. Nagy - 65

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[Fairchild Engine and Airplane Corp.] Fairchild Engine
Div., Deer Park, N. Y.

PROPERTIES OF OBLIQUE DETONATION WAVES, by
W. Chinitz, L. C. Bohrer, and K. M. Foreman. Apr. 15,
1959, 1v. incl. diagrs. table. (AFOSR-TN-59-462)
(AF 49(638)15) AD 215267; PB 142018   Unclassified

The 2-dimensional steady flow equations for oblique
detonation waves are solved for the conditions across
the wave in terms of the initial Mach number, the heat
addition, and the wave angle. Using an IBM digital
computer, the resulting equations are solved over a
range of the independent variables. Graphs are pre-
sented which show the results of this computation.
(Contractor's abstract)

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Fairchild Engine and Airplane Corp. Fairchild Engine
Div., Deer Park, N. Y.

EXPLORATORY STUDIES OF COMBUSTION IN
SUPERSONIC FLOW, I. PLANE DETONATION WAVES.
II. OBLIQUE DETONATION WAVES, by R. A. Gross.
June 15, 1959, 56p. incl. illus. diagrs. refs. (AFOSR-
TN-59-587) (AF 49(638)15) AD 216769; PB 142039
Unclassified

Methods for releasing chemical energy in supersonic
flow were investigated. A study was made of (1) stand-
ing-stable detonation waves, both strong and Chapman-
Jouguet types, (2) standing-stable oblique detonation
waves, (3) combustion in a boundary layer on a flat
plate immersed in a supersonic stream, (4) combustion
behind a wedge-shaped flame holder in supersonic flow,
and (5) thermal ignition properties of mixtures of hy-
drogen with air and methane with air. An ignition
hysteresis effect was found which permitted the detona-
tion studies to be conducted over a wide range of initial
stagnation temperatures. The detonation wave front
was remarkably plane, although the flow field immedi-
ately behind the wave was subsonic and complex. Steady
oblique detonations were produced in the supersonic
test section. These waves also exhibited the ignition
hysteresis effect. However, the flow field downstream
of the wave was, under many conditions, still supersonic.

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Fairchild Engine and Airplane Corp. Fairchild Engine
Div., Deer Park, N. Y.

SOME PROPERTIES OF A HYDROGEN PLASMA, by
C. L. Eisen and R. A. Gross. June 1959 [37]p. incl.
diagrs. (AFOSR-TN-59-588) (AF 49(638)15)
AD 216770; PB 144449   Unclassified

Also published in Proc. Third Biennial Gas Dynamics
Symposium on Dynamics of Conducting Gases,

Evanston, Ill. (Aug. 24-26, 1959), Evanston, North-
western U. Press, Mar. 1960, p. 15-24. (AFOSR-TR-
60-87)

The chemical equilibrium composition of a hydrogen
mixture is determined over the temperature range from
$10^3 °$K to $10^6 °$K and pressures from 10^{-6} to 10^6 atm.
The species recognized are, H_2, H, H^+, H^- and e^-.

Equilibrium and frozen values of γ, C_p and the speed of
sound are presented in the dissociation and ionization
regimes. Electrical conductivity and bremsstrahlung
power radiation data are also given. (Contractor's
abstract)

522

Fairchild Engine and Airplane Corp. Fairchild Engine
Div., Deer Park, N. Y.

A DETONATION WAVE HYPERSONIC RAMJET, by
W. H. Sargent and R. A. Gross. June 1959, 40p. incl.
illus. diagrs. refs. (AFOSR-TN-59-589) (AF 49(638)-
15) AD 216811; PB 142244   Unclassified

Also published in Proc. Second Symposium on Ad-
vanced Propulsion Concepts, Boston, Mass. (Oct. 7-8,
1959), Boston, v. 2: 3-28, 1959. (AFOSR-637)

Also published in ARS Jour., v. 30: 543-549, June 1960.

This report examines the performance of a hypersonic
ramjet having a detonation wave combustion process.
Flight speeds from Mach 2.5 to 10 are examined. En-
gine performance characteristics are presented and
compared with those of a conventional ramjet. (Con-
tractor's abstract)

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[Fairchild Engine and Airplane Corp.] Fairchild Engine
Div., Deer Park, N. Y.

A DIRECT NUCLEAR ELECTROGENERATOR. ANAL-
YSIS OF CYLINDRICAL ELECTRODE CONFIGURA-
TION, by A. Schock. June 15, 1959, 139p. incl. diagrs.
tables, refs. (AFOSR-TN-59-590) (AF 49(638)15)
AD 216812   Unclassified

A system for the direct conversion of nuclear fission
energy to high voltage electricity is examined. The
system is based on the motion of highly charged fission
fragments counter to a strong electric field. In this
manner, part of the fragments' kinetic energy is con-
verted into potential (electric) energy. The superiority
of cylindrical over plane electrodes is explained, and
the effect of various geometric and operating variables
on system performance is analyzed. For various con-
ditions, it is possible to achieve conversion efficiencies
up to 13%, electric power densities up to 4.5 megawatts/
cu m of reactor core, and neutron multiplication factors

up to 2.1. However, these 3 performance parameters are shown to be mutually interdependent, and the choice of a design point must represent a compromise between their respective maximization. The optimum design parameters will depend on the intended application of the system. (Contractor's abstract)

524

[Fairchild Engine and Airplane Corp.] Fairchild Engine Div., Deer Park, N. Y.

RESEARCH ON SUPERSONIC COMBUSTION, by R. A. Gross. [1959] [2]p. incl. illus. diagr. (AF 49(638)15)
Unclassified

Published in ARS Jour., v. 29: 63-64, Jan. 1959.

A means of releasing chemical energy steadily in supersonic flow was devised to study combustion waves and their stability. It was found possible to produce strong steady detonations at very high propagation speeds, with fast chemical reaction rate, with wide fuel-oxidizer combustion capability, and with high heat release rate.

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Fairchild Engine and Airplane Corp. Fairchild Engine Div., Deer Park, N. Y.

SMOOTH INTERPOLATION, by T. J. Rivlin. [1959] [4]p. (AF 49(638)15) Unclassified

Published in SIAM Rev., v. 1: 60-63, Jan. 1959.

Given n distinct points (x_i, y_i), $i = 1, \ldots, n$, there is a unique polynomial of degree n, $P(x)$, which passes through these points and for which the arc length $\int_{x1}^{x_n}$ $(1 + (P'(x))^{1/2} dx$ is minimum. This polynomial is called a "smooth" interpolant, and is determined in terms of the zero of a certain transcendential equation. Several examples are presented which were computed from an IBM 650 program. (Math. Rev. abstract)

526

Fairchild Engine and Airplane Corp. Fairchild Engine Div., Deer Park, N. Y.

RESEARCH ON SUPERSONIC COMBUSTION, by R. A. Gross. Final rept. Apr. 1-June 30, 1959, 5p. incl. refs. (Technical status rept. no. 11) (AF 49(638)15)
Unclassified

This report summarizes the additional experimental aerothermodynamic data gathered to date on standing, normal detonation waves. The experiment included installing a remote activated movable probe in the supersonic section. Axial and vertical distribution of the fuel/air ratio, total pressure, total temperature and products of combustion data were obtained. Detonation waves were also obtained by using methane and air. These possess the same general considerations as the hydrogen detonation. Spectroscopic studies were conducted to examine the molecular changes in properties across the wave. Oblique detonation waves were also generated, observed, and definitely confirmed in the supersonic tunnel for the 1st time.

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Fairchild Engine and Airplane Corp. Fairchild Engine Div., Deer Park, N. Y.

A HIGH-TEMPERATURE, STEADY-FLOW, SUPER-SONIC TUNNEL, by R. A. Gross. [1959] [2]p. incl. illus. table. (AF 49(638)15) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 676-677, Oct. 1959.

Details of the construction, characteristics, and operating experiences with this tunnel are described. The tunnel is designed to function at M3 and has a flow area of 3 x 6 in. When initial operating experience showed that the heat transfer design was conservative, a hydrogen injection system was installed in the plenum chamber. By burning the hydrogen, a max operating temperature of 4800°F can theoretically be obtained. The present manual control permits a temperature change of 1000°F per sec.

528

Florida State U. Dept. of Mathematics, Tallahassee.

OPENNESS OF THE DERIVATIVE OF A COMPLEX FUNCTION, by R. L. Plunkett. Sept. 1959, 8p. (AFOSR-TN-59-1120) (AF 49(638)598) AD 231818; PB 145769 Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 671-675, Oct. 1960.

Using the results and techniques of topological analysis, the openness of the derivative of a complex function is proved here in 2 ways, each dependent on the uniform differentiability of any differentiable function on compact subsets of its region of definition. (Contractor's abstract)

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Florida State U. [Dept. of Physics] Tallahassee.

"OVER AND UNDER" MAGNETIC ANALYZER. Sept. 1959, 8p. incl. tables. (Technical note no. 1) (AFOSR-2870) (AF 49(638)427) Unclassified

By mounting 2 magnetic spectrometers 1 above the other such that they may rotate with respect to each other and with respect to the beam, yields of charged particles with radically different gyromagnetic ratios or momenta may be simultaneously measured at 2 independent angles. Thus, precision excitation curves and angular distributions may be taken for any 2 charged particle exit channels. In the energy range of the tandem Van de Graaff accelerator, at least 2 such channels are open. Ambiguities in nuclear energy level parameters are often removed more easily by observing the angular distribution of 2 reaction products than by detailed study of 1 product. In addition to this unique advantage, many of the advantages of the conventional multi-angle magnets accrue at a fraction of the capital outlay. When broad range analyzers are used for the component magnets, several exit channels may be simultaneously detected in each analyzer, or the device may be used as a 2 angle broad range spectrograph. Design characteristics for the magnetic analyzer and a research program using this analyzer in conjunction with the Florida State U. tandem Van de Graaff accelerator are presented. (Contractor's abstract)

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Florida State U. [Dept. of Physics] Tallahassee.

EVIDENCE FOR COLLECTIVE EXCITATION IN Ca^{40} (Abstract), by R. H. Davis. [1959] [1]p. [AF 49-(638)427] Unclassified

Presented at meeting of the Amer. Phys. Soc., Loyola U., New Orleans, La., Apr. 9-11, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 387, Aug. 27, 1959.

In spite of the doubly closed shell structure of Ca^{40}, the interpretation of the excited states of this nucleus in terms of the shell model is somewhat unsatisfactory because of the need to invoke a 2-nucleon excitation to explain the O^+ first excited state and lack of uniqueness in the assignments for higher states. The low-lying states may also be interpreted as vibrational states according to the collective model, but again the O^+ first excited state requires some refinement in the model, unless it is simply a breathing mode excitation. Evidence for collective effects in the first 3 states is found in the correlation between excitation energies of states observed in the elastic scattering of protons from Ca^{40} with those observed in the inelastic proton scattering experiments. Maxima in the inelastic scattering strength closely correspond to a recurrence of the low-lying states in Sc^{41} above a Ca^{40} core in 1 of its first 3 excited states. This correlation is simply explained if the core states are collective in character.

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Florida State U. Dept. of Physics, Tallahassee.

ON THE IMAGINARY OPTICAL POTENTIAL, by R. H. Lemmer, T. A. J. Maris, and Y. C. Tang. [1959] [6]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)427] and Atomic Energy Commission) Unclassified

Published in Nuclear Phys., v. 12: 619-624, Sept. 1959.

The imaginary part of the nuclear optical potential for nucleons is investigated in a semi-quantitative way. For simplicity, harmonic oscillator wave functions have been used to perform calculations for O^{16} and Ca^{40}. Results indicate that surface absorption is quite important for incident energies up to about 60 mev.

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Florida U. Dept. of Chemistry, Gainesville.

THE FORMATION OF LINEAR POLYMERS FROM DIENE MONOMERS BY A CYCLIC POLYMERIZATION MECHANISM. III. A STUDY OF THE STRUCTURE OF CYCLIC POLYMERS OF CERTAIN UNSYMMETRICAL 1,6- AND 1,7-DIENES, by M. D. Barnett, A. Crawshaw, and G. B. Butler. [1959] [4]p. incl. diagrs. tables, refs. (AFOSR-TN-59-431) (AF 18(603)116) AD 214793 Unclassified

Presented at meeting of the Polymer Chem. Div. of the Amer. Chem. Soc., Boston, Mass., Apr. 5-10, 1959.

Abstract published in 135th meeting of the Amer. Chem. Soc. Abstracts of papers, 1959, p. 17-S.

Also published in Jour. Amer. Chem. Soc., v. 81: 5946-5949, Nov. 20, 1959.

The methyl alkyl, methyl 2-butenyl and methyl 3-butenyl mixed esters of maleic and fumaric acid have been synthesized and polymerized in bulk using benzoyl peroxide to afford a series of low molecular weight linear polymers containing 37-77% residual unsaturation. The properties of the polymers indicated that polymerization had occurred by an intramolecular-intermolecular mechanism leading, in part, to a poly-[3(5)-methylene-4-carbomethoxy-δ-valerolactone] or (in the case of the 3-butenyl esters) to a poly-[3(5)-methylene-4-carbomethoxy-ε-caprolactone] structure. In addition, poly-(methyl allyl maleate) and poly-(methyl 2-butenyl maleate) showed absorption at 1780 cm^{-3} characteristic of a γ-butyrolactone ring system. This band was lacking in the corresponding fumarates. Possible explanations of the various modes and relative degrees of cyclization in the polymers are presented. (Contractor's abstract)

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Florida U. Dept. of Chemistry, Gainesville.

THE FORMATION OF LINEAR POLYMERS FROM
DIENE MONOMERS BY A CYCLIC POLYMERIZATION
MECHANISM. IV. THE SYNTHESIS AND POLYMERI-
ZATION STUDIES OF SOME DOUBLY-UNSATURAT-
ED, UNSYMMETRICAL MONOMERS, by M. D. Barnett
and G. B. Butler. May 1960 [2]p. incl. tables.
(AFOSR-TN-59-810) (AF 18(603)116) AD 240034
Unclassified

Also published in Jour. Org. Chem., v. 25: 309-310,
Feb. 1960.

Allyl crotonate (Ia), crotyl crotonate (Ib), β-methallyl
crotonate (Ic), propargyl crotonate (Id), N-allyl crotona-
mide (Ie), allyl vinylacetate (IIa), crotyl vinylacetate
(IIb), and β-methallyl vinylacetate (IIc) were prepared.
Polymerization experiments were carried out in bulk
under dry nitrogen with 5- to 10-g monomer samples
and 2 wt-% of either benzoyl peroxide or azobisisobuty-
ronitrile as initiators. Benzoyl peroxide-initiated reac-
tions were run at 100°; those initiated by azobisisobuty-
ronitrile were maintained at 75°. Only Ia and Ic gave
solid, titratable polymers; Ib, IIb, and Ie gave no poly-
meric material; IIa, IIc and Id afforded only viscous
oils which resisted crystallization. Gel time for Ia was
110 hr; there was no gelation for Ic after 32 days at 100°
with 2 wt-% Bz_2O_2. Cyclization values were 25 and 31%
for Ia and Ic, respectively. This is reflected in the
great difference in reactivities between the alcohol and
acid bonds; values for residual alcohol and acid bonds
of Ia and Ic are 15% (alcohol), 60% (acid) and 11% (alco-
hol) and 58% (acid), respectively. Infrared spectros-
copy revealed absorption in the C = C stretching (1640
to 1655 cm^{-1}) and carbonyl (1725 to 1740 cm^{-1}) regions
and a strong band at 1770 to 1772 cm^{-1} characteristic
of a 5-membered lactone ring.

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Florida U. Dept. of Chemistry, Gainesville.

A STUDY OF POLYMERIZATION BY AN ALTERNAT-
ING INTRAMOLECULAR-INTERMOLECULAR CHAIN
PROPAGATION MECHANISM, by M. D. Barnett.
Final rept. Sept. 16, 1956-Sept. 15, 1959, 8p. incl.
tables. (AFOSR-TR-59-146) (AF 18(603)116)
AD 228268; PB 145435   Unclassified

The peroxide-initiated polymerization of diallyl- and
diallyldimethylammonium bromide has given saturated,
linear, soluble polymers containing recurring N-sub-
stituted piperidinium halide units alternating along the
chain with methylene groups. The structure of the
polymers was confirmed by degradative cleavage of the
piperidinium rings. Acrylic anhydride has been poly-
merized in solution to afford a series of saturated,
linear polymers whose molecular weights ranged from

a few thousand up to 95,000. The properties of the
polymers showed that polymerization had occurred by
an intramolecular-intermolecular mechanism leading
to a poly[3(5)-methylene-glutaric anhydride] structure.
The poly[acrylic acid] obtained by hydrolysis of a
poly[acrylic anhydride] was shown by x-ray diffraction
patterns to have a much more regular structure than
normal poly[acrylic acid]. Poly[methacrylic anhydride]
has been prepared from methacrylic anhydride and
found to have properties similar to poly[acrylic anhy-
dride]. The methyl allyl, methyl 2-butenyl, and methyl
3-butenyl mixed esters of maleic and fumaric acid have
been synthesized and polymerized in bulk to afford a
series of low molecular weight polymers containing 37-
77% residual unsaturation. This indicated that the ap-
proximate percent cyclization in the various polymers
ranged from 23 to 63%. Although the cyclic portions of
the polymers were composed predominately of 6- and 7-
membered lactone rings, the infrared spectra of
poly[methyl allyl maleate] and poly[methyl 2-butenyl
maleate] also showed the presence of 5-membered lac-
tone rings. Several unsymmetrical dienes were pre-
pared and subjected to free-radical polymerization
conditions. (Contractor's abstract)

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Fordham U. Dept. of Chemistry, New York.

NUCLEOPHILIC REACTIONS OF SEMIIONIC OXY-
GEN. II. A NOVEL PREPARATION OF ETHYL GLY-
OXYLATE FROM ETHYL BROMOACETATE AND DI-
METHYL SULFOXIDE. THE STOICHIOMETRY AND
THE SULFUR-CONTAINING BY-PRODUCTS, by J. M.
Tien and I. M. Hunsberger. Technical status rept. no.
11, pt. VI, Mar. 1-May 31, 1959, 14p. incl. refs.
(AFOSR-TN-59-570) (Sponsored jointly by Air Force
Office of Scientific Research under AF 18(603)127 and
Public Health Service) AD 264111   Unclassified

Presented in part at meeting of the Org. Chem. Div.
of the Amer. Chem. Soc., Chicago, Ill., Sept. 7-12, 1958.

Abstract published in 134th meeting of the Amer. Chem.
Soc. Abstracts of papers, 1958, p. 75-P.

The reaction of excess dimethyl sulfoxide with ethyl
bromoacetate produced ethyl glyoxylate, hydrogen bro-
mide, and dimethyl sulfide. A convenient preparation
of ethyl glyoxylate in yields averaging 70% was devel-
oped. The generality of the dimethyl sulfoxide oxida-
tion was demonstrated by applying it to a variety of al-
pha-halogenated acids and esters. An ionic mechanism
for this oxidation is suggested which involves nucelo-
philic displacement of the halogen by the sulfoxide oxy-
gen. A number of earlier-reported reactions of sulf-
oxides also appear to depend on the nucleophilic nature
of their oxygen atoms. It is suggested that other com-
pounds containing semiionic oxygen will exhibit anal-
ogous reactions. (Contractor's abstract)

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Franklin Inst. Bartol Research Foundation, Swarthmore,
Pa.

DETERMINATION OF NUCLEAR DISINTEGRATION
ENERGIES, by C. E. Mandeville, D. M. Van Patter and
others. Final rept. Nov. 1, 1954-Oct. 31, 1958 [15]p.
incl. diagr. refs. (AFOSR-TR-59-28) (AF 18(600)-
1320) AD 211322   Unclassified

The precise determination of nuclear disintegration en-
ergies is being sought using a magnetic spectrometer
for charged particles in conjunction with the ONR-
Bartol Van de Graaff accelerator. Investigations were
made of nuclear reactions caused by the bombardment
by 1.5 to 5.0 mev protons of the following nuclei:
Al^{27}, P^{31}, Cl^{35}, Cl^{37}, Cr^{50}, Cr^{52}, Cr^{53}, Cr^{54}, Zn^{64},
Zn^{66} and Zn^{68}. In several cases, the excitation curves
for inelastic proton scattering were observed over a
limited range of bombarding energies. Contributions
have been made with respect to the compilation of nu-
clear reaction energy data, and the comparison of
masses obtained from mass spectroscopy and nuclear
reaction data. An attempt to understand some of the
results of the experimental results obtained for ine-
lastic proton scattering has resulted in a systematic
study of the data available concerning the properties
of low-lying levels of even-even nuclei, particularly
those in the medium weight range. This study has re-
vealed new possible trends which are of considerable
theoretical interest.

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Franklin Inst. Bartol Research Foundation, Swarthmore,
Pa.

E2-M1 MIXING RATIOS IN $2' \to 2 \to 0$ TRANSITIONS, by
S. S. Malik, V. R. Potnis, and C. E. Mandeville. [1959]
[5]p. incl. diagrs. table. [AF 49(638)512]
                                        Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II,
v. 4: 233, Apr. 30, 1959.

Published in Nuclear Phys., v. 11: 691-695, June 1959.

The results of 12 published angular correlation experi-
ments have been analyzed, and the E2-M1 mixing ratios
of the $2' \to 2$ transitions have been obtained for 12 differ-
ent even nuclei. Particular attention has been given to
evaluation of the errors in the measured values of the
mixing ratios. The available data range from A = 56 to
A = 198. When $(\delta/E_\gamma)^2$ is plotted against $Z^2 A^{4/3}$,
three of the experimentally observed points, those for

Fe^{56}, Zr^{92} and Hg^{198}, deviate sharply from a curve
calculated from the theoretical considerations of
Davydov and Filippov. (Contractor's abstract)

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[Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.]

PROCEEDINGS OF THE FIRST INTERNATIONAL
SYMPOSIUM ON GAS-LUBRICATED BEARINGS,
Washington, D. C. (Oct. 26-28, 1959), ed. by D. D.
Fuller. Washington, Office of Naval Research, 1950,
617p. incl. illus. diagrs. tables, refs. (AFOSR-1001)
(Sponsored jointly by Air Force Office of Scientific
Research, Army Engineer Research and Development
Labs., Atomic Energy Commission, Bureau of Aero-
nautics, Bureau of Ordnance, Bureau of Ships, Mari-
time Administration, National Aero-Research, and
Wright Air Development Center)   Unclassified

This symposium was the first to be devoted exclusively
to broad international scientific coverage of gas-lubri-
cated bearings. In addition to United States participa-
tion, 8 or more foreign countries, as well as Asia
were represented. Twenty papers were presented cov-
ering the progress of theoretical and experimental re-
search on lubricated bearings at home and abroad. It
was suggested that the gas-lubricated bearing has the
potential for years of reliable, frictionless operation
with virtually no maintenance. This would be particu-
larly essential in the operation of manned satellites
and space vehicles.

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

ETCH PATTERNS IN ZINC, by V. V. Damiano and M.
Herman. Interim rept. July 1959, 21p. incl. illus.
diagrs. (Rept. no. I-A1878-3) (AFOSR-TN-59-133)
(AF 18(600)1581) AD 210861; PB 143674
                                        Unclassified

Also published in Jour. Franklin Inst., v. 267: 303-
315, Apr. 1959.

Loops and spiral etch patterns were observed on sur-
faces parallel or nearly parallel to the basal plane of
zinc. Their motion and growth were recorded and ap-
peared similar to the mechanism proposed by Frank
and Read (Phys. Rev. v. 79: 722-723, 1950) for the
generation of dislocations. These observations have
been tentatively interpreted as the dissolution of a step
in the surface with the end of the steps pinned. (Con-
tractor's abstract)

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

CELLULAR SUBSTRUCTURE IN ZINC CRYSTALS
GROWN FROM THE MELT, by V. V. Damiano and M.
Herman. Interim rept. Aug. 1959, 20p. incl. illus.
diagrs. refs. (Rept. no. I-A1878-4) (AF 18(600)1581)
AD 227704; PB 144015　　　　　Unclassified

The observations suggest that the development of a
cellular substructure starts as the concentration of the
liquid adjacent to the solid interface increases from a
value C_0 to C_0/k and the degree of constitutional super-
cooling increases. This constitutes the incubation
range where small projections on the interface grow in-
to elongated cells and finally into regular hexagonal net-
works. The regularity in the stacking of cells is con-
fined to domains of the order of 1/2 mm. A stable
shape which predominates after the crystal has grown
for a considerable distance beyond the incubation range
is of the type "a". Combinations of type "a", type "b",
and other irregular forms are observed earlier in the
growth process, indicating that a preferred growth proc-
ess establishes a stable cell shape after a period of
time. The precise mechanism by which these stable
cell shapes develop is not known but appears to be a re-
sult of the initial development of elongated cells in a
preferred direction and the influence of these anisotropic
growth velocities on the distribution of solute in liquid
adjacent to the solid. (Contractor's abstract)

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

MAGNETIC ANALYSIS OF THE PRECIPITATION OF
IRON FROM BETA BRASS, by A. E. Berkowitz and
P. J. Flanders. Interim rept. Aug. 1959, 27p. incl.
illus. diagrs. tables, refs. (Rept. no. I-A2026-2)
(AFOSR-TN-59-762) (AF 49(638)159) AD 226492;
PB 143830　　　　　Unclassified

Also published in Acta Metall., v. 8: 823-832, Dec. 1960.

Single crystals of beta brass containing 0.07 wt % iron
were annealed at 300 and 400°C to precipitate the iron.
At various stages in the anneals, magnetization curves,
hysteresis loops, and torque curves were measured.
These magnetic data were analyzed in terms of the con-
cepts of fine particle ferromagnetism to derive size and
shape distributions of the iron precipitate particles and
the orientations of their crystallographic and shape sym-
metry axes. In the superparamagnetic size range, the
av diam was determined up to 140A. These particles
showed no shape anisotropy and had the same saturation
magnetization and magnetocrystalline anisotropy sym-
metry as bulk iron. The crystal habit of the particles
coincided with that of the beta brass matrix. In this size
range the particle diam increased at the rate of $t^{2.2}$.

With further annealing single domain properties ap-
peared, and the particles showed increasing elongation
in the <100> directions as determined by analysis of the
torque data. Distributions of shapes and sizes of the
single domain particles were calculated from remanent
torque data. These calculations were consistent with the
conclusions from remanence measurements. The shapes
of the hysteresis loops and the spread in annealing time
between max coercive force and max remanence could
be simply interpreted on the basis of mixtures of super-
paramagnetic, single, and multidomain particles. When
the particles were principally in the multidomain
(>300A diam) range, little information about size distri-
butions could be derived, although the data indicated that
the particles become progressively elongated in the
<100> directions. Electron micrographs of replicas gave
qualitative confirmation of the conclusions from the mag-
netic analysis. (Contractor's abstract)

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

PRECIPITATION IN A BETA-BRASS-Fe ALLOY, by
A. E. Berkowitz and P. J. Flanders. [1959] [2]p. incl.
diagr. (AFOSR-4432) (AF 49(638)159)
　　　　　Unclassified

Also published in Jour. Appl. Phys., Suppl., v. 30: 1118-
1128, Apr. 1959.

Single crystal samples of beta-brass containing 0.1% Fe
were annealed at 300°C and 400°C in order to develop the
Fe precipitate particles. At intervals during the anneals,
magnetic data were obtained and analyzed in terms of the
size, shape, orientation, and general magnetic behavior
of the precipitate particles. During the earliest anneal-
ing stages, superparamagnetic behavior was observed,
and particle diam were calculated from the Langevin re-
lation. On continued annealing the magnetic properties
indicated the presence of mixtures of superparamagnetic
and single domain particles, and subsequently mixtures
of single domain and multidomain particles. Torque
curves showed that the particles were single crystals,
with Fe-like magnetocrystalline anisotropy, oriented with
the same crystal habit as the matrix. Single domain be-
havior was first observed when the particle diam were of
the order of 200A. Elongation of the particles in the
111 directions and rotational hysteresis were noted
when single domain behavior appeared. The magnetocrys-
talline anisotropy coefficients calculated from the torque
data were reasonably close to those of Fe. Maximum
remanence was reached before max coercive force due
to the much larger initial susceptibility of the superpa-
ramagnetic as compared to the multidomain particles.
This was confirmed by the shapes of the hysteresis
loops for the various cases. (Contractor's abstract)

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Franklin Inst. [Labs. for Research and Development]
Philadelphia, Pa.

ANISOTROPY FIELD, ANISOTROPY TORQUE, AND
THEIR GENERAL ANALYTICAL EXPRESSIONS (Ab-
stract), by H. Amar. [1959] [1]p. [AF 49(638)159]
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
177, Mar. 30, 1959.

A description of magnetocrystalline anisotropy by an
equivalent field has been used by Kittel and Bickford
and later by other investigators in the analysis of ferro-
magnetic resonance experiments. Kittel and Bickford
calculated approximate expressions for the anisotropy
field for several special cases. A discussion of the
concept of equivalent field is here followed by a general
and rigorous derivation. Let e_τ (direction cosines

$\alpha_1 \alpha_2 \alpha_3$) be a unit vector parallel to the magnetization

density I of a ferromagnetic crystal. It is shown in
general that a P.E. $U(\alpha_1 \alpha_2 \alpha_3)$ is equivalent to a uniquely

defined torque $T = \text{curl } U = \text{grad } U \times e_\tau$, acting on e_τ,

$\alpha_1 \alpha_2 \alpha_3$ being the differentiation variables. This leads

to an anisotropy field $H' = -\text{grad } U + \lambda I$ where the arbi-
trary scalar function $\lambda (\alpha_1 \alpha_2 \alpha_3)$ may be so chosen as to

make the vectors I, H', T mutually perpendicular. Be-
sides their relevance to the analysis of ferromagnetic
resonance experiments, these results may be applied to
the calculation of the magnetization curve of single
domain uniaxial or cubic crystals.

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

DISLOCATIONS IN DEFORMED SINGLE CRYSTALS OF
ALPHA BRASS. PART I. GENERAL OBSERVATIONS,
by J. D. Meakin and H. G. F. Wilsdorf. Interim rept.
Dec. 1959, 26p. incl. illus. diagrs. refs. (Rept. no. I-
A2027-1) (AFOSR-TN-59-1047) (AF 49(638)162)
AD 229609; PB 144570   Unclassified

Also published in Trans. Metall. Soc. AIME, v. 218:
737-745, Aug. 1960.

Using a combined decoration and etching technique the
dislocation structure of annealed and deformed α brass
has been studied. Annealed crystals revealed a low
density forest and well-developed subboundaries; light-
ly deformed crystals contained discrete groups of dis-
locations. The dislocation density and the number of
dislocations in a group were obtained from the micro-
graphs. Using slip-line data, the mean path of a dislo-

cation and the configuration of groups along an active
slip plane have been deduced. Observations on sec-
ondary and cross-slip are reported. (Contractor's
abstract)

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Franklin Inst. [Labs. for Research and Development]
Philadelphia, Pa.

DISLOCATION GROUPS AND PILE-UPS IN LIGHTLY
DEFORMED α-BRASS (Abstract), by H. G. F. Wilsdorf
and J. D. Meakin. [1959] [1]p. [AF 49(638)162]
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
170, Mar. 30, 1959.

Dislocation patterns in α-brass, as revealed by a dec-
oration technique, exhibit the presence of discrete dis-
location groups. If these groups are lying not too close
to other dislocations, the spacings between dislocations
are as predicted by theory. Pile-ups in heavily de-
formed regions show deviations from the spacings
which had been expected theoretically, indicating the
strong influence of neighboring groups. In addition,
there is direct experimental information on the disloca-
tion density before and after plastic deformation, the
number of dislocations per group and the density of the
groups. Making use of slip-line data, the average glide
length of a dislocation, the average distance between
groups on a single slip line, and the number of groups
per line have been calculated. Possible mechanisms of
dislocation pinning will be discussed.

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Franklin Inst. [Labs. for Research and Development]
Philadelphia, Pa.

STUDY OF THE DISLOCATION DISTRIBUTION IN
SINGLE CRYSTALS OF α BRASS (Abstract), by J. D.
Meakin and H. G. F. Wilsdorf. [1959] [1]p. [AF 49-
(638)162]   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
170, Mar. 30, 1959.

A decoration technique capable of revealing individual
dislocations in α brass has been used to study the dis-
location distribution in the easy-glide range. Doped
single crystals strained in tension and aged at 200°C
were electro-polished and etched in a phosphoric acid
solution, the dislocations being then revealed as small,
crystallographic etch pits. The minimum resolvable
distance between dislocations is limited by the size of

the pits and is generally of the order of 500A. The method has been used to study dislocations within the bulk of the crystal by careful sectioning and polishing after the aging treatment. In addition to the expected glide on the primary system, there is clear evidence of slip on secondary systems although all crystals were oriented for single slip. The observations furnish direction evidence of the difficulty experienced by dislocations in cutting through intersectioning systems, and these results will be discussed in the light of current theories of work hardening.

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Franklin Inst. Labs. for Research and Development, Philadelphia, Pa.

THE INFLUENCE OF THE MOLECULAR MEAN FREE PATH ON THE PERFORMANCE OF HYDRODYNAMIC GAS LUBRICATED BEARINGS, by A. Burgdorfer. Interim rept. June 1958 [17]p. incl. diagrs. (Rept. no. I-A2049-2) ([Sponsored jointly by Air Force Office of Scientific Research] and Office of Naval Research under Nonr-234200)   Unclassified

A modified Reynolds equation is derived for gas-lubricated hydrodynamic bearings operating under "slip flow" conditions. Closed analytical solutions are given for a Rayleigh-type step-bearing and an inclined plane slider bearing for the case of two-dimensional flow. The influence of the molecular mean free path on the performance of bearings of arbitrary form is obtained by means of a small parameter, perturbation technique. (Contractor's abstract)

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Franklin Inst. Labs. for Research and Development, Philadelphia, Pa.

A STUDY OF THE STABILITY OF EXTERNALLY PRESSURIZED GAS BEARINGS, by L. Licht and H. [G.] Elrod. Interim rept. Nov. 1958, 41p. incl. diagrs. tables. (Rept. no. I-A2049-4) ([Sponsored jointly by Air Force Office of Scientific Research] and Office of Naval Research under Nonr-234200)   Unclassified

The stability of externally pressurized gas bearings is discussed. The pertinent equations are linearized and the stability criteria stated in considering small deviations from the equilibrium point. The flow in the bearing clearance is treated on a distributed rather than on a lumped parameter basis. Results thus obtained, when compared with those previously arrived at by means of a simplified analysis, show a marked divergence in the limiting values of parameters which influence the stability of the bearing. Differences in predictions of the simplified and present analyses with regard to the permissible compression volume in the bearing interspace and the effect of varying the mass of the bearing are emphasized and discussed. (Contractor's abstract)

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Franklin Inst. Labs. for Research and Development, Philadelphia, Pa.

A DERIVATION OF THE BASIC EQUATIONS FOR HYDRODYNAMIC LUBRICATION WITH A FLUID HAVING CONSTANT PROPERTIES, by H. G. Elrod. Interim rept. Apr. 1959, 21p. incl. diagr. (Rept. no. I-A2049-5) ([Sponsored jointly by Air Force Office of Scientific Research] and Office of Naval Research under Nonr-234200)   Unclassified

Small parameter techniques are used to derive Reynolds lubrication equations from the full Navier-Stokes equation for fluids having constant properties. The derivation given applies directly to the geometries of both journal and slipper bearings. It is expected that analytical techniques similar to those employed in this study can be adapted to the development of equations applicable to fluids having pressure and temperature-dependent properties, such as gases.

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Franklin Inst. Labs. for Research and Development, Philadelphia, Pa.

A BIBLIOGRAPHY ON GAS LUBRICATED BEARINGS - REVISED, by E. B. Sciulli. Interim rept. Sept. 15, 1959, 104p. (Rept. no. I-A2049-6) ([Sponsored jointly by Air Force Office of Scientific Research] and Office of Naval Research under Nonr-234200)   Unclassified

Also published in Proc. First Internat'l. Symposium on Gas-Lubricated Bearings, Washington, D. C. (Oct. 26-28, 1959), Washington, Office of Naval Research, p. 533-616.

This work is a revision and expansion of a bibliography issued in December 1957 (item no. FRA.08:001, Vol. II). The present compilation contains 290 applicable references, more than twice the number of its predecessor. Wherever possible a resumé in English of each reference is included. In most cases the abstracts were taken verbatim from the author, translations or revisions being made when necessary. Five indexes are provided. The yearly and corporate name indexes are the same as in the previous bibliography with the exception of new references. The new subject index contains 13 descriptively worded categories or headings specifically chosen to cover the many varieties and types of gas lubricated bearings. Of the other 2 indexes, 1 lists all the patents in numerical order and the other lists the country of origin of the reference when that country is other than the United States. Every effort has been made to make this a comprehensive listing of all references published prior to July 1, 1959 which deal directly or indirectly with gas lubricated bearings.

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

AXIAL, RELATIVE MOTION OF A CIRCULAR STEP
BEARING, by L. Licht. Interim rept. Oct. 1959 [9]p.
incl. diagrs. (Rept. no. I-A2049-7) ([Sponsored jointly
by Air Force Office of Scientific Research] and Office
of Naval Research under Nonr-234200) AD 231065
Unclassified

Also published in Jour. Basic Eng., v. 81: 109-117,
June 1959.

Equations relating the flow of the lubricant and the axial
motion of an externally pressurized thrust bearing are
developed. The bearing is shown to be stable when the
fluid is incompressible. Expressions for local stiff-
ness and damping coefficients, useful in the evaluation
of the dynamic response of the bearing, are given. An
analog computer solution of the equation of motion is
compared with the results of the corresponding, small
displacement equation. (Contractor's abstract)

552

Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

STABILITY OF EXTERNALLY PRESSURIZED GAS
JOURNAL BEARINGS, by L. Licht. Interim rept. Oct.
1959 [31]p. incl. diagrs. (Rept. no. I-A2049-8) ([Spon-
sored jointly by Air Force Office of Scientific Re-
search] and Office of Naval Research under Nonr-
234200) AD 228299 Unclassified

A stability analysis is developed for gas journal bear-
ings having externally pressurized pads, symmetrically
spaced along the circumference. Simplifying assump-
tions are made and equations of flow and motion are
stated in terms of perturbation quantities. The case
considered is when the journal, initially in an eccentric
equilibrium position, begins to move in an arbitrary di-
rection under the influences of a small, random dis-
turbance. Methods of factorizing and simplifying the
characteristic determinants are shown, with the objec-
tive of reducing the work of examining the roots of
characteristic equations. Special cases, such as the
bidirectional thrust bearing and that of the journal ini-
tially in concentric position are discussed. Numerical
and semi-experimental procedures of determining the
coefficients of characteristic equations are outlined.
Stability tests are suggested. A simple numerical ex-
ample is included. Bearing parameters affecting sta-
bility are discussed. (Contractor's abstract)

553

Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

EXTENSION OF THE CONDUCTING SHEET ANALOGY

TO EXTERNALLY PRESSURIZED GAS BEARINGS, by
L. Licht. Interim rept. Oct. 1959 [11]p. incl. diagrs.
(Rept. no. I-A2049-9) ([Sponsored jointly by Air Force
Office of Scientific Research] and Office of Naval Re-
search under Nonr-234200) Unclassified

Incompressible, viscous flow in narrow passages
bounded by parallel surfaces yields the 2-dimensional
Laplace equation, $\nabla^2 P = 0$. The pressure field, load
capacity and lubricant flow of hydrostatic oil bearings
can be readily determined by means of the electric
analogy of the conducting sheet. The equation

$$\frac{\partial}{\partial x}\left(P\frac{\partial P}{\partial x}\right) + \frac{\partial}{\partial y}\left(P\frac{\partial P}{\partial y}\right) = 0 \text{ characterizes laminar,}$$

isothermal flow of gas lubricants in otherwise geomet-
rically identical bearings. It is shown that by means of
suitable change of the dependent variable the above
equation can be reduced to the Laplacian form. The en-
suing advantage is the extension of the conducting sheet
analogy to externally pressurized thrust and journal
guide bearings when the lubricant is a gas. (Contrac-
tor's abstract)

554

Free U. of Brussels (Belgium).

IRREVERSIBLE PROCESSES IN GASES. I. THE DIA-
GRAM TECHNIQUE, by I. Prigogine and R. Balescu.
[1959] [21]p. incl. diagrs. refs. (AFOSR-TN-59-1237)
[AF 61(514)957] AD 229360 Unclassified

Also published in Physica, v. 25: 281-301, Apr. 1959.

A general method is developed of studying the irrever-
sible phenomena in gases consisting of an asymptotic
study of the Liouville equation solutions to the limit of
a large system ($n \to \infty$, $\Omega \to \infty$, N/Ω constant, N being the
number of degrees of freedom and Ω the volume of the
system). A diagrammatic technique is employed to ren-
der the method systematic. It is shown that a limited
dependence exist between the topological properties of
the diagrams and their asymptotic behavior. The ver-
tices' name and type of connection determine their
asymptotic dependence of the volume and name of the
particles; their asymptotic dependence is fixed by the
structural characteristics of a more global nature.
This technique permits analyzing completely the asymp-
totic behavior of the Liouville equation solution by a
simple inspection of the corresponding diagrams.

555

Free U. of Brussels (Belgium).

IRREVERSIBLE PROCESSES IN GASES. II. THE
EQUATIONS OF EVOLUTION, by I. Prigogine and R.
Balescu. [1959] [22]p. incl. diagrs. refs. (AFOSR-TN-
59-1238) [AF 61(514)957] AD 229359 Unclassified

Also published ln Physica, v. 25: 302-323, Apr. 1959.

The general method developed in a previous paper
(Item no. 554) ls applied to a number of slmple situa-
tions. In the case of the weakly coupled homogeneous
gas the equations obtained previously are rederlved.
A systematic deduction of the equations of evolution to
their subsequent approximations ls shown. The study
of inhomogeneous gases leads to a first approximation
of Boltzmann's equation. The signlficance and origin
of the lrreverslbility of the mechanical systems having
a large number of degrees of freedom are also dlscussed.

556

Free U. of Brussels (Belgium).

STATISTICAL MECHANICS AND THERMODYNAMICS
OF IRREVERSIBLE PROCESSES. VOL. I. IRREVERSI-
BLE PROCESSES IN GASES, by R. Balescu and I.
Prigogine. [1959] 190p. incl. diagrs. refs. (Technical
rept. no. EOARDC-PR-59-18, vol. 1) (AFOSR-TR-59-
44a) (AF 61(514)957) AD 214526; PB 140695
Unclassified

The idea of an ensemble Llouville's equation and the
concept of weakly-coupled systems are introduced.
This ls followed by a discussion of the general proper-
ties of the distribution functions; precise definitions
are collected and their value at thermodynamical equi-
librium ls discussed. The various contributions are
classified; beginning by the association of a diagram
to each contribution. This association ls chosen in
such a way as to establish a one-to-one correspondence
between the structure of the diagram and the asymptotic
behavior of the contribution which it represents. Also
examined is an interesting property of disconnected
diagrams. This property enables one to perform easily
certain types of summations. The diagram technique
is applied to the derivation of irreverslble equation
for the one particle distribution function on a weakly-
coupled perfect homogeneous gas. Flnally, applications
are made of the equations reviously obtained to 2 con-
crete problems inspire om astronomy; these are:
(1) the phenomenon of dynamical friction which is a
typical Brownian phenom on, and (2) a dissipative
mechanism, illustrated by the problem of the dissocia-
tion of a binary star through its interaction with the
medium.

557

Free U. of Brussels (Belgium).

STATISTICAL MECHANICS AND THERMODYNAMICS
OF IRREVERSIBLE PROCESSES. VOL. II. IRREVERS-
IBLE PROCESSES IN POLYATOMIC GASES, by A.
Festraets and I. Prigogine. [1959] 44p. (Technical
rept. no. EOARDC-PR-59-18, vol. 2) (AFOSR-TR-59-
44b) (AF 61(514)957) AD 214527; PB 140696
Unclassified

The approach to equilibrium of a gas of polyatomic
molecules ls described. The case ls considered, ln a
preliminary manner, of a single dipole interacting
through electrostatic forces with ions. This example
shows clearly the main dilferences between the approach
to equillbrium of the translational and internal degrees
of freedom

558

Free U. of Brussels (Belgium).

STATISTICAL MECHANICS AND THERMODYNAMICS
OF IRREVERSIBLE PROCESSES. VOL. III. QUANTUM
MECHANICS OF IRREVERSIBLE PROCESSES, by I.
Prigogine, M. Toda, and S. Ono. [1959] [42]p. incl.
diagrs. refs. (Technical rept. no. EOARDC-PR-59-18,
vol. 3) (AFOSR-TR-59-44c) (AF 61(514)957)
AD 214528; PB 140697   Unclassified

Quantum systems are discussed, wherein it is shown
that the previously developed diagram technique (Item
no. 556) may be extended to cover also the case of quan-
tum mechanics. The only difference is the definition of
the vertex. In the quantum mechanical case to each ver-
tex there corresponds a finite transfer of momentum,
as opposed to the classical case where an infinitesimal
transfer exists. This difference directly expresses the
indivisibility of quantum act. The case of the quantum
gases ls first treated, followed by the study of harmonic
oscillators, and, finally 2 simple examples are dis-
cussed—homogeneous and inhomogeneous weakly-
coupled gases.

559

Free U. of Brussels (Belgium).

STATISTICAL MECHANICS AND THERMODYNAMICS
OF IRREVERSIBLE PROCESSES. VOL. IV. ELECTRO-
DIFFUSION, by W. Kauman and T. [A.] Bak. [1959]
147p. Incl. diagrs. table, refs. (Technical rept. no.
EOARDC-PR-59-18, vol. 4) (AFOSR-TR-59-44d)
(AF 61(514)957) AD 214529; PB 140698   Unclassified

Electrodiffusion ls presented as a particular case of ex-
change diffusion which arises through the interaction
of a chemical exchange reaction with a flow due to an
external force field. The macroscopic transport equa-
tions of the electrodiffusion are formulated and solved
by Fourier-transforming to give equations of the Hill
type or by applying time-dependent perturbation tech-
niques. It ls shown that the effective diffusion coefficient
in electrodiffusion ls the sum of the ordinary diffusion
constant and a term proportional to the square of the
electric field and containing simple algebraic functions
of the ionic mobilities, the rate constants of the chemical
reaction, and the frequency of the applied field. Expres-
sions for the ionic concentration are given for time-
dependent and time-independent electric fields and for
finite and infinite boundary conditions. The stationary
electric current in a finite system is calculated, and

the entropy production of electrodiffusion is derived. The application of electrodiffusion to measurements of the rate constants by diffusional or electrical measurements is discussed. A theoretical investigation was also made of the behavior of amphoteric electrolytes under the combined action of a gradient of pH and an electrostatic potential.

560

Free U. of Brussels (Belgium).

ON THE TRANSPORT EQUATION IN QUANTUM GASES, by I. Prigogine and S. Ono. [1959] [8]p. incl. diagrs. [AF 61(514)957]   Unclassified

Published in Physica, v. 25: 171-178, Feb. 1959.

It is shown that a general diagram technique developed in a recent paper (item no. 554, Vol. III) for the classical system can be applied without modification to the quantum system. The only difference is the definition of the vertex which corresponds in the quantum case to a finite transfer of momentum. This permits considerable simplifiction of the calculations. The transport equation for a weakly coupled gas is established. This equation changes character when the characteristic length of the inhomogeneity approaches a value comparable to the de Broglie wave length of the particles.

561

Free U. of Brussels. [Dept. of Chemical Physics] (Belgium).

IRREVERSIBLE PROCESSES IN A PLASMA, by R. Balescu. [1959] 4p. (AFOSR-TN-59-203) (AF 61(052)-179) AD 264280   Unclassified

Also published in Physica, v. 25: 324-325, Feb. 1959.

The diagram technique recently developed by Prigogine and Balescu (Physica, v. 23: 555, 1957) is applied to a plasma, and some preliminary results are briefly reported.

562

Free U. of Brussels. [Dept. of Chemical Physics] (Belgium).

THEORY OF ELECTRODIFFUSION, by T. A. Bak and W. G. Kauman. [1959] [13]p. [AF 61(052)179]
Unclassified

Published in Trans. Faraday Soc., v. 55: 1109-1121, July 1959.

A theory of electrodiffusion based on macroscopic transport equations rather than stochastic argu-

ments is proposed. For a constant applied field the present theory confirms results previously obtained by Mysels, whereas with an alternating field it gives different results. The diffusion equations which arise are Fourier-transformed to give equations of the Hill-type or are solved by time-dependent perturbation techniques leading to essentially the same equations. The possible use of this effect as a method of determining rate constants is discussed. The theory also shows that measurements of the diffusion constant may possibly be replaced by electrical measurements. (Contractor's abstract)

563

Free U. of Brussels. [Dept. of Chemical Physics] (Belgium).

IRREVERSIBLE PROCESSES IN A PLASMA: EFFECT OF LONG RANGE FORCES, by R. Balescu. [1959] [4]p. [AF 61(052)179]   Unclassified

Published in Proc. Third Biennial Gas Dynamics Symposium on Dynamics of Conducting Gases, Evanston, Ill. (Aug. 24-26, 1959), Evanston, Northwestern U. Press, Mar. 1960, p. 32-35. (AFOSR-TR-60-87)

The well known divergences appearing in the calculation of transport coefficients of a plasma may be eliminated without any need of an arbitrary cut-off if one starts from a transport equation which takes into account correctly the long range of the electrostatic interactions. Such an equation can be derived from first principles by applying the statistical mechanical methods developed by Prigogine and Balescu. The characteristic property of this equation is its collective character. The main consequences of this property are discussed.

564

Free U. of Brussels. Lab. of Molecular Chemistry and Physics (Belgium).

VAPORIZATION OF COMPOUNDS AND ALLOYS AT HIGH TEMPERATURE, by P. Goldfinger, M. Ackerman, and M. Jeunehomme. Final technical rept. Jan. 1959, 59p. incl. diagrs. tables, refs. (AFOSR-TR-59-32) (AF 61(052)19) AD 212930; PB 142100   Unclassified

The vaporization of ZnS, CdS, HgS, $CdSe$, $HgSe$, $CdTe$, $HgTe$ from 400 to 1175°K, of sulfur, selenium, tellurium from 350 to 600°K, $InAs$, GaP, $GaSb$ from 900 to 1250°K and of an iron-nickel alloy from 1400 to 1600°K have been investigated. The molecular composition of the vapor in equilibrium with the solid compounds (except for $GaSb$ which in part of the experiments is liquid) has been determined. No molecules containing both elements of the compounds are present in the vapor

phase at a measurable concentration (10^{-3} or less). The change in free energy, heat content and entropy for the vaporization processes have been measured and permit

the calculation of thermodynamic properties of the compounds investigated. The vapors contain the group V and group VI elements in the form of different polyatomic species; equilibria between these species have been observed and the relevant thermodynamic quantities measured: $D(Te_2) = 49 \pm 2kcal$; $D(As_2 - As_2) = 65 \pm 2kcal$; $D(Sb_2 - Sb_2) = 62 \pm 1kcal$; $D(S_2-S_2-S_2) = 61 \pm 7kcal$; $S^\circ_{530}(S_6) = 100 \pm 8$ e.u. Preliminary experiments on the evaporation of an alloy show that this method can give useful information on thermodynamic properties, especially on activities of the components. (Contractor's abstract)

565

Fribourg U. Dept. of Physics (Switzerland).

LIQUIDS FOR USE IN LARGE BUBBLE CHAMBERS, by B. Hahn, G. Riepe, and A. W. Knudsen. [1959] [9]p. incl. diagrs. table. (AFOSR-TN-59-561) (AF 61(514)-1262) AD 253122   Unclassified

Also published in Rev. Scient. Instr., v. 30: 654-655, Aug. 1959.

The pure liquids C_3F_8, C_4F_{10}, SF_6, C_2ClF_5, $CBrF_3$ and TeF_6, as well as binary mixtures of these sub-

stances, have been found to have very desirable properties for use in large bubble chambers for studying decay modes of elementary particles. (Contractor's abstract)

566

Fribourg U. [Dept. of Physics] (Switzerland).

STABILIZATION AND CONTROL OF BUBBLE CHAMBER SENSITIVITY, by B. Hahn and A. W. Knudsen. [1959] [2]p. incl. diagrs. [AF 61(514)1262]
                    Unclassified

Published in Proc. Internat'l. Conf. on High-Energy Accelerators and Instrumentation - CERN 1959, Geneva (Switzerland) (Sept. 14-19, 1959), Geneva CERN, Scientific Information Service, 1959, p. 506-507.

The bubble density of a bubble track is known to depend strongly on the liquid temperature and on the pressure drop. Pressure stabilization by providing pressure communication of the chamber liquid with a reference pressure through flexible membranes is discussed.

Frick Chemical Lab., Princeton, N. J.
    see Princeton U. Frick Chemical Lab., N. J.

567

Gaustad Mental Hospital, Oslo (Norway).

AIRBORNE EEG RECORDING IN HIGH PERFORM-
ANCE AIRCRAFT, by C. W. Sem-Jacobsen, O. Nilseng
and others. Final technical rept. Jan. 28, 1959, 4p.
(AFOSR-TR-59-35) (AF 61(514)1201) AD 213035;
PB 145074   Unclassified

Thirty pilots performed 10 commonly flown maneuvers
during which EEG recordings were made to determine
whether the EEG was a suitable device for measuring
physiological and psychological responses to flight
stresses. The pilots were divided into 3 groups on the
basis of the EEG records. Group A showed only mini-
mal changes in response to the test flight. Group B
showed marked high voltage changes of short duration
in response to the same maneuvers. In the EEG's of
the pilots belonging to group C gross changes of proba-
bly more pathological nature were seen. Out of the 30
pilots, 19 were in group A; 8 were in group B, and 3 in
Group C. After the test the pilots in group A appeared
unaffected by the flight, kept good radio contact, were
in good spirits, and reported no blackouts. The pilots
of the B-group, on returning to the ground, perspired
and appeared fatigued. They revealed blackouts and
made mistakes in recollecting the flight. The pilots of
group C were pale, perspired heavily, and had gone
through episodes of loss of consciousness.

568

Gaustad Mental Hospital, Oslo (Norway).

ELECTROENCEPHALOGRAPHIC STUDY OF PILOT
STRESSES IN FLIGHT, by C. W. Sem-Jacobsen. [Final
rept.] [1959] [5]p. incl. diagrs. table. (AFOSR-1727)
(Sponsored jointly by Air Force of Scientific Research
under [AF 61(052)197], Ford Foundation, and Norwegian
Air Force)   Unclassified

Presented at Thirtieth annual meeting of the Aero Med.
Assoc., Los Angeles, Apr. 29, 1959.

Also published in Aerospace Med., v. 30: 797-801,
Nov. 1959.

With 8-channel airborne EEG equipment, tracings were
made of a group of jet pilots, as well as personnel with
no previous flight experience, during simulated combat
flight. A uniform standardized flight schedule was util-
ized. On the basis of the EEG tracings, 30 jet pilots
were divided into 3 groups according to the changes
seen in the records. A minimal, B marked, and C gross.
The same pilots were graded by the Air Force accord-
ing to their flight performances. The results obtained
strongly support a close correlation between the
changes in the brain as measured by EEG during flight
stress and the pilot's ability to perform under these
conditions. Airborne EEG recording is demonstrated
as a new method for studying the stress to which the
jet fighter pilot is subjected. (Contractor's abstract)

569

General Applied Science Labs., Inc., Westbury, N. Y.

THE OSCILLATION AND NOISE OF AN OVERPRES-
SURE SONIC JET, by A. G. Hammitt. Nov. 1959, 35p.
incl. illus. diagrs. (GASL Technical rept. no. 137)
(AFOSR-TN-59-1307) (AF 49(638)194) AD 233878;
PB 146364   Unclassified

Also published in Jour. Aero/Space Sci., v. 28: 673-
680, Sept. 1961.

A series of experiments on plane 2-dimensional and
axially symmetric over pressure sonic jets were per-
formed to study the oscillating behavior of the jet and
accompanying sound field. Shadowgraphs were obtained
which show the oscillations and generation of the sound
waves for the plane 2-dimensional jet in some detail;
but similar results could not be obtained for the axially
symmetric jet. Measurements from these pictures show
that the oscillating jet and sound fields can be described
in terms of the length of the shock wave cells. The im-
portance of the sound waves acting upon the base of the
jet is demonstrated and it is found that the jet can be
stabilized by shielding its base from these sound waves.
(Contractor's abstract)

570

General Applied Science Labs., Inc., Westbury, N. Y.

ON THE AERODYNAMIC NOISE OF A JET, by S.-I.
Cheng. Apr. 1959, 50p. incl. diagrs. (GASL Technical
rept. no. 148) (AFOSR-TN-59-1308) (AF 49(638)194)
AD 233164; PB 148689   Unclassified

Also published in Jour. Aero/Space Sci., v. 28: 321-
331, Apr. 1961.

A new model is advanced for analyzing the broad spec-
trum noise of a turbulent jet. To the sound emitting
small scale turbulent eddies (with frequencies much
larger than those large scale ones, responsible for the
intermittent phenomena near the edge of a turbulent
jet), the shear layer is laminar and is of an irregular
contour, as if the large scale turbulent motions were
frozen. The linearized analysis is then applied to the
laminar shear layer to relate the acoustic oscillations
across it. The concept of "geometrical acoustics" is
generalized to represent the passage of an acoustic ray
through a laminar shear layer. The "generation" of
the acoustic ray is visualized as the schematic repre-
sentation, within the framework of geometrical acoustics,
of the action of the Reynolds stress in transferring en-
ergy from the shearing mean flow to the acoustic waves.
Such action of the Reynolds stress is of crucial impor-
tance to the aerodynamic noise of high speed turbulent
jet where the Reynolds stress is the fundamental element
of the radiating quadrupoles according to Lighthill. In
relating the quadrupole strength across the shear layer,
those acoustic waves that become "stationary" with

respect to the local mean flow somewhere in the interior of the shear layer, are significantly modified by the viscous action through the critical layer. (Contractor's abstract)

571

General Applied Science Labs., Inc., Westbury, N. Y.

NOTE ON THE BROAD SPECTRUM NOISE OF A JET AND ITS SILENCER, by S.-I. Cheng. Nov. 1959, 23p. incl. diagrs. (GASL Technical rept. no. 149) (AFOSR-TN-59-1309) (AF 49(638)194) AD 236522; PB 147320
Unclassified

Some of the implications are amplified of the model for analyzing the broad spectrum noise of a jet as was presented previously (item no. 570) when applied to practical systems. Experimental results on the noise reduction by the C. F. 100 Orenda IIR diffuser silencer and by the UTIA Model Ground Muffler are discussed from the points of view of both the Lighthill's model and the present model. Based upon Lighthill's model, it appears necessary to assume a very large increase of the turbulence intensity accompanying the diffusion of the jet velocity. According to the present model, where the change of the turbulence intensity is neglected, the observed noise reduction or increase is explained by the change of the relative thickness of the shear layer that appears to be of reasonable magnitudes. (Contractor's abstract)

572

General Applied Science Labs., Inc., Westbury, N. Y.

THE NOISE FIELD OF A SUBSONIC JET, by G. Moretti and S. Slutsky. Nov. 1959, 165p. incl. diagrs. table. (GASL Technical rept. no. 150) (AFOSR-TN-59-1310) (AF 49(638)194) AD 236386; PB 147321
Unclassified

The acoustic far field of a singularity was investigated under several different conditions of the medium. The simple cases of a source in an infinite wind, as observed at a fixed or a moving point, were analyzed to permit comparison with physical systems of practical interest, e.g., jet engine fly-by noise analysis. Widespread misunderstanding of the Lighthill Mach number dependence was noted and clarified by means of the above analysis. The far field of a singularity imbedded in a jet was determined as a function of jet velocity and temperature distribution with special emphasis on the case of uniform distribution in the jet. Comparison of experimental results is made and fair agreement noted. Factors involved in failure to obtain complete agreement are discussed. (Contractor's abstract)

573

General Dynamics Corp. Convair Div., Pomona, Calif.

THERMAL STRESSES IN A SQUARE PLATE WITH A CENTRAL CIRCULAR HOLE SUBJECTED TO AN ARBITRARY TEMPERATURE GRADIENT, by R. D. Sutherland and F. M. White. Feb. 1959, 33p. incl. diagrs. tables. (Rept. no. TM-349-2) (AFOSR-TR-59-11) (AF 49(638)235) AD 209850; PB 139663 Unclassified

An analysis of the thermal stress problem in a thin square plate containing a single concentric circular perforation is presented for an arbitrary temperature distribution. The results of the analysis are applied to a plate subjected to a simple doubly-symmetrical temperature distribution. The hoop stresses are calculated around the perimeter of the perforation and are presented as functions of angular displacement for 4 different inside radii. (Contractor's abstract)

574

General Dynamics Corp. Convair Div., Pomona, Calif.

THERMO-ELASTIC EQUATIONS APPLICABLE TO THICK-WALL POINTED SHELLS OF REVOLUTION, by R. D. Sutherland and R. G. Shook. Nov. 1959, 29p. incl. diagr. (Rept. no. TM-349-14) (AFOSR-TN-59-1274) (AF 49(638)592) AD 233495; PB 146439
Unclassified

The thermo-elastic equations necessary to define the stress distribution in a thick-wall, pointed shell of revolution are presented. A coordinate system based on the classic ogive shape which is applicable to a variety of low aerodynamic drag shapes is utilized in the analysis. Stress functions equations are derived in these ogive coordinates. Techniques are presented for use at the boundaries of the shells of revolution and at the axis of revolution. The equations presented can be solved by numerical methods and are a basis for further work in obtaining analytical solutions to the stresses in thick-wall, pointed shell of revolution. (Contractor's abstract)

575

General Dynamics Corp. General Atomic Div., San Diego, Calif.

FORMATION OF FREE-RADICAL SOLIDS USING ATOMIC-BEAM TECHNIQUES, PART I. MEASUREMENT OF VAPOR PRESSURE OF HYDROGEN AT TEMPERATURES BETWEEN 3° AND 10°K, PART II, by W. L. Fite and G. L. Guthrie. July 1959, 51p. incl. illus. diagrs. refs. (Rept. no. GA-803) (AFOSR-TN-59-364) (AF 49(638)301) AD 213674; PB 142972 Unclassified

Part I presented at Symposium on Unstable Chem. Species, Los Angeles, Calif., June 23-24, 1958.

Part I: The probability of condensation and stabiliza-
tion of atomic H in matrices of solid molecular H and
Ar appears to be less than 10^{-5} under the conditions
of atomic-beam experimentation, including the use of
spin-aligned atoms. From energy-storage studies of
molecular H, there appear to be 2 states of solid H
formed from condensation of molecular H, and that
state which is formed seems to depend on whether the
condensation occurs above or below about 4.0°K.
Further understanding of the formation of atomic-H
solids depends very strongly on the obtaining of more
information on solid molecular H, in particular the
rates for phase transition between the solid and gaseous
states. Part II: The experimental method chosen made
use of the fact that, at the temperatures of interest,
the density of H is low and the mean free path is very
large compared with the diameter of the tubing in the
apparatus. Since under these circumstances the pres-
sure and temperatures in 2 different parts of the appa-
ratus are quantitatively related, the H pressure at the
coldest part of the apparat   could be calculated if the
coldest temperature was known. Measurements of the
vapor pressure of H were made at temperatures in the
liquid-He range and slightly above. The measured pres-
sure after correction appeared to be of the same order
of magnitude as would be given by an extension of the
Wooley, Scott, and Brickweddle formula (Jour. Re-
search Nat'l. Bur. Standards, v. 41: 379, 1951).

576

General Dynamics Corp. General Atomic Div.,
San Diego, Calif.

IONIZATION OF ATOMIC OXYGEN ON ELECTRON
IMPACT, by W. L. Fite and R. T. Brackmann. Oct. 8,
1958 [4]p. incl. diagr. (Rept. no. GA-544) (AFOSR-
TN-59-17) (AF 49(638)356) AD 208598   Unclassified

Also published in Phys. Rev., v. 113: 815-816, Feb. 1,
1959.

The cross section for ionization of atomic oxygen has
been measured by using modulated atomic beam tech-
niques. First the ratio of the cross sections for pro-
duction of the molecular oxygen ion and for total ion
production in collisions of electrons with oxygen mole-
cules was measured. Then the ratio of the ionization
cross section of the free oxygen atom and the cross
section for production of the molecular ion in electron-
molecule collisions was determined. From the previ-
ously known total ionization cross section of the mol-
ecule, and the measured ratios, the unknown cross sec-
tions were determined. The experimental results are
compared with the calculations of Seaton. (Contractor's
abstract)

577

General Dynamics Corp. General Atomic Div.,
San Diego, Calif.

IONIZATION OF ATOMIC AND MOLECULAR OXYGEN
ON ELECTRON IMPACT, by W. L. Fite and R. T.
Brackmann. Mar. 1959, 16p. incl. diagrs. refs. (Rept.
no. GA-632) (AFOSR-TN-59-18) (AF 49(638)356)
AD 208599; PB 139995   Unclassified

In order to determine absolute cross sections of atomic
and molecular oxygen on electron impact, ratios of
cross sections for different ionization processes were
measured directly, using the atomic-beam apparatus,
and then compared with the absolute cross-section
measurements of other investigators. In particular, it
is quite straightforward to measure the ratio Q_1/Q_2,
where Q_1 is the ionization cross section of the atom,
i.e., the cross section for the process $e + O \rightarrow O^+ + 2e$,
and Q_2 is the cross section for the process $e + O_2 \rightarrow$
$O_2^+ + 2e$. In a second experiment the ratio Q_2/Q_T was
determined, where Q_T is the total cross section of the
oxygen molecule for producing ions, irrespective of the
mass, charge, and initial kinetic energy of the resultant
ions. (Contractor's abstract)

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General Dynamics Corp. General Atomic Div.,
San Diego, Calif.

THE USE OF MODULATED ATOMIC-BEAM TECH-
NIQUES FOR THE STUDY OF SPACE-FLIGHT PROB-
LEMS, by G. S. Hollister, R. T. Brackmann, and W. L.
Fite. Oct. 14, 1959 [19]p. incl. diagrs. (Rept. no. GA-
1024) (AFOSR-TN-59-1033) (AF 49(638)356)
AD 229282; PB 150065   Unclassified

Presented at Conf. on Phys. Chem. in Aerodynam. and
Space Flight, Pennsylvania U., Philadelphia, Sept. 1-3,
1959.

Also published in Planetary and Space Sci., v. 3: 162-
168, Feb. 1961.

Two types of experiments are discussed. In the first,
an incident beam impinges on a surface and the particles
leaving the surface are examined with a mass spectrome-
ter. By varying the incident beam and/or surface tem-
perature, thermal accommodation coefficients are de-
termined for a variety of surfaces and gases. Using an
incident atomic beam, the probability that an atom will
rebound from the surface as a free atom is measured;
from examination of the reflected molecular signal, in-
formation on the probability of reassociation at the sur-
face is obtained. In the second, the atomic beam, which
is monitored mass-spectrometrically, is allowed to
strike a surface placed on a torsion balance, and mo-
mentum transfer is measured directly. In these

experiments, the atomic-beam apparatus is used as an atomic wind tunnel; when a hydrogen-atom beam from a furnace source operating at 3000°K is used, the case of a high-altitude satellite is fairly closely duplicated. Results of a number of experiments using these techniques are presented. (Contractor's abstract)

579

General Dynamics Corp. General Atomic Div., San Diego, Calif.

IONIZATION OF HYDROGEN AND OXYGEN ATOMS NEAR THRESHOLD (Abstract), by W. L. Fite and R. T. Brackmann. [1958] [1]p. [AF 49(638)356]
Unclassified

Presented at Eleventh Annual Gaseous Electronics Conf., New York, Oct. 22-25, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 110, Mar. 6, 1959.

Using modulated atomic beam techniques, the cross sections for ionization of ground-state hydrogen and oxygen atoms upon electron impact have been measured, in the neighborhood of threshold. For both atoms the cross section appears proportional to the excess incident electron energy, and confirms the prediction of Geltman. For the hydrogen atom the absolute value of

the cross-section slope is 0.078 ($\pm$ 0.006)πa_0^2/ev),

while Geltmann's S-wave theory predicts 0.044πa_0^2/ev.

The discrepancy is understood on the basis of the theory's consideration of only the S-wave contributions to the total cross section.

580

General Electric Co. [Flight Propulsion Lab. Dept.] Cincinnati, Ohio.

NITROGEN AT HIGH TEMPERATURES, by F. Martinek. Feb. 1959, 1v. incl. diagrs. tables, refs. (AFOSR-TN-59-264) (AF 49(638)243) AD 212467   Unclassified

Presented at ASME Symposium on Thermophysical Properties, Purdue U., Lafayette, Ind., Feb. 23-26, 1959.

The basic thermodynamic properties of pure nitrogen at high temperatures are presented. Internal energy, enthalpy, entropy, electron density, and electrical conductivity are given in engineering units for the temperature range from 5000 to 30,000°K, and pressure varying from 0.2 to 100 atm. The temperature and pressure dependency of dissociation and ionization is also shown. All calculations are based on statistical thermodynamics. (Contractor's abstract)

581

General Electric Co. Flight Propulsion Lab. Dept., Cincinnati, Ohio.

HIGH TEMPERATURE HEAT TRANSFER FROM GASES TO CYLINDERS AND NOZZLES, by L. E. Kanter, F. Martinek, and M. L. Ghai. Feb. 1, 1958-Feb. 1, 1959, 128p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-488) (AF 49(638)243) AD 215841; PB 143597
Unclassified

A gas stabilized plasma generator operating with nitrogen gas and water cooled metal electrodes was successfully operated to supply the hot gas necessary for this study. The required instrumentation was, or is being, developed to measure the various temperatures, flow velocities, and power consumption rates experienced with the generator and associated equipment. Preliminary temperature traverses and photographic studies were made to investigate the flow field of the effluent gas. Calculations are presented for the thermodynamic properties of nitrogen gas at high temperatures including the pressure effect. Also included are the general considerations on experimentation and data reduction as pertains to this study. (Contractor's abstract)

582

General Electric Co. General Electric Research Lab., Schenectady, N. Y.

PROCEEDINGS OF INTERNATIONAL CONFERENCE ON STRUCTURE AND PROPERTIES OF THIN FILMS, BOLTON LANDING, N. Y. (Sept. 9-11, 1959), ed. by C. A. Neugebauer, J. B. Newkirk, and D. A. Vermilyea. New York, Wiley and Sons, 1959, 561p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-212) [AF 49(638)605]
Unclassified

This conference brought together investigators concerned with the phase transformations, chemical reactivity, superconductivity, electric resistance, Hall effect, magnetic properties, and magnetoresistance related to thin films. Papers were also presented on the little known physical status of films that are responsible for their anomalous properties and on problems of growth and characterization. Surface chemistry was also discussed shedding light on structures and interactions at surfaces. Also included were papers of a strictly theoretical nature.

583

[Georgetown U., Washington, D. C.].

CHANGES IN PALMYRA ATOLL AND ITS VEGETATION THROUGH THE ACTIVITIES OF MAN, 1913-1958, by E. Y. Dawson. [1959] 51p. incl. illus. diagrs. refs. (AFOSR-TN-59-141) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)187 and National Institutes of Health) AD 210972

Unclassified

Also published in Pacific Naturalist, v. 1: 1-51, Feb. 4, 1959.

This history of man-made changes in this atoll is given and illustrated. The past and present land vegetation is described, and collections of 38 naturalized species cited. A survey of the marine vegetation is given and contrasted to known conditions 45 yr ago; 89 species are cited of which Pterocladia tropica, Cryptonemia? umbraticula, Antithamnion palmyrense, and Alsidium? pacificium are described as new. It is concluded that ecological conditions throughout a large part of the feeding area of fishes on the reef-flats and in the lagoons have been changed by man's activities to favor the development of Lyngbya majuscula which is now ubiquitous. Certain past tests and occurrences which indicate that this alga may have properties toxic to human beings place it under strong suspicion as a contributor to ichthyosar-cotoxism in the Palmyra region.

584

[Georgetown U., Washington, D. C.]

SCIENCE AND SOCIAL CHANGE, by N. F. Washburne. Aug. 17, 1959, 44p. incl. diagrs. tables, refs. (AFOSR-TN-59-910) [AF 49(638)187] AD 227172
Unclassified

The problem of assessing the relationships between science and social change is discussed. A model is presented in which social change is conceived of as a series of waves, each wave beginning with some overwhelming event or process which strikes at the functions of one or more of our social systems, necessitating structural changes therein. Six types of such agents of change are noted: technological developments, population movements, changes in natural resources, natural occurrences, physiological changes and world pressures. These affect first those areas of our social structure which we hold least sacred, but as the structural alterations made necessary by them are put into effect, dysfunctions arise in other parts of our social structure, necessitating further alterations, and so on, as our whole society adjusts to maintain equilibrium. Trends in 4 of the agents of change are traced, and their relationship to science is discussed. It is concluded that while there will be great growth in American science in the future, scientists will nonetheless remain in short supply. (Contractor's abstract)

585

Georgetown U., Washington, D. C.

AUTOMATIC TEACHING; THE STATE OF THE ART [A CONFERENCE], Pennsylvania U., Philadelphia (Dec. 8-9, 1958), ed. by E. Galanter. New York, Wiley and Sons, 1959, 198p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-157) (AF 49(638)187] AD 235911
Unclassified

The techniques of teaching by machines are discussed in the 16 papers presented by some of the leading researchers in the behavior sciences. Programming, efficient learning, programs in elementary subjects, psychology, elements of successful programs, and the relation between programmed textbooks and teaching machines are presented.

586

Georgetown U. Medical Center, Washington, D. C.

SCORING MANUAL FOR A SENTENCE COMPLETION TEST OF HOSTILITY, AGGRESSION ANXIETY AND PROJECTION, by H. Zimmer. Sept. 1959, 1v. (AFOSR-TN-59-949) (AF 49(638)487) AD 227059
Unclassified

This test was developed as a research tool for the purpose of studying intrapersonal processes through the medium of hostility. It was constructed because it appeared that a similar instrument was not available. The measurement of 3 processes is attempted by means of the test: (a) the subject's direction and strength of hostility, (b) the extent of his aggression anxiety, and (c) his proclivity for projecting hostility. Nine items are devoted to the measurement of aggression anxiety, 12 to projection of hostility, and the remaining 34 to measuring hostility per se. The last 34 items are divided into 3 categories, on the basis of the stimulus value of their sentence stems: 12 are labelled "aggressing against," 7 are "ambipuritive," and 15 are called "being agressed against." Together they constitute the hostility group, and are scored and treated in an identical fashion. (Contractor's abstract)

Giannini Research Lab., Santa Ana, Calif.
see Plasmadyne Corp. Giannini Research Lab., Santa Ana, Calif.

587

Göttingen U. Inst. of Physiology (Germany).

THE INTERACTION OF TWO TYPES OF INSPIRATORY NEURONS IN THE REGION OF THE TRACTUS SOLITARIUS OF THE CAT, by R. von Baumgarten and E. Kanzow. [1958] [13]p. incl. diagrs. refs. (AFOSR-TN-59-841) (AF 61(514)1265) AD 225420   Unclassified

Also published in Arch. Ital. Biol., v. 96: 361-373, 1958.

Microelectrode recordings of spike discharges from the lower brainstem of decerebrated or of anaesthetized cats led to the conclusion that a pool of neurons firing during inspiration are localized in a circumscribed reticular region close to the tractus solitarius, 1-3 mm rostrally to the obex. One group of units (R_α-neuron)

was found to fire synchronously with the phrenic motoneurons during each inspiration. Their discharge was not abolished during the respiratory paralysis produced by succinyl-choline, but was inhibited simultaneously

with that of the phrenic motoneurons during lung infla-
tion. In the same region another type of units (R_β-
neuron) was also found to fire in phase with the phrenic
motoneurons under our experimental conditions. How-
ever the inflation of the lungs greatly strengthened and
sometimes drove the spike discharges of these units.
It is suggested (1) that the R_α-units drive, directly or
indirectly, the discharge of the spinal inspiratory moto-
neurons and (2) that the R_β-units inhibit the discharge
of the R_α ones. They would in turn be driven intracen-
trally by the R_α-cells and reflexly by the lung stretch
receptors, thus subserving the inhibitory control of

the inspiratory act. (Contractor's abstract)

Guggenheim Aeronautical Lab., Pasadena, Calif.
    see California Inst. of Tech. Guggenheim Aeronautical
    Lab., Pasadena.

Guggenheim Jet Propulsion Center, Pasadena, Calif.
    see California Inst. of Tech. Guggenheim Jet Propul-
    sion Center, Pasadena.

Gustaf Werner Inst. of Nuclear Chemistry (Sweden)
    see Uppsala U. Gustaf Werner Inst. of Nuclear
    Chemistry (Sweden).

Hamilton Coll., Ont. (Canada) see McMaster U.
Hamilton Coll., Ont. (Canada).

Hammond Metallurgical Lab., New Haven, Conn. see
Yale U. Hammond Metallurgical Lab., New Haven,
Conn.

588

Harvard U. [Cruft Lab.] Cambridge, Mass.

SOME OBSERVATIONS ON POOL BURNING, by H. W.
Emmons. [1959] [17]p. incl. diagrs. (AFOSR-TN-59-
1084) (AF 49(638)29)   Unclassified

Also published in Proc. Internat'l. Symposium on The
Use of Models in Fire Research, Washington, D. C.
(Nov. 9-10, 1959), Washington, Nat'l. Acad. Sci., 1961,
p. 50-67.

The burning of acetone and methyl alcohol from small
open pools was examined for pool sizes from 1/4 in.
to 10 in. The very large influence of the radiant heat-
ing of the surrounding area on convective disturbances
is noted and the subsequent transfer of some of this
heat through the pan rims to the fuel is examined. A
method of separating burning rate into more tractable
pieces is proposed and is shown to be effective in
treating the meager data now available. (Contractor's
abstract)

589

Harvard U. Cruft Lab., Cambridge, Mass.

TRANSIENT PHENOMENA IN SEMICONDUCTOR
DIODES, by Y.-F. Chang. Jan. 5, 1959 [49]p. incl.
diagrs. tables, refs. (Technical rept. no. 294) (Spon-
sored jointly by Air Force Office of Scientific Re-
search, Office of Naval Research, and Signal Corps un-
der Nonr-186616) AD 225451   Unclassified

Transient analyses have all suffered from 2 simplifying
assumptions: the assumption of low-level injection, and
the exclusion of reactive circuit elements. This pres-
ent study concerns the transient analysis of p-n junc-
tions without these restrictions. The problem was
dealt with using approximation methods. The approxi-
mation involved was that of the distribution of injected
holes in the base-region of p-n junction diodes. Com-
parison of results showed very good agreement between
theoretical and experimental transients. Two new re-
lations have been derived from rigorous considerations.
The boundary condition relates the total current flow-
ing through the p-n junction and the normal derivative
of the carrier concentration at the junction. The injec-
tion relation is the relation between the total current
and the injecting hole-current. It was found that the
physical size of the p-n junction base region and the
equilibrium carrier composition within the junction
could be determined from 3 simple electrical transient

measurements. An equivalent circuit of the p-n junc-
tion under transient conditions has been derived from
the consideration of many different transient responses.

590

Harvard U. Cruft Lab., Cambridge, Mass.

NUCLEAR SPIN SATURATION BY ULTRASONICS IN
SODIUM CHLORIDE, by E. F. Taylor and N.
Bloembergen. Jan. 15, 1959 [8]p. incl. diagrs. table,
refs. (Technical rept. no. 284) (Sponsored jointly by
Air Force Office of Scientific Research, Office of Na-
val Research, and Signal Corps under Nonr-186616)
AD 225452   Unclassified

Presented at meeting of the Amer. Phys. Soc., Williams
Coll., Williamstown, Mass., Oct. 11, 1958.

Also published in Phys. Rev., v. 113: 431-438, Jan. 15,
1959.

Abstract also published in Bull. Amer. Phys. Soc., Ser-
ies II, v. 4: 108, Mar. 1, 1959.

An ultrasonic vibrational mode with rather well-defined
properties has been set up in a cylindrical single crys-
tal of sodium chloride. The saturation of the spin lev-
els of Na^{23} and Cl^{35} by acoustically induced quadrupole
transitions, $\Delta m = \pm 2$, has been measured in the steady
state by a standard nuclear magnetic resonance tech-
nique, for several orientations of the ultrasonic wave
and external magnetic fields. The components of the
fourth-order tensor connecting the electrical field gra-
dient tensor at the nuclei with the strain deformation
tensor have been determined. The components satisfy
an isotropy condition rather than the Cauchy relation.
The results show the inadequacy of the ionic point-
charge model coupled with an isotropic Sternheimer an-
tishielding factor. The interpretation of the data re-
quires a considerable amount of covalent character and
configurational interaction on the Na^+ ion. (Contractor's
abstract)

591

Harvard U. [Cruft Lab.] Cambridge, Mass.

NUCLEAR MAGNETIC RESONANCE IN ALKALI
METAL ALLOYS (Abstract), by L. Rimai and N.
Bloembergen. [1959] [1]p. (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval Re-
search, and Signal Corps under [Nonr-186616])
                                       Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
166, Mar. 30, 1959.

The Na^{23} and Rb^{87} resonances in Na-K and Na-Rb systems have been observed. The solid solubility is small but the components are completely miscible in the liquid phase. The Knight shifts in the liquid phase are linear functions of the relative concentration. Let K_0 be the Knight shift in the pure metal, K in the alloy with a solute concentration c. The value of K_0^{-1} ($\delta K/\delta c$) is + 0.30 for Na in NaK, + 0.51 for Na in NaRb, and - 0.27 for Rb^{87} in NaRb. These results agree rather well with recent theories. The line width of Na^{23} increases on alloying, whereas the Rb^{87} line width decreases with increasing c. Saturation data indicate that T_1 is proportional to T_2. The change in T_1 calculated from the Korringa relation is much smaller than the observed change. The results can be explained if the effect of the spin-exchange interactions $AI(Na) \cdot I(Rb)$ and $A'I(Rb^{85})$. $I(Rb^{87})$ on T_1 and T_2 is taken into account.

592

Harvard U. Cruft Lab., Cambridge, Mass.

TABLES OF COULOMB WAVE FUNCTIONS. VOLUME I. (r = 2.0 — r = 8.3), by M. Blume, N. Briggs, and H. Brooks. Apr. 1, 1959, 1v. incl. tables. (Technical rept. no. 260, v. 1) (Sponsored jointly by [Air Force Office of Scientific Research], Office of Naval Research, and Signal Corps under Nonr-186616) AD 218751   Unclassified

The solutions and the derivatives of the solutions are tabulated of the differential equation

$$\frac{d^2 U^{(1)}}{dr^2} + [E + \frac{2}{r} - \frac{1(1+1)}{r^2}] U^{(1)} = 0$$

This is the radial part of the hydrogenic wave equation expressed in atomic units (energy in rydbergs and distance in Bohr radii). The tables are accurate to 7 significant figures. They run from r = 2.0 to r = 5.0 in intervals of 0.1, and from ϵ (= -E) = 0.07 to ϵ = 1.20 in intervals of 0.01. The functions are grouped so that all values of ϵ for a given r are adjacent in the tables. For each set of values of ϵ and r the solutions for 1 = 0, 1, 2 are listed consecutively. (Contractor's abstract)

593

Harvard U. Cruft Lab., Cambridge, Mass.

TABLES OF COULOMB WAVE FUNCTIONS. VOLUME II. (r = 8.4 - r = 15.0), by M. Blume, N. Briggs, and H. Brooks. Apr. 1, 1959, 1v. incl. tables. (Technical rept. no. 260, v. 2) (Sponsored jointly by Air Force Office of

Scientific Research, Office of Naval Research and Signal Corps under Nonr-186616) AD 219947
                Unclassified

A most extensive listing of Coulomb wave function computations is presented.

594

Harvard U. Cruft Lab., Cambridge, Mass.

STRESS AND TEMPERATURE DEPENDENCE OF THE PARAMAGNETIC RESONANCE SPECTRUM OF NICKEL FLUOSILICATE, by W. M. Walsh, Jr. [1959] [13]p. incl. illus. diagrs. refs. [Technical rept. no. 292] (In cooperation with Harvard U. Gordon McKay Lab.) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [Nonr-186616]) AD 232202   Unclassified

Published in Phys. Rev., v. 114: 1473-1485, June 15, 1959.

The crystalline field splitting of the ground state of divalent nickel in the fluosilicate, $NiSiF_6 \cdot 6H_2O$, has been measured at room temperature as a function of hydrostatic pressure to 10,000 kg/cm^2 and uniaxial stress to 150 kg/cm^2. The anisotropic compressibility and thermal expansion of this trigonal crystal have also been determined. Combining these data with the known variation of the splitting with temperature, its dependence on isothermal unit cell geometry and on temperature at constant unit cell dimensions is calculated. The splitting is found to be independent of volume within experimental error but proves to be quite sensitive to unit cell shape. The deduced explicit temperature dependence is 3 times larger than that measured at atmospheric pressure. The magnitude and geometrical variation of the crystalline field splitting may be qualitatively understood using a static, ionic model of the $(Ni \cdot 6H_2O)^{2+}$ octahedral complex. A rather general analysis of the explicit temperature dependence indicates, however, that low-frequency lattice vibrations play a dominant role in determining the observed value of the splitting. The resonance line widths are observed to increase monotonically and quite nonlinearly with increasing pressure. This broadening is discussed in terms of isotropic and anisotropic exchange interactions. In agreement with earlier conclusions of Ollom and Van Vleck it is inferred that the 2 mechanisms are of comparable importance in this paramagnetic salt. (Contractor's abstract)

595

Harvard U. Cruft Lab., Cambridge, Mass.

PRESSURE DEPENDENCE OF THE PARAMAGNETIC RESONANCE SPECTRA OF TWO DILUTE CHROMIUM SALTS, by W. M. Walsh, Jr. [1959] [6]p. incl. diagrs.

tables, refs. [Technical rept. no. 293] (In cooperation with Harvard U. Gordon McKay Lab.) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [Nonr-186616]) AD 232203   Unclassified

Published in Phys. Rev., v. 114: 1486-1490, June 15, 1959.

The pressure dependences of the spin-Hamiltonian parameters of trivalent chromium in ammonium aluminum alum and potassium cobalticyanide have been measured up to 10,000 kg/cm^2 near room temperature. In the case of the alum, runs have been made at 0, 24 and 50°C. The g-value remains unchanged while the crystalline field splitting, δ, increases by $\sim 30\%$, $(\partial\delta/\partial P)_m$ creasing with rising temperature and pressure. Using an empirically determined equation of state the crystalline field splitting variations are converted to isothermal volume and explicit temperature dependences. These are discussed in terms of static and dynamic crystalline fields but are not satisfactorily explained. This failure is attributed to inhomogeneous internal deformation of the unit cell as a function of stress and temperature. A room temperature run on the covalent chromicyanide shows the g-value as well as the principal splitting parameter, D, to be nonmonotonic functions of pressure. The rhombic splitting parameter, E, increases quadratically with pressure. Since no attempt was made to determine the crystalline equation of state the resonance data are only qualitatively discussed. It is difficult to reconcile the results with the equivalent crystalline field model of the chromicyanide complex. (Contractor's abstract)

596

Harvard U. Cruft Lab., Cambridge, Mass.

NUCLEAR RESONANCE STUDY OF ELECTRONIC MAGNETISM IN COPPER-NICKEL, by D. [L.] Weinberg and N. Bloembergen. July 13, 1959 [14]p. incl. diagrs. table, refs. (Technical rept. no. 307) (In cooperation with Harvard U. Gordon McKay Lab.) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186616) AD 225350   Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 15: 240-248, Oct. 1960.

Alloying with 27, 38 or 43% Ni is found to produce extreme broadening and asymmetry of the NMR of Cu. Almost every observable Cu nucleus appears to undergo a decrease in magnetic field. The width between derivative peaks is increased by as much as 12 times. It is satisfactorily proportional to or independent of applied field, according as electronic paramagnetism (in the 27% alloy) or weak ferromagnetism is expected to be involved, but the central portion of the line expands in proportion to the field. The concentration dependences are much slower than that of the macroscopic magneti-

zation. Isotropic indirect exchange coupling between the Cu nuclei and the time average magnetic moments of the Ni atoms, and inhomogeneity of the Knight shift account for the measurements approx. It is necessary to include large contributions from Cu nuclei in noncubic environments. The field and concentration dependences are interpreted in terms of inhomogeneous electronic magnetism in the ferromagnetic alloys. The Ni paramagnetism cannot be identified in alloys of up to 15% Ni because of quadrupole effects. (Contractor's abstract)

597

Harvard U. Cruft Lab., Cambridge, Mass.

CROSS RELAXATION IN LiF, by P. S. Pershan. Aug. 1, 1959, 26p. incl. diagrs. refs. (Technical rept. no. 308) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186616) AD 230334   Unclassified

Also published in Phys. Rev., v. 117: 109-116, Jan. 1, 1960.

A combined experimental and theoretical study of cross relaxation in LiF was carried out. In agreement with theory the cross relaxation time T_{21}, is observed to be strongly anisotropic and field dependent, at 51.7 gauss it goes from 0.025 sec in the [100] direction to 7 sec in the [111] direction. A frequency distribution function analogous to the line shapes for magnetic absorption is measured down to 10^{-4} times the maximum value; for most orientations a Gaussian is an excellent approximation to it. (Contractor's abstract)

598

Harvard U. Cruft Lab., Cambridge, Mass.

CROSS RELAXATION IN SPIN SYSTEMS, by N. Bloembergen, S. Shapiro and others. Oct. 15, 1958, 42p. incl. diagrs. refs. (Technical rept. no. 285) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186616) AD 207205   Unclassified

Also published in Phys. Rev., v. 114: 445-459, Apr. 15, 1959.

The energy transfer between adjacent resonances in nuclear and electron spin systems is analyzed in terms of the overlap of line-shape functions. The procedure is an enlargement on the original proposal of Kronig and Bouwkamp, and consists of taking partial account of off-diagonal elements in the spin-spin interaction, which are omitted in Van Vleck's truncated Hamiltonian. If the frequency of these off-diagonal elements is sufficiently small, they give rise to an additional kind of spin-spin relaxation, observed by Gorter and co-workers. They

are also responsible for cross-saturation effects in paramagnetic salts of the type observed by Townes and co-workers. A crucial experiment is described which can be explained by spin-spin interactions, but not by the assumption of a hot-photon region. Implications of the cross-relaxation for the operation of solid state masers are discussed. Special consideration is given to magnetically dilute substances and inhomogeneously broadened lines. Paradoxically, the latter will usually still undergo a homogeneous steady-state saturation. (Contractor's abstract)

599

Harvard U. Cruft Lab., Cambridge, Mass.

NUCLEAR MAGNETIC RESONANCE IN ANTIFERRO-MAGNETIC MnF_2 UNDER HYDROSTATIC PRES-SURE, by G. B. Benedek and T. Kushida. Oct. 30, 1959, 27p. incl. diagrs. tables, refs. (Technical rept. no. 315) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186616) AD 230335
Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 183, Mar. 30, 1959. (Title varies)

Also published in Phys. Rev., v. 118: 46-57, Apr. 1, 1960.

The nuclear magnetic resonance frequency of the F^{19} nucleus in antiferromagnetic MnF_2, in zero external field, was measured as a function of pressure at 4.2°K, and 35.7°K using a new type VHF variable frequency spectrometer. From these measurements were deduced the pressure dependence of the hyperfine coupling constant (A) between the manganese electrons and the fluorine nucleus, and the pressure dependence of the Néel temperature. This deduction gives $(1/A)(dA/dP) =$ $+(1.9 \pm 0.1) \times 10^{-6}/(kg/cm^2)$ and $(1/T_N)(dT_N/dP) =$ $+(4.4 \pm 0.3) \times 10^6/(kg/cm^2)$. Also measured was the compressibility of MnF_2. The magnitude and pressure dependence of A is explained using the theories of A. Mukherji and T. P. Das and W. Marshall and R. N. Stuart, which permit a calculation of the dependence of A on the interatomic distances, starting from the Hartree-Fock self-consistent field wave functions for Mn^{2+} and F^- with the Mn^{2+} wave functions properly adjusted to bring it into agreement with neutron scattering form factor measurements. The theory is in very good agreement with the experimental results. (Contractor's abstract)

600

Harvard U. Cruft Lab., Cambridge, Mass.

NUCLEAR MAGNETIC RESONANCE IN ALKALI AL-LOY SYSTEMS, NaK AND NaRb, by L. Rimai and N. Bloembergen. Nov. 20, 1959 [14]p. incl. diagrs. refs. (Technical rept. no. 314) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186616) AD 243874
Unclassified

Published in Jour. Phys. and Chem. Solids, v. 13: 257-270, 1960.

The Knight shift K in liquid NaK and NaRb systems is a linear function of the relative Na-concentration 1-C. The relative variation $K^{-1}(\partial K/\partial C) = 0 \cdot 361$ for Na^{23} in NaK, $= 0 \cdot 518$ for Na^{23} in NaRb and $= 0 \cdot 270$ for Rb^{87} in NaRb. An interpretation in terms of the scattering theory of conduction electrons is given. The line width of the Na^{23} and Rb^{87} resonances is a non-linear function of C. It is about a factor 5 larger in the Rb-rich alloys than at the Na-rich end. This result can be explained by the electron-coupled spin exchange interaction between different nuclei. The remarkable fact that these spin-spin interactions do not average to a small value in the liquid metals necessitates the postulate of a long range character for the electron-coupled interaction. The Knight shift and line width in solid terminal solutions have also been observed and compared with theory. The experiments show that nuclear magnetic resonance is particularly well suited to determine phase diagrams of alkali alloy systems. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

RELAXATION EFFECTS IN A MASER MATERIAL, $K_3(CoCr)(CN)_6$, by S. Shapiro and N. Bloembergen. [1959] [6]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [Nonr-186616])
Unclassified

Published in Phys. Rev., v. 116: 1453-1458, Dec. 15, 1959.

The rate equations for the occupation of spin levels are augmented to include cross-relaxation processes. It is confirmed experimentally that the latter are important when the concentration of magnetic ions is high or 2 resonances have a small separation. Maser action is usually impaired under such circumstances. When experimental conditions are chosen such that cross-relaxation effects are negligible, it is shown that all spin-lattice relaxation processes for Cr^{+++} in the cyanide are proportional to the absolute temperature in the

liquid helium range. The susceptibilities at both the pump and maser frequencies follow the general theoretical dependence and reach asymptotic values as a function of pump power. (Contractor's abstract)

602

Harvard U. [Cruft Lab.] Cambridge, Mass.

NUCLEAR MAGNETIC RESONANCE INTENSITIES IN ALLOYS, by D. L. Weinberg. [1959] [12]p. incl. diagrs. tables, refs. (In cooperation with Harvard U. Gordon McKay Lab.) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [Nonr-186616]) Unclassified

Published in Jour. Phys. and Chem. Solids, v. 15: 249-260, Oct. 1960.

The steady state magnetic resonances of Cu^{63}, Al^{27} and Li^7 have been studied in the majority constituents of the Cu-Ni, Cu-Au, Al-Zn and Li-Mg alloy systems, over wide ranges of composition, magnetic field and temperature. Nuclear electric quadrupole effects are most prominent. The line widths, shapes and frequencies can be qualitatively understood in simple cases, but the predictions of the general statistical problem have not been obtained. Initial intensity reductions in copper alloys are consistent with screening of excess charge by conduction electrons and enhancement by antishielding factors. The field gradients seem to be primarily of charge origin when there is a valence difference, but those arising from size differences can be comparable. The intensity falls markedly less rapidly above about 20% solute in Cu-Ni and Cu-Au, and increases very strongly at about 40% Ni. The anomalous intensity is believed to arise from non-cubic configurations of solute atoms which give rise to small field gradients at the central nucleus. The influence of order in Cu-Au on the intensity is described better by the conventional long range order than short range order, because the former distinguishes between the Cu and Au sublattices. The predictions are compared with effects of heat treatment. (Contractor's abstract)

603

Harvard U. Cruft Lab., Cambridge, Mass.

THEORY OF CORNER-DRIVEN COUPLED SQUARE LOOP ANTENNAS, by S. Prasad. Feb. 1, 1959 [41]p. incl. diagrs. (Technical rept. no. 277) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 214979 Unclassified

A theory for 2 identical square loop antennas driven in the zeroth-phase sequence (voltages in phase at all 4 corners) and the 2nd-phase sequence (voltages alternately in and out of phase at the corners) is formulated. Eight independent integral equations are obtained. They

are solved individually by the method of iteration and 1st-order formulas are obtained for the current distributions and driving-point impedances. For each phase sequence, the sum of the symmetrical and anti-symmetrical impedances gives the self-impedance and the difference between them gives the mutual impedance. Self-and mutual impedances are also obtained for a superposition of the 2-phase sequences. (Contractor's abstract)

604

Harvard U. Cruft Lab., Cambridge, Mass.

SELF-AND MUTUAL IMPEDANCES OF STACKED ARRAYS OF SQUARE LOOP ANTENNAS, by S. Prasad. Feb. 5, 1959 [23]p. incl. diagrs. tables. (Technical rept. no. 278) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 218430 Unclassified

Stacked arrays of square loops driven in the zeroth-phase sequence (voltages in phase at all 4 corners) and the 2nd-phase sequence (voltages alternately in and out of phase at the corners) were studied. Self-and mutual impedances were calculated for each phase sequence and for a simple superposition of the 2 phase sequences using a modified zeroth-order theory. Self-and mutual impedances were obtained experimentally for the same superposition of the 2 phase sequences. (Contractor's abstract)

605

Harvard U. Cruft Lab., Cambridge, Mass.

RADIATION FIELD OF THE CORNER-DRIVEN SQUARE LOOP ANTENNA, by S. Prasad. Feb. 10, 1959 [31]p. incl. diagrs. tables. (Technical rept. no. 283) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 220322 Unclassified

The radiation properties of square loop antennas driven in the zeroth-phase sequence (voltages in phase at all 4 corners), the 2nd-phase sequence (voltages alternately in and out of phase at the corners) and a simple superposition of the 2 phase sequences have been studied. The theoretical far-zone electric field has been obtained for each phase sequence and for the simple superposition of the 2 phase sequences. The radiation patterns have been obtained experimentally for the same cases. (Contractor's abstract)

606

Harvard U. Cruft Lab., Cambridge, Mass.

A CORNER-REFLECTOR ANTENNA DERIVED FROM THE SQUARE LOOP, by S. Prasad. Feb. 25, 1959, 11p.

incl. illus. tables. (Technical rept. no. 287) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 218139   Unclassified

The circuit and field properties of a corner-reflector antenna derived from a square loop was studied. Input impedances and current distributions were obtained experimentally and compared with the theoretical results, for antennas of different sizes. Radiation patterns were also obtained for such antennas. (Contractor's abstract)

607

Harvard U. Cruft Lab., Cambridge, Mass.

AN EXPERIMENTAL STUDY OF A SLOT ANTENNA AND A THREE-ELEMENT COLLINEAR ARRAY OF SLOT ANTENNAS, by G. H. Owyang. May 15, 1959, 1v. incl. illus. table. (Technical rept. no. 291) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 226952   Unclassified

The conventional transmission-line measuring techniques are shown to be applicable on a slot transmission line. The 2-slot transmission line is used to drive the slot antenna under study. The complementary normalized input impedance, the distribution of E'-field and the distribution of H'-field are measured as a function of the half-length of the slot antennas. The experimental results are then compared with the theory for a cylindrical antenna. Qualitative discussions are given to take account of the effect of the thickness of the ground plane. Similar study was made on a collinear array of slot antennas. (Contractor's abstract)

608

Harvard U. Cruft Lab., Cambridge, Mass.

EXPERIMENTAL STUDY OF A TWO-SLOT TRANSMISSION LINE, by G. H. Owyang. May 15, 1959, 1v. incl. diagrs. (Technical rept. no. 289) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 226889   Unclassified

The experimental set-up which consists of 2 slot transmission line together with its probing system is described. The method for testing the balance of the 2-slot line is discussed. The measuring techniques on the slot transmission line are given. The transverse distribution of the longitudinal current and the attenuation constant of a 2-slot line are measured. (Contractor's abstract)

609

Harvard U. Cruft Lab., Cambridge, Mass.

THE MEASUREMENT OF THE LINE PARAMETERS OF THE TWO-SLOT LINE BY THE METHOD OF ANALOGY, by G. H. Owyang. May 15, 1959 [14]p. incl. illus. table. (Technical rept. no. 290) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 226890   Unclassified

The analogy between the steady state field in a conducting medium and the electrostatic field in a dielectric is investigated. The expressions for the constants of a 2-slot line are derived in a form so that they can be easily evaluated from the experimental data obtained from the electrolytic tank. The measured results are compared with theoretical values. (Contractor's abstract)

610

Harvard U. Cruft Lab., Cambridge, Mass.

ON THE RADIATION PATTERN OF A BASE-DRIVEN ANTENNA OVER A CIRCULAR CONDUCTING SCREEN, by C. L. Tang. May 15, 1959 [13]p. incl. illus. tables. (Technical rept. no. 301) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 220323   Unclassified

The radiation pattern of a base-driven antenna of length h over a circular ground screen of radius a is examined from the point of view of high-frequency diffraction theory. By the use of Babinet's principle, the antenna problem is shown to be reducible to a scalar problem of diffraction of an infinitesimal dipole field by a circular aperture in a plane acoustically soft screen. In the limit of large ka and h << a, the leading terms in an asymptotic development of the distant magnetic field are found. (Contractor's abstract)

611

Harvard U. Cruft Lab., Cambridge, Mass.

THE PRINCIPLE OF COMPLEMENTARITY FOR SLOT LINES AND ANTENNAS, by G. H. Owyang. May 15, 1959 [21]p. incl. diagrs. (Technical rept. no. 288) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 226888   Unclassified

The principle of complementarity is reviewed and reformulated with particular reference to its application in the study of slot transmission lines and slot antennas. The properties of a dual circuit together with the restricting conditions are investigated. The pairs of several possible duals for a given arbitrary configuration are correlated. New quantities are defined for use in the discussion of the different types of circuits.

A complete parallelism between the 2 wire-line and the 2-slot line is established for the ideal cases and is extended by approximation to include the practical cases. The line constants of the 2-slot line and of the 2-strip line were derived for both the ideal case and the practical case. (Contractor's abstract)

612

Harvard U. Cruft Lab., Cambridge, Mass.

THE SLOT ANTENNA WITH COUPLED DIPOLES, by G. H. Owyang. May 15, 1959, 1v. incl. diagrs. tables. (Technical rept. no. 302) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Ncnr-186632) AD 226951   Unclassified

The problem of an array consisting of a slot antenna and 2 symmetrically located cylindrical dipoles is formulated. Subjected to certain conditions, the approx distribution of the current along each antenna is obtained by the method of iteration. The radiation function, the coupling coefficients between the slot and the dipole, the relation between the magnetic current in the slot and the electric current in the dipole, and the input impedance of the slot in the presence of the dipoles were obtained. The experimental set-up for measuring the radiation patterns is described. The measured and the theoretical patterns are presented. (Contractor's abstract)

613

Harvard U. Cruft Lab., Cambridge, Mass.

HIGH-FREQUENCY DIFFRACTION BY A SPHERE, by C. L. Tang. May 25, 1959 [12]p. incl. illus. (Technical note no. 303) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 220325
Unclassified

A systematic procedure is given for the determination of the asy nptotic series directly from the Helmholtz equation and the boundary conditions for the field in the shadow region of a sphere illuminated by a plane wave at high frequencies. The first 2 terms in the series for the shadow region, including the regions near the axial caustic and the boundary layer near the surface of the sphere, are explicitly evaluated. The present procedure can be generalized to any smooth convex 3-dimensional object with a rotational symmetry, illuminated by a plane wave in the direction of the axis of rotational symmetry. (Contractor's abstract)

614

Harvard U. Cruft Lab., Cambridge, Mass.

A NUMERICAL STUDY OF AN UNFAMILIAR TYPE OF

IMPEDANCE, by W. F. Pickard and T. T. Wu June 1, 1959 [16]p. incl. diagrs. table. (Technical rept. no. 300) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 220324
Unclassified

A procedure is outlined for decomposing a rather general class of microwave impedances into 5 unique subclasses, and a method is indicated by which 3 of these can be studied by means of their voltage response functions. Of these 5 subclasses, only the 5th is unfamiliar. The computation of the response function is outlined for a special case of this 5th type, and selected numerical results are presented. (Contractor's abstract)

615

Harvard U. Cruft Lab., Cambridge, Mass.

THE ELECTROPHORESIS OF A SPHERICAL PARTICLE, by W. F. Pickard. July 1, 1959 [37]p. incl. illus. (Technical rept. no. 304) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 231945   Unclassified

The problem of predicting the electrophoretic velocity of a spherical-charged particle in an infinite dielectric liquid containing impurities is re-examined. A model, somewhat different from those commonly used, is postulated, and the associated equations are formulated and are solved subject to certain approximations. The electrophoretic velocity U is found to be linear in the applied field and to vary algebraically in the parameter $\mu = ka$. Curves for determining $U(\mu)$ are presented. (Contractor's abstract)

616

Harvard U. Cruft Lab., Cambridge, Mass.

REFLECTION OF ELECTROMAGNETIC WAVES FROM SOUND WAVES, by H. J. Schmitt. Aug. 10, 1959 [18]p. incl. diagrs. (Technical rept no. 310) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 226886   Unclassified

The reflection of electromagnetic waves normally incident on the wavefronts of a semi-infinite standing sound wave is discussed. By analogy with the Bragg reflection in optics, a maximum reflection occurs when the wavelength of the electromagnetic radiation in the sound perturbed region is twice the acoustic wavelength. Since the reflecting planes of maximum sound pressure disappear periodically, the reflected electromagnetic signal is modulated with the sound frequency. An experiment is described in which the Bragg reflection of 3 cm electromagnetic waves from a standing sound wave beneath a water surface is observed. (Contractor's abstract)

617

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

ON DEGREE OF APPROXIMATION BY BOUNDED
HARMONIC FUNCTIONS, by J. L. Walsh. Apr. 1959,
28p. incl. refs. (AFOSR-TN-59-235) (AF 18(600)1461)
AD 212005; PB 144468   Unclassified

Also published in Jour. Math. Pures et Appl., v. 39:
201-220, July-Sept. 1960.

If u(x,y) is defined on an analytic Jordan curve C, a
necessary and sufficient condition that u(x,y) be of
class $L(p,\alpha)$, $0 < \alpha < 1$, on C is that there exist func-
tions $u_n(x,y)$ harmonic in a region D containing C sat-
isfying $|u_n(x,y)| = AR^n$ in D and $|u(x,y)-u_n(x,y)| \leq$
$A_1/n^{p+\alpha}$ on C. (Contractor's abstract)

618

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

NOTE ON INVARIANCE OF DEGREE OF POLYNOMI-
AL AND TRIGONOMETRIC APPROXIMATION UNDER
CHANGE OF INDEPENDENT VARIABLE, by J. L.
Walsh. Aug. 1959, 12p. (AFOSR-TN-59-593) (AF 18-
(600)1461) AD 217183; PB 144489   Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 1528-
1533, Oct. 1959.

Various commonly used measures of degree of approxi-
mation are shown to be invariant under one-to-one
analytic transformation of the independent variable.
This is true for both approximation by polynomials in
the complex variable and trigonometric approximation
in the real variable. The methods used emphasize the
invariance of degrees of approximation. (Contractor's
abstract)

619

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

POLYNOMIALS OF BEST APPROXIMATION ON AN
INTERVAL, by J. L. Walsh and T. S. Motzkin. Oct.
1959, 10p. (AFOSR-TN-59-854) (In cooperation with
California U., Berkeley) (Sponsored jointly by Air
Force Office of Scientific Research under AF 18(600)-
1461 and Office of Naval Research) AD 228078;
PB 144494   Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 1523-
1528, Oct. 1959.

New results are indicated, partly without proof, on the
analogous problems of approximation to a given continu-
ous function on a closed finite interval E. (Contractor's
abstract)

620

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

THE BILINEAR RELATION ON OPEN RIEMANN SUR-
FACES, by R. D. M. Accola. Oct. 1959 [35]p. incl.
diagr. (AFOSR-TN-59-951) (AF 18(600)1461)
AD 228008; PB 144871   Unclassified

Also published in Trans. Amer. Math. Soc., v. 96: 143-
161, July 1960.

Let Γ_h be the Hilbert space of square integrable harmon-
ic differentials on an open Riemann surface W. If
$\{\Omega_n\}$ is an exhaustion of W, let $A_1, B_1, ..., A_{p(n)}, B_{p(n)}, ...$
be a canonical homology basis, where $A_1, B_1, ..., A_{p(n)}$,
$B_{p(n)}$ is a basis modulo dividing cycles of Ω_n. Let Γ_{he} be ex-
act, Γ_{hse} be semi-exact, and Γ_a be analytic differentials.
Let $\Gamma_{ho} = \Gamma_{he}^{*\perp}$, and $\Gamma_{hm} = \Gamma_{hse}^{*\perp}$. Let $\sigma(c)$ be the
unique differential in Γ_{ho} such that $\int_c \omega = (\omega, \sigma^*(c))$, where
c is a cycle. For $\omega \in \Gamma_{hse}$ let $T_n \omega = \sum_{k=1}^{p(n)} (\int_{B_k} \omega)\sigma(A_k) -$

$(\int_{A_k} \omega)\sigma(B_k)$. It is said that the generalized bilinear rela-
tion (GBR) holds for $\omega \in \Gamma_{hse}$ if $(\tau, (T_n \omega)^*) \to (\tau, \omega^*)$ for all
$\tau \in \Gamma_{ho}$. The GBR holds for ω if and only if the projec-
tions of $T_n \omega$ on Γ_{ho}^* are bounded. If $W \in O_{HD}$ let $\Phi_k \in$
Γ_a satisfy $\int_{A_j} \Phi_k = \delta_{jk}$. The validity of the GBR for all
$\omega \in \Gamma_h$ implies that $\sum_{k=1}^{p(n)} (\int_{A_k} \alpha)\Phi_k \to \alpha$ strongly for $\alpha \in \Gamma_a$.

Parabolic surfaces exist where the GBR holds and does
not hold. Let $\mathfrak{A}$ be the span of the $\sigma(A_k)$'s, $\mathfrak{B}$ the span of
the $\sigma(B_k)$'s. If $W \in O_{HD}$ and $\mathfrak{A} + \mathfrak{B}$ is closed then
$(\tau, (T_n \omega)^*) \to (\tau, \omega^*)$ whenever τ and ω have a finite num-
ber of non-zero A (or B) periods. Then the Φ_k's span
Γ_a. Examples of parabolic surfaces exist where $\mathfrak{A} + \mathfrak{B}$
is not closed. A surface exists where Γ_{hm} is a proper
subset of $\Gamma_{he} \cap \Gamma_{he}$. On this letter surface the GBR can
hold for no canonical homology basis. (Contractor's
abstract)

621

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

NOTE ON DEGREE OF APPROXIMATION BY BOUNDED
ANALYTIC FUNCTIONS: PROBLEM β, by J. L. Walsh.
Oct. 1959, 22p. incl. refs. (AFOSR-TN-59-952) (AF 18-
(600)1461) AD 228076; PB 144472   Unclassified

Also published in Trans. Amer. Math. Soc., v. 96: 246-258, Aug. 1960.

A stronger result is presented of the relation between the degree of approximation on a point set E to the continuity properties on a different point set E' of the function f(z) approximated. Integrated Lipschitz conditions are used in the hypothesis in place of Lipschitz conditions used in the general result previously discussed (HAR.05:006, Vol. II). The study is divided into 2 parts: (1) the study of the classes of functions involving Lipschitz conditions, and (2) applications to approximation by bounded analytic functions. (ASTIA abstract)

622

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

ON THE ASYMPTOTIC PROPERTIES OF EXTREMAL POLYNOMIALS WITH PRESCRIBED CONSTANT TERM, by J. L. Walsh. Oct. 1959, 14p. (AFOSR-TN-59-1037) (AF 18(600)1461) AD 228077; PB 144368
Unclassified

Also published in Math. Zeitschr., v. 73: 339-345, 1960.

The analog is studied of $\lim_{n \to \infty} \|T_n(z)\|^{1/n} = \tau(E)$, for the polynomials: $p_n(z) = z^n + a_1 z^{n-1} + \ldots + a_n$ of least norm, where the numbers $a_n = A_n$ are prescribed. Under suitable conditions on the closed bounded set of the z-plane, E, necessary and sufficient conditions are obtained on the A_n that the analog be valid. (Contractor's abstract)

623

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

EXPANSIONS IN TERMS OF HEAT POLYNOMIALS AND ASSOCIATED FUNCTIONS, by P. C. Rosenbloom and D. V. Widder. [1959] [47]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1461 and Office of Naval Research under Nonr-71016) Unclassified

Published in Trans. Amer. Math. Soc., v. 92: 220-266, Aug. 1959.

Let $V_n(x,t)$ be defined by $\exp(zx + z^2 t) = \Sigma V_n(x,t)z^n/n!$, and $W_n(x,t)$ by $k(x-2z,t) = \Sigma W_n(x,t)z^n/n!$, where $k(x,t)$ is the fundamental solution of the heat equation. It is shown that V_n and W_n form a biorthogonal system and the questions involved in the expansion of functions in terms of a V or W series are thoroughly investigated. These questions include the determination of coefficients, the region of convergence, and the characterization of those functions for which the expansions are

possible. Asymptotic values of V_n and W_n are investigated and results in the L^2 theory are included. (Math. Rev. abstract)

624

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

PROOF THAT ANY BIRATIONAL CLASS OF NONSINGULAR SURFACES SATISFIES THE DESCENDING CHAIN CONDITION, by O. Zariski. [1959] [11]p. (AFOSR-TN-59-89) (AF 18(600)1503) AD 210089
Unclassified

Also published in Mem. Coll. Sci., Kyoto U., Series A, v. 32: 21-31, 1959.

Proof is proposed for a descending chain condition for algebraic surfaces by elementary algebra-geometric considerations as follows: If Pn is a fundamental point of Fn → Fn-1 and ξn is the cycle corresponding to Pn in Fn → F, it is verified that the set $\{\xi i\}$ contains an infinite subset $\{\xi ij\}$ of maximal elements of the set. One can fix an irreducible exceptional curve ξ j for each ξ i, and it is proved that: (1)$\xi_j \cap \xi_k = \phi$; (2) $(D \cdot \xi j) = 1$ for all j, where D is a cycle of the anticanonical system $|-K|$ on F and the left hand side of (2) denotes intersection index of D and Ej; (3) the relation (2) holds for all D of a certain linear subsystem L of $|-K|$, hence Ej is a component of one and only one cycle Dj of L; (4) $(Ej2) = 1$. The propositions (3) and (4) are in contradiction. (Math. Rev. abstract, modified)

625

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

ON FINITE GROUPS OF EVEN ORDER WHOSE 2-SYLOW GROUP IS A QUATERNION GROUP, by R. Brauer and M. Suzuki. [1959] [3]p. (AFOSR-TN-59-1173) (In cooperation with Illinois U., Urbana) (AF 49(638)287) AD 249161 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 1757-1759, Dec. 1959.

A proof is given of the following theorem: Let G be a group of finite even order. If the 2-Sylow group P of G is a quaternion group (ordinary or generalized), then G is not simple.

626

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

[ON THE REPRESENTATIVE THEORY OF GROUPS

OF FINITE ORDER, II] Zur Darstellungtheorie der Gruppen endlicher Ordnung, II, by R. Brauer. [1959] [22]p. (AF 49(638)287)   Unclassified

Published in Math. Zeitschr., v. 72: 25-46, 1959/1960.

The chief problem solved in this paper (theorem 7D) is that of determining the number k_τ of ordinary irreducible representations of a finite group $\mathfrak{G}$ which lie in the block B_τ, for a prime p which divides the order g of $\mathfrak{G}$. The ideas introduced in Part I (Math. Zeitschr., v. 63: 406-444, 1956) are further developed and lead to a refinement of the whole modular representation theory, in the sense that the block structures of certain sub-groups $\mathfrak{H}$ of $\mathfrak{G}$ yield information concerning that of $\mathfrak{G}$. In order to state the main theorem (6A), 2 preliminary ideas are necessary. If G is any element of $\mathfrak{G}$ it is well known that we may write G = PR, where P is p-singular, i.e., of order a power of p, and R is p-regular, of order prime to p; each of P and R is a power of G and PR = RP. If $\mathfrak{N}(P)$ is the normalizer of P in $\mathfrak{G}$, G $\in$ $\mathfrak{N}(P)$, so that we may write

$$\chi_i(PR) = \sum_j d_{ij}^P \varphi_j^P(R),$$

where χ_i is any ordinary character of G and φ_j^P a modular character of $\mathfrak{N}(P)$; the d_{ij}^P are algebraic integers called generalized decomposition numbers, and they are independent of R. For P = 1, the φ_j^P are the modular representations φ_j of $\mathfrak{G}$ and the d_{ij}^P the ordinary decomposition numbers of $\mathfrak{G}$. The second preliminary idea is that every block $\widetilde{B}$ of $\mathfrak{H} = \mathfrak{N}(P)$ arises by restricting $\mathfrak{G}$ to $\mathfrak{H}$ relative to some block B of $\mathfrak{G}$; this relationship is written B = $\widetilde{B}^\mathfrak{G}$, and §2 of the paper is devoted to studying the conditions under which such a block B is uniquely defined. Theorem 6A then reads as follows: the generalized decomposition numbers d_{ij}^P can differ from zero only if χ_i belongs to the block B = $\widetilde{B}^\mathfrak{G}$. From this main theoren follow certain results concerning the characters of $\mathfrak{G}$, in particular, theorem 7D, mentioned above: If B_1, B_2, $\cdots$ B_t are the p-blocks of $\mathfrak{G}$, and if P_1, P_2, $\cdots$, P_r is a representative set of p-singular elements of $\mathfrak{G}$ such that $l_\tau(P_i)$ is the number of irreducible modular characters $\varphi_j^{P_i}$ of $\mathfrak{N}(P_i)$ belonging to B with $\widetilde{B}^\mathfrak{G} = B_\tau$, then the number of ordinary irreducible characters of $\mathfrak{G}$ in B_τ is given by $k_\tau = \sum_{i=1}^r l_\tau(P_i)$. (Math. Rev. abstract)

627

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

COMPLETE IDEALS IN REGULAR LOCAL RINGS

OF DIMENSION 2, by O. Zariski. Dec. 1959, 29p. (AFOSR-TN-59-1114) (AF 49(638)494) AD 230077; PB 145484   Unclassified

The theory of complete ideals in polynomial rings k[x, y] of 2 variables presents some striking features. This theory (Amer. Jour. Math., v. 60: 51-204, 1938) is presented in the appendix in a simpler form and in greater generality. The generalization consists in dealing with arbitrary regular local rings of dimension 2, rather than with that special class of such rings which come from quotient rings of k[x, y] with respect to maximal ideals in k[x, y]. Very little is known about complete ideals in regular local rings of dimension greater than 2. It is almost certain that the theory developed here cannot be generalized to higher dimension without substantial modifications of both statements and proofs. (Contractor's abstract)

628

Harvard U. Lyman Lab. of Physics, Cambridge, Mass.

KNIGHT SHIFT IN SUPERCONDUCTORS, by P. C. Martin and L. P. Kadanoff. [1959] [2]p. [AF 49(638)-589]   Unclassified

Published in Phys. Rev. Ltrs., v 3: 322-323, Oct. 1, 1959.

A suggested explanation is given of the fact that the Knight shift (and hence the electron spin susceptibility) does not vanish in superconductors at low temperatures. It is shown that the B.C.S. theory yields a nonzero susceptibility if the magnetic field is non-uniform, as in hulk metals.

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Harvard U. [Lyman Lab. of Physics] Cambridge, Mass.

FIELD THEORY OF UNSTABLE PARTICLES, by J. Schwinger. [1959] [25]p. (AFOSR-1787) [AF 49(638)-589] AD 611513   Unclassified

Published in Proc. Ninth Internat'l. Annual Conf. on High Energy Phys., Kiev (USSR) (July 15-25, 1959), Moscow, 1960, Pt. 6, p. 54-89.

Also published in Ann. Phys., v. 9: 169-193, Feb. 1960.

Using the example of a spinless boson field, the structure of the simplest Green's function is developed to provide a uniform theory of particles, stable and unstable. Some attention is given to the time decay law of unstable particles and it is emphasized that a full account of the relevant physical situation must be contained in its mathematical representation, leading to the conclusion that an essential failure of the exponential decay law marks the limit of applicability of the physical concept of unstable particle. There is a brief discussion of the π and K mesons. (Contractor's abstract)

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Harvard U. Mallinckrodt Chemical Lab., Cambridge, Mass.

INFRARED SPECTRA OF SiF_3H, SiF_3D, SiD_3F, AND SiD_3Cl, by C. Newman, S. R. Polo, and M. K. Wilson. [1959] [17]p. incl. diagrs. tables, refs. (AFOSR-TN-59-472) (AF 18(600)590) AD 262126   Unclassified

The infrared spectra of SiF_3H, SiF_3D, SiD_3F, and SiD_3Cl have been obtained under prism dispersion, and an assignment of fundamental modes has been made. All of these molecules exhibit C_{3v} symmetry and have 6 fundamental frequencies, 3 totally symmetric, C_1, and 3 doubly degenerate.

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Harvard U. Mallinckrodt Chemical Lab., Cambridge, Mass.

PERFLUOROALKYL DERIVATIVES OF TIN AND LEAD, by H. D. Kaesz, J. R. Phillips, and F. G. A. Stone. [1959] [2]p. (AFOSR-TN-59-950) (AF 49(638)-518)   Unclassified

Also published in Chem. and Indus. (London), No. 45: 1409-1410, Nov. 7, 1959.

$R_3PbC_nF_{2n+1}$ (R = alkyl) type compounds were prepared from R_4Pb and IC_nF_{2n+1} (I) under ultraviolet light, or by heating. A typical compound prepared in this way was $Me_3PbC_2F_5$ (II), bp 138.0° (by extrapolation of the vapor pressure equation). R_3SnCF_3 and $R_3SnC_2F_5$ were prepared in small yields from R_4S_n and CF_3I or C_2F_5I, however, CHF_3 and HC_2F_5 were the main products, as well as R_3SnF. $(R_3Sn)_2$ with I gave $R_3SnC_nF_{2n+1} + R_3SnI$. The reaction proceeded readily to give Me_3SnCF_3, mp -50.5°, bp 100.0° (extrapolation). Compounds containing CF_3 bonded to Sn or Pb showed strong infrared bands near 1158 and 1073 cm^{-1} (C-F). $Me_3MC_nF_{2n+1}$ (M = Sn or Pb) showed asymmetric and symmetric Me rocking modes near 790 and 730 cm^{-1}. In $Ph_3MC_2F_5$, C-C stretching appeared at 935 cm^{-1} (CS_2 solution). Sn compounds were vapor-chromatrographed on diisodecyl phthalate, Pb compounds on Carbowax 4000. At 65° (He flow 180 cc/min) elution of Me_3PbCF_3 occurred in 13 min, while the elution time for II was 9 min. This is to be compared with an elution time of 2 min for Me_4Pb.

632

Harvard U. Mallinckrodt Chemical Lab. Cambridge, Mass.

PERFLUOROVINYL METALLIC COMPOUNDS, by H. D. Kaesz, S. L. Stafford, and F. G. A. Stone. [1959] [1]p. (AFOSR-TN-59-987) (AF 49(638)518)   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 6336, Dec. 5, 1959.

In a brief communication to the editor the electronegativity of perfluoroalkyl groups is discussed. It is suggested that it is the tin-bonded carbon atom of the perfluoroalkyl group which is the relatively electron deficient center and not the tin-bonded carbon atoms of alkyl or aryl groups. It is also stated that many properties of the perfluorovinyl compounds contrast strikingly with those of their vinyl or perfluoroalkyl analogs.

633

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ON SOME COVERING AND INTERSECTION PROPERTIES IN MINKOWSKI SPACES, by B. Grünbaum. [1959] [8]p. incl. refs. (AF 61(052)04)   Unclassified

Published in Pacific Jour. Math., v. 9: 487-494, 1959.

This report is concerned with 2 numbers, E_x and J_x, determined by the geometric properties of X. They are defined as follows: (1) The expansion constant E_x is the greatest lower bound of real numbers $\mu \geq 0$ which possess the following property: Given any family $\{x_i + \alpha_i S; i \in I\}$ of mutually intersecting cells. (2) Jung's constant J_x of X is the greatest lower bound of real numbers μ which possess the following property: Given any family $\{x_i + S; i \in I\}$ of mutually intersecting cells. The main object of the present note is the determination of the exact upper bound of E_x for n-dimensional spaces X and the characterization of those spaces for which the bound is attained.

634

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ANALYTIC FUNCTIONS OF THE CLASSES L^2 AND ℓ^2 AND THEIR KERNEL FUNCTIONS, by M. Maschler. Dec. 1958, 31p. incl. refs. (Technical scientific note no. 1) (AFOSR-TN-59-342) (AF 61(052)187) AD 213662   Unclassified

Also published in Rend. Circ. Matem. Palermo, Series II, v 8: 163-177, May-Aug. 1959.

Removable point sets for the Bergman kernel function are characterized completely. Necessary conditions on various kernel functions of essentially simply-connected domains are obtained, and are applied to the study of minimal and representative domains. (Contractor's abstract)

635

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ON THE ITERATION PRODUCT OF SUMMABILITY METHODS. I. NEW CLASSES OF TRANSFORMATIONS AND PROPERTIES, by A. Jakimovski. Feb. 1959, 56p. incl. refs. (Technical scientific note no. 2) (AFOSR-TN-59-343) (AF 61(052)187) AD 213663
Unclassified

Two new classes of transformation, which might be looked upon, respectively, as the sequence-to-function analogues to the Hausdorff and quasi-Hausdorff transformations are defined and investigated. Their relation to the iteration product problem is shown. (Contractor's abstract)

636

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ON DIVERGENCE OF RANDOM POWER SERIES, by A. Dvoretzky and P. Erdős. Feb. 1959 [8]p. (Technical scientific note no. 3) (AFOSR-TN-59-344) (AF 61-(052)187) AD 213664
Unclassified

Also published in Michigan Math. Jour., v. 6: 343-347, 1959.

The following theorem is proved:
Let c_n, $n = 0, 1, 2, ...$, be a monotone sequence of positive integers tending to zero and satisfying

$$\limsup_{n = \infty} \frac{\sum_{j=0}^{n} c_j^2}{\log 1/c_n} > 0.$$

If a_n, $n = 0, 1, 2, ...$, is a sequence of complex numbers satisfying $|a_n| \geq c_n$ for all sufficiently large n, then almost all series of $F(a_n)$ are divergent everywhere on $|z| = 1$.

637

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ON THE CONCEPT OF A DIFFERENTIALLY CLOSED FIELD, by A. Robinson. July 1959, 38p. incl. refs. (Technical scientific note no. 6) (AFOSR-TN-59-814) (AF 61(052)187) AD 226396; PB 145483
Unclassified

Also published in Bull. Israel Research Council, v. 8F: 113-128, Dec. 1959.

A concept of a differentially closed field is formulated which contains Kolchin's universal extension as a special case. Applications include a theorem on the specialization of parameters and a constructive version of Ritt's Nullstellensatz. (Contractor's abstract)

638

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

THE L_p APPROACH TO THE DIRICHLET PROBLEM. PART I, by S. Agmon. Aug. 1959, 99p. incl. refs. (Technical scientific note no. 7) (AFOSR-TN-59-815) (AF 61-(052)187) AD 226395; PB 145312   Unclassified

A Lipschitz L_p approach is presented to the Dirichlet problem, and to related regularity problems for higher order elliptic equations. The L_p approach is based on a L_p regularity theorem for very weak solutions of the Dirichlet problem. The regularity theorem is obtained by using the explicit solution of the Dirichlet problem for elliptic operators with constant coefficients in a half-space, and the L_p estimates for such solutions.

The basic regularity theorem is given both in the interior and at the boundary. When the simpler problem of interior regularity is considered, the weak solutions of overdetermined elliptic systems are also considered, and the L_p estimates are derived for such solutions.

The regularity theorem is combined with some general results on Banach spaces to develop the L_p existence theory for the Dirichlet problem. (Contractor's abstract)

639

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

THE PRODUCT OF SUMMABILITY METHODS. II. NEW CLASSES OF TRANSFORMATIONS AND THEIR PROPERTIES, by A. Jakimovski. Aug. 1959 [76]p. (Technical scientific note no. 2, pt. 2) (AFOSR-TN-59-816) (AF 61(052)187) AD 232071; PB 146101
Unclassified

Two new classes of transformation, which might be looked upon, respectively, as the sequence-to-function analogues to the generalized (and quasi-) Hausdorff transformation are defined and investigated. (Contractor's abstract)

640

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

LOCAL DIFFERENTIAL ALGEBRA, by A. Robinson.

May 1959, 61p. (Technical scientific note no. 4)
(AFOSR-TN-59-817) (AF 61(052)187) AD 220569;
PB 145311   Unclassified

A consistency condition is obtained for a system of
algebraic differential equations with given initial values.
Theories are developed for ideals, polynomial ideals,
and corresponding varieties. The starting point is a
differential ring whose elements, at a given point, are
represented by a homomorphic mapping into an ordin-
ary ring.

641

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ON SOME COMPOSITIONS OF HADAMARD TYPE IN
CLASSES OF ANALYTIC FUNCTIONS, by C. Loewner
and E. Netanyahu. June 1959, 6p. (Technical scien-
tific note no. 5) (AFOSR-TN-59-843) (AF 61(052)187)
AD 220708; PB 145310   Unclassified

Also published in Bull. Amer. Math. Soc., v. 65: 284-
286, July 1959.

Let S be the class of regular, and Schlicht functions in

the unit circle. Let $f(Z) = \sum\limits_{n=1}' a_n z^n$, $a_1 = 1$ and

$g(Z) = \sum\limits_{n=1}^{\infty} b_n z^n$, $b_1 = 1$, be the representing power series

of 2 elements of S. Then the composition $h(Z) =$

$\sum\limits_{n=1}^{\infty} \dfrac{a_n b_n z_n}{n}$ leads to an element of the same class.

The weak conjecture that h(z) has a non-varnishing de-
rivative in $|z| < 1$ is proved to be false.

642

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

RESEARCH IN THE AREA OF MATHEMATICAL A-
ANALYSIS, by S. Agmon, A. Dvoretzky, and A. Robinson.
Annual summary rept. Oct. 1959, 19p. (AFOSR-TR-
59-100) (AF 61(052)187) AD 232061; PB 146099
                                              Unclassified

This report summarizes the work done under this
contract to date. Agmon's work deals mainly with a
new L_p approach to the Dirichlet problem and to related
regularity problems for higher order elliptic equations
(item no. 638). A typical regularity result is pre-
sented. Dvoretzky's subject was on rearrangement of
series; comparison of densities of sequences (item no.
636) and a short recap of his work is presented also.
The investigations of Robinson are published in 2 parts
(item nos. 637 and 640) and are concerned with initial

value problems and differential algebra. The results
of Netanyahu's investigations are also presented in
brief. His subject, univalent functions, is discussed
in detail in another publication (item no. 641). Tau-
berian theorems and summability are discussed by
Jakimowski (item nos. 635 and 639). The heuristic
theorem is discussed briefly here. The investigations
of Marchler were concerned with the Bergman kernel
and sought to find properties of its function of a planar
domain D. The results, presented here in abstract form,
are discussed fully in another report (item no. 634).

643

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

THE SEQUENCE-TO-FUNCTION ANALOGUES TO
HAUSDORFF TRANSFORMATIONS, by A. Jakimovski.
[1959] [20]p. incl. refs. [AF 61(052)187]
                                              Unclassified

Published in Bull. Research Council, Israel, v. 8F: 135-
154, Nov. 1959.

A class of transformations-the J transformations (which
might be looked on as the sequence to function analogues
to the Hausdorff transformations) is defined. The basic
properties of the J transformations are given; and in-
clusion relations between the iteration product of J and
Hausdorff transformations and the J transformations
are given. (Contractor's abstract)

644

Hebrew U. Dept. of Physics, Jerusalem (Israel).

DETERMINATION OF RELATIVE ABUNDANCE, RA-
TIO OF MAGNETIC MOMENTS, RATIO OF CAPTURE
CROSS-SECTIONS OF GADOLINIUM ISOTOPES BY
MEANS OF PARAMAGNETIC RESONANCE SPEC-
TRUM, by W. Low and D. Shaltiel. Nov. 1958 [10]p.
incl. tables. (Technical note no. 5) (AFOSR-TN-59-
84) (AF 61(052)59) AD 210144; PB 138711
                                              Unclassified

Presented at Forty-fourth Nat'l. Congress of the
Italian Phys. Soc., Palermo (Italy), Nov. 6-11, 1958.

Abstract published in Nuovo Cimento, Series X, Suppl.,
v. 11: 468, 1959.

Precision of the hyperfine structure of the transitions
corresponding to $\Delta M = 4$ of the cubic field paramagnetic
resonance spectrum of gadolinium in single crystals of
thorium oxide yields the following values: Isotopic
abundance: Even isotopes - 69.45%; Gd^{155} - 15.05 $\pm$
0.2%; Gd^{157} - 15.5 $\pm$ 0.2%. Ratio of magnetic moments
$-\dfrac{\mu 155}{\mu 157} = 0.7495 \pm 0.0045$. Crystals irradiated at the
Harwell pile with a thermal neutron flux of 1.2×10^{12}

$n/cm^2/sec$, and a fast flux of 2.3×10^{11} $n/cm^2/sec$, yields the ratio of nuclear capture cross-sections $\frac{\sigma 157}{\sigma 155} = 2.82$, using the above abundance values. No F center spectrum was detected in crystals irradiated with a total neutron flux of about 10^{18} n/cm^2. The paramagnetic resonance spectrum of gadolinium in irradiated crystals is unchanged indicating negligible radiation damage in the neighborhood of the paramagnetic ions. (Contractor's abstract)

645

Hebrew U. Dept. of Physics, Jerusalem (Israel).

PARAMAGNETIC RESONANCE OF S STATE IONS IN STRONTIUM CHLORIDE, by W. Low and U. Rosenberger. [1959] [12]p. incl. table, refs. (Technical note no. 6) (AFOSR-TN-59-416) (AF 61(052)59) AD 214563; PB 140803   Unclassified

Also published in Phys. Rev., v. 116: 621-623, Nov. 1, 1959.

Paramagnetic resonance spectra were observed of Mn^{2+}, Gd^{3+} and Eu^{2+} in single crystals of strontium chloride grown from the melt. The Mn^{2+} shows a very small cubic field splitting a $< 1 \times 10^{-4}$ cm^{-1} and a hyperfine structure constant of $A = 81.2 \times 10^{-4}$ cm^{-1}, indicating some covalent bonding. The Gd^{3+} and Eu^{2+} have cubic symmetry with splitting parameters; Gd^{3+}: $c = \pm (39.6 \pm 0.1) \times 10^{-4}$ cm^{-1}, $d = \mp (0.2 \pm 0.1) \times 10^{-4}$ cm^{-1}, $g = 1.9906 \pm 0.001$; for Eu^{2+}: $c = (52 \pm 5) \times 10^{-4}$ cm^{-1}, $A^{151} = (34.5 \pm 0.3) \times 10^{-4}$ cm^{-1}, $A^{153} = (15.5 \pm 0.3) \times 10^{-4}$ cm^{-1}, $g = 1.995 \pm 0.001$. The smaller cubic field splittings in $SrCl_2$ compared with CaF_2 seem to favor a mechanism responsible for cubic-field splitting which is linear in the crystal potential terms. (Contractor's abstract)

646

Hebrew U. Dept. of Physics, Jerusalem (Israel).

PARAMAGNETIC SUBSTANCES SUITABLE FOR MASER OPERATION IN THE MILLIMETER RANGE, by W. Low. June 1959 [21]p. incl. diagrs. refs. (Technical note no. 7) (AFOSR-TN-59-675) (AF 61(052)59) AD 218387   Unclassified

Also published in Proc. Symposium on Millimeter Waves, New York, N. Y. (Mar. 31-Apr. 2, 1959), Brooklyn, Polytechnic Inst. of Brooklyn Press [1960] p. 45-56.

Requirements of continuous wave masers are listed. They include proper energy level spacings, relaxation times, line width, low dielectric losses, chemical stability, good thermal conductivity, and stable energy level scheme. These requirements are met by a number of ions in ionic lattices in the cm range. In the mm range only very few paramagnetic substances in usual crystal symmetries have the required energy splittings suitable for maser operation.

647

Hebrew U. Dept. of Physics, Jerusalem (Israel).

PARAMAGNETIC RESONANCE SPECTRA OF CHROMIUM AND MANGANESE IN THE SPINEL STRUCTURE, by R. Stahl-Brada and W. Low. June 1959, 12p. incl. diagrs. tables, refs. (Technical note no. 8) (AFOSR-TN-59-961) (AF 61(052)59) AD 226397   Unclassified

Also published in Phys. Rev., v. 116: 561-564, Nov. 1, 1959.

The paramagnetic resonance spectrum of Cr^{3+} was measured on the single crystal of ruby spinel $MgAl_2O_4$ at the wavelengths of 3 cm, 1.2 cm and 8.6 mm. The spectrum confirms that Cr^{3+} is at a 'B' site and can be described with an axial spin Hamiltonian $S = \frac{3}{2}$, $2D = 0.990 \pm 0.005$ cm^{-1}, $g_{\shortparallel} = 1.986 \pm 0.001$, $g_{\perp} = 1.989 \pm 0.002$. The paramagnetic resonance spectrum of Mn^{2+} was measured on the single crystal of $ZnAl_2O_4$ at 3 cm. The spectrum consists of 6 nearly isotropic lines with $A = 74.9 \pm 0.5 \times 10^{-4}$ cm^{-1}, $g = 2.000_2 \pm 0.001$. The cubic or axial splitting was less than 8×10^{-4} cm^{-1}. The spectrum is indicative that Mn^{2+} is located at an 'A' site. (Contractor's abstract)

648

Hebrew U. Dept. of Physics, Jerusalem (Israel).

TABLES OF EIGENVALUES AND MATRIX ELEMENTS OF TRANSITION PROBABILITIES FOR AN AXIAL SPIN HAMILTONIAN WITH S = 3/2, by R. Stahl-Brada and W. Low. July 1959, 1v. incl. tables. (Technical note no. 9) (AFOSR-TN-59-1125) (AF 61(052)59) AD 232062; PB 146717   Unclassified

Also published in Nuovo Cimento, Series X, Suppl., v. 15: 290-334, 1960.

Numerically computed eigenvalues of the matrix corresponding to the axial spin Hamiltonian $\mathcal{K}_e = g\beta H.S + D(S_z - \frac{1}{3}S(S+1))$ with the spin number S = 3/2 are tabulated. These tables $(I_{5°} - I_{85°})$ are given for

various values of Θ, the angle between the magnetic field and the crystalline axis in steps of 5° to 85°, and for the dimensionless parameter $x = \frac{g\beta H}{4D}$ taking on various values between 10 and 0.05. The matrix elements $|<M| J_x |M'>|^2$ and $|<M| J_z |M'>|^2$ are tabulated for the same range of angles Θ and the parameter x. With the help of these matrix elements the transition probability corresponding to transitions $M \to M'$ can be evaluated. (Contractor's abstract)

649

Hebrew U. Dept. of Physics, Jerusalem (Israel).

RATIOS OF RELATIVE ABUNDANCE, MAGNETIC MOMENTS, AND CAPTURE CROSS SECTIONS OF GADOLINIUM ISOTOPES FROM PARAMAGNETIC RESONANCE SPECTRUM, by W. Low and D. Shaltiel. [1959] [3]p. incl. tables. (AFOSR-3091) [AF 61(052)59] Unclassified

Published in Phys. Rev., v. 115: 424-426, July 15, 1959.

Precision measurements on the hyperfine structure of the transitions corresponding to $\Delta M = 4$ of the cubic-field paramagnetic resonance spectrum of gadolinium in single crystals of thorium oxide yield the following values: isotopic abundance: even isotopes, 69.45%; Gd^{155}, 15.05 ± 0.2%; Gd^{157}, 15.5 ± 0.2%. Ratio of magnetic moments: $\mu^{155}/\mu^{157} = 0.7495 \pm 0.0045$. Irradiation of crystals at the Harwell pile with a thermal neutron flux of $1.2 \times 10^{12} n/cm^2$ sec, and a fast flux of $2.3 \times 10^{11} n/cm^2$ sec, yields the ratio of nuclear capture cross sections $\sigma^{157}/\sigma^{155} = 2.82$, using the above abundance values. No F-center spectrum was detected in crystals irradiated with a total neutron flux of about $10^{18} n/cm^2$. The paramagnetic resonance spectrum of gadolinium in irradiated crystals is unchanged, indicating negligible radiation damage in the neighborhood of the paramagnetic ions. (Contractor's abstract)

650

Hebrew U. Dept. of Physics, Jerusalem (Israel).

THE GERMANIUM CuKα (2,2,2) DOUBLE X-RAY REFLECTIONS. I. INDEXATION, by E. Alexander, B. S. Fraenkel, and Z. H. Kalman. Apr. 1959 [16]p. incl. illus. diagr. tables. (Technical rept. no. 1) (AFOSR-TN-59-625) (AF 61(052)222) AD 217689; PB 143013 Unclassified

A method is developed to calculate the azimuthal positions of the double x-ray reflection points as they appear on a double reflection x-ray camera exposure.

The germanium CuKα (2,2,2) double reflection points are identified according to their measured positions on a film. (Contractor's abstract)

651

Hebrew U. Israel Inst. of Applied Social Research, Jerusalem.

A STOCHASTIC FACET THEORY OF SOCIAL INTER-ACTION IN THE DYAD, by W. G. Foa and S. Zacks. Apr. 1959, 33p. incl. tables, refs. (Technical scientific note no. 1) (AFOSR-TN-59-446) (AF 61(052)121) AD 214808 Unclassified

A model is described which attempts to predict how the reciprocal behavioral expectations of 2 interacting persons change in time as a result of their intervening perceptions of behavior. It is shown that the probability of a given future behavior of a person can be predicted from the knowledge of what he did before and of the reaction of the other to his earlier behavior. The transitional probabilities of this process are not constant and are obtained by applying the reinforcement schedule to the probabilities of the preceding stage. The process is determined by the initial probabilities and by the reinforcement schedule. Each probability tends to a limit which is independent of the initial probability. (Contractor's abstract)

652

Heidelberg U. (Germany).

FOURTH "BROOKHAVEN" CONFERENCE ON MOLEC-ULAR BEAMS, Heidelberg U. (Germany) (June 9-11, 1959). 1959, 40p. incl. tables. (AFOSR-TR-59-152) AD 228005 Unclassified

Preliminary results and data of experiments at date still in progress were presented at the present conference. The program was an informal exchange of information and emphasized the preliminary nature of the results, much of which might be only tentative.

653

Henri-Rousselle Hospital, Paris (France).

RELATION OF THE VISCERAL AFFERENTS ON THE ACTIVITY OF THE BRAIN STEM RETICULAR FORMATION. PART I. CONTROL OF AFFERENT RETICULAR AND CORTICAL ACTIVITIES. PART II. CENTRAL EFFECTS OF HYPOXIA AND THEIR CONSEQUENCES IN THE FIELD OF VIGILANCE AND MUSCULAR TONE, by P. C. Dell. [Final] technical rept. [1959] [16]p. (AFOSR-TR-59-93) (AF 61(514)1100 and AF 61(052)45) AD 219422; PB 143587 Unclassified

Pt. I: Experimental results suggested that the reticular facilitatory descending system of Rhines and Magoun

and the reticular ascending system of Moruzzi and Magoun are a single functioning unit. This is good supporting evidence for theorizing that the "activating potentiality" of afferent messages is a function of their admittance into the reticular network. This admittance depends upon the control exercised by the cortex on the reticular activity. Pt. II: Neurogenic and humoral effects of hypoxia on the ascending and descending reticular systems were presented. Direct effects of hypoxia at the cortical level and the ensuing release phenomena were discussed. A summary of the factors at hand and their temporal interplay was given.

654

Herner and Co., Washington, D. C.

BASIC RESEARCH RESUMES. A SURVEY OF BASIC RESEARCH ACTIVITIES IN THE AIR RESEARCH AND DEVELOPMENT COMMAND, ed. by S. Herner. Dec. 1959, 334p. incl. refs. (AFOSR-TR-59-204) (AF 49-(638)652) AD 232933; PB 161291   Unclassified

All basic research activities which can clearly and formally be identified as comprising the ARDC basic research program are described. This includes some 1400 scientific efforts with leading universities, research institutions and industrial laboratories in the U. S. and the Free World. The following 6 technical program areas are covered: (1) Propulsion; (2) Materials; (3) Electronics; (4) Geophysics; (5) Biosciences; and (6) Aeromechanics.

655

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

MAGNETIC SUSCEPTIBILITIES OF PRASEODYMIUM AND TERBIUM OXIDES, by R. C. Vickery and A. Ruben. [1959] [4]p. incl. diagr. tables, refs. (AF 49(638)80)   Unclassified

Published in Jour. Chem. Soc. (London), v. 106: 510-513, Feb. 1959.

Magnetic susceptibility-temperature measurements below 300° of 3 oxides of praseodymium and 3 of terbium over a range of temperature yield magnetic moments for Pr_2O_3, Pr_6O_{11}, and PrO_2 of 3.55, 2.77, and 2.51 Bohr magnetons respectively and for Tb_2O_3, Tb_4O_7, and Tb_6O_{11} of 9.62, 8.70, and 8.49. The Curie-Weiss law is obeyed. The values agree well with theoretical ones

for the proposed formula. (Contractor's abstract)

656

Human Sciences Research,Inc., Arlington, Va.

A CONCEPTUAL FRAMEWORK FOR THE INTEGRATION OF SMALL GROUP RESEARCH INFORMATION, by I. Altman and J. E. McGrath. Feb. 1959, 1v. incl. diagrs. tables, refs. (Rept. no. HSR-TN-59/1-GN) (AFOSR-TN-59-252) (AF 49(638)256) AD 212252; PB 140706   Unclassified

The results of the 2nd phase of a research program designed to integrate small group research information are presented. The pilot phase was reported in item no. PSY.01:001, Vol. II. The present approach has 2 distinctive features: (1) it is data-oriented; that is, the integrative system deals with existing empirical research results in detail, rather than on a general and gross level, and (2) the classification system utilized in the study is one based on the form or syntax of empirical data, rather than on content or substantive distinctions. Application of the syntactical framework to classification of small group research results provides a means for empirical validation of the logic of the framework. A description is presented of the classification system for integrating small group research information, and procedures for applying it to small group studies are outlined. Some major potential applications of the research to basic and operational problem areas are discussed. A coder instruction manual is appended to this report.

657

Human Sciences Research,Inc., Arlington, Va.

THE TRANSLATION OF SMALL GROUP RESEARCH INFORMATION FOR COMPUTER ANALYSIS, by I. Altman, J. P. Jenkins, and J. E. McGrath. Oct. 1959 [73]p. incl. diagr. tables. (Rept. no. HSR-TN-59-59/9-GN) (AFOSR-TN-59-1194) (AF 49(638)256) AD 230241   Unclassified

This report presents the results of one aspect of a research program designed to develop and apply a classification system to synthesize small group research knowledge. It sets forth a data translation system which will be used to process a large amount of data currently being collected as a result of application of the classification system. The appendix to the report describes detailed rules and procedures for applying the translation system.

658

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

THE RADIATION CHEMISTRY OF FLUORINATED ORGANIC COMPOUNDS, by P. Y. Feng. [1958] [5]p. incl. diagrs. tables. refs. [AF 18(603)121]
Unclassified

Published in Proc. Second UN Internat'l. Conf. on Peaceful Uses of Atomic Energy (Geneva), v. 29: 166-170, 1958.

Although organic chlorine compounds are particularly radiation sensitive compounds on the basis of radical yield determinations, organic fluorine compounds are expected to exhibit different radiation chemical behavior as a result of the extremely strong C-F bond. This expectation is borne out by dpph experiments, which show that the radical yields of either solutions of CF_4, CHF_3, C_6H_5F or $C_6H_5CF_3$ in benzene, or pure C_6H_5F or $C_6H_5CF_3$, are of the order of unity or less, and are considerably lower than those of the corresponding chlorine compounds. Mixtures of benzene and carbon tetrafluoride produce upon irradiation various amounts of fluorobenzene, benzo-trifluoride, fluoroform and perhaps also hydrogen fluoride depending on the composition of the irradiated system. Under favorable conditions, the combined G values of the fluoroaromatic products amounted to 2.5, which cannot be accounted for by a purely radical mechanism. Inasmuch as chain reaction is also not applicable for the observed product formation, other processes, for example the ion-molecule processes, are believed to be operative in the reaction mechanism.

659

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

REVIEW OF RADIATION CHEMISTRY PAPERS PRESENTED AT THE 2ND GENEVA CONFERENCE, by P. Y. Feng. [1959] 41p. incl. tables, refs. (AFOSR-TN-59-365) (AF 18(603)121) AD 231085; PB 145655
Unclassified

Condensation of papers presented at the Sec d UN Conf. on the Peaceful Uses of Atomic Ener Geneva (Switzerland), Sept. 1958.

A review of the papers presented for oral presentation at the Radiation Chemistry sessions is presented including topics on elementary processes, detection of intermediates, irradiation facilities, aqueous systems, organic systems, polymers, catalysts, and reactions of hot atoms. It is hoped that the material condensed will serve as a source of general information to scientific workers in related fields as well as a convenient abstract for specialists in the field of radiation chemical research.

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[Illinois Inst. of T ch.] Armour Research Foundation, Chicago.

HIGH INTENSITY FLASH RADIOLYSIS OF n-HEXADECANE (Abstract), by P. Y. Feng. [1959] [1]p. [AF 18-(603)121]
Unclassified

Presented at meeting of the Phys. Chem. Div. of the Amer. Chem. Soc., Boston, Mass., Apr. 5-10, 1959.

Published in 135th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1959, p. 56-R.

The radiolysis of n-hexadecane with a high intensity, pulsed electron source is reported. Pulse rates at 15, 30, 60, 120, and 180/sec (10 microsec pulse length) were used in the experiments. The radiation energy input during each pulse amounted to 2.3×10^8 rads/sec. Within the limits of experimental accuracy, there is no observable effect of pulse rate on either the gas yield or the extent of trans-C = C group formation. The gaseous products are largely hydrogen, and the $G(H_2)$ values are approximately 5. This value is considerably higher than those obtained with continuous low intensity irradiations reported in the literature, and is explained by the reduced probability of alkyl-hydrogen recombination in the reported system. Up to a total dose of 10^8 rads, the $G(H_2)$ values remain practically constant, whereas the yield of the C = C groups is seen to decrease with increased dose. This is explained on the basis of the competition of the olefinic products with the original hydrocarbon for the absorbed radiation energy, and the reduced probability for the reactive species to attain macroscopic spatial equilibrium in the high intensity pulsed irradiation system.

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Illinois Inst. of Tech. Armour Research Foundation, Chicago.

EXPERIMENTAL MEANS OF DETERMINING WAVE PROPAGATION PHENOMENA IN SOLIDS, by A. J. Durelli and W. F. Riley. Final rept. Oct. 1, 1956-Feb. 28, 1959. 15p. incl. refs. (AFOSR-TR-59-21) (AF 18-(603)144) AD 211067
Unclassified

Methods of photoelasticity and grids in conjunction with low-modulus materials were developed as means for studying wave propagation in solids. A number of low modulus materials were studied and Hysol 8705 (a urethane rubber compound) was selected as the model material. A complete study of its mechanical and optical properties was made under static and dynamic loadings. The modulus of elasticity was dependent upon the rate of loading and the specific energy loss for the material was about 10% for the stress ranges associated with photoelastic determinations. The specific problems studied included struts subjected to axial impact, disks

subjected to diametrical impact, plates subjected to explosive loads on the boundary, and wave propagation past various geometric discontinuities in rectangular bars. (Contractor's abstract)

662

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

PROPERTIES OF SULFIDE SEMICONDUCTORS, by J. W. Buttrey, I. Siegel and others. Technical rept. no. 2, Jan. 1, 1958-Dec. 31, 1958. Feb. 1959, 18p. incl. diagrs. table, appendices. (AFOSR-TR-59-4) (AF 49(638)112) AD 208757; PB 138736   Unclassified

The fabrication of metal-sulfide type semiconductors and their properties were studied; emphasis was placed on As_2Te_3 and Sb_2Se_3. An As_2Te_3 sample with an impurity of 1.9% Sb showed a Hall mobility of 6650 sq cm/volt-sec with a resistivity of 5.53×10^{-4} ohm-cm and carrier density of 0.17×10^{19} at room temperature. The mobility value is more than an order of magnitude larger than that of any other sample studied. Samples of As_2Te_3 and Sb_2Se_3 were characterized by measuring sample resistivity as a function of temperature up to 300°C, together with Hall effect measurements at room temperature. The results indicated that (1) from 71° to 258°C the variation of carrier concentration with temperature is insignificant compared to the change of carrier mobility, and (2) the observed increase of sample resistivity with increasing temperature is mainly due to decreasing carrier mobility caused by lattice scattering of the charge carrier. Specimen resistivity values vs temperature data indicated that temperatures sufficiently high for intrinsic activation energy calculations were not reached.

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Illinois Inst. of Tech. Armour Research Foundation, Chicago.

PRESSURE EFFECTS IN LUMINESCENCE. PART II. ISOBARIC EXPERIMENTS ON NaI(Tl), by L. Reiffel. Feb. 2, 1959 [26]p. incl. diagrs. refs. table. (Technical note no. 2) (AFOSR-TN-59-6) (AF 49(638)113) AD 208302   Unclassified

Also published in Phys. Rev., v. 114: 1493-1499, June 15, 1959.

The effect of steady-state hydrostatic pressure on the properties of luminescent systems, with particular reference to the phosphorescence of NaI(Tl), is examined. It is shown that readily observable changes in decay mean life may be produced by very modest pressures. An interpretation of these effects is developed from a configurational coordinate model and also from thermodynamic considerations. Experimental results are

in good agreement with these theoretical expectations. For a 0.66-ev trap in NaI(Tl), the change in center volume at the point of transition from metastable to emitting state is found to be $+ 17.5 \times 10^{-24}$ cm^3. Assuming a specific model for the center allows computation of the sign and magnitude of the critical displacement of ions required for trap collapse — in this case + 0.19A. The force constant for the metastable state is computed to be 5.8×10^5 dynes/cm; and the vibrational frequency, assuming an effective mass equal to six I$^-$ ions, is 3.4×10^{12} sec^{-1} corresponding to a zero point energy for this trap of 0.007 ev and cross over at a vibrational quantum number of about 47. The transmission coefficient for cross-over to the emitting state appears to be of the order of 0.03 per cent. Other possible experiments involving steady-state or transient pressure effects are outlined. (Contractor's abstract)

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Illinois Inst. of Tech. Armour Research Foundation, Chicago.

PRESSURE EFFECTS AND CONFIGURATION COORDINATE MODELS OF KCl(Tl), by L. Reiffel. July 24, 1959 [7]p. incl. diagr. table. (Technical note no. 3) (AFOSR-TN-59-761) (AF 49(638)113) AD 225665; PB 143523   Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 215-217, Sept. 1, 1959.

The pressure effects and configuration coordinate models of KCl(Tl) were studied by using, as the phosphor, a single KCl crystal grown from a melt containing 0.00018 Tl (mol fraction). Separation of the 3050A and 4750A emission was accomplished with Corning filters 9863 and 3389. At room temperature, the 3050A band showed a half-width of about 400A and a long wavelength tail which extended to 4200A, but only 1% of the emission was beyond 3800A. The 4750A band typically exhibited 1/3 the peak intensity of the 3050A emission with a half-width of 1200A at room temperature. The crystal, installed in a pressure vessel with quartz optics, was stimulated with an Ir^{192} gamma ray source in a W alloy collimator. Light emission was measured with a cooled-type photomultiplier tube driving a standard electrometer circuit and equipped with a sodium salicylate wavelength shifter. The band intensity ratio of 4750A emission to 3050A emission was not affected by pressure. At 19° and 9.5°, the factor changes in emission intensity of the 4750A band relative to the 3050A band for 40,000 psi were 0.96 and 0.98. At 0°C the values were 1.04, 1.07, and 1.05, respectively. The small systematic change with temperature may be the result of excitation of trapping states which fed the emitting states under observation. (Contractor's abstract)

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Illinois Inst. of Tech. Armour Research Foundation, Chicago.

SODIUM OZONIDE, by I. J. Solomon and A. J. Kacmarck. [1959] [5]p. incl. diagr. (AFOSR-TN-59-742) (AF 49-(638)618) AD 235638   Unclassified

Also published in Jour. Phys. Chem., v. 64: 168-169, Jan. 1960.

Spectrophotometric studies indicate that Na ozonide is formed easily at -60° by reaction of NaOH with O_3. The ozonide also forms at 25° but decomposes rapidly. Diffuse reflectance measurements on the Na ozonide formed at 25° show a broad peak at approximately 450 mμ, although no ozonide can be extracted.

666

Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

THE VINYL CARBANION, by S. I. Miller and W. G. Lee. Apr. 1959 [27]p. incl. diagrs. tables, refs. (Technical rept. no. 1) (AFOSR-TN-59-147) (AF 49(638)39) AD 210981; PB 142432   Unclassified

Abstract published in 135th meeting of the Amer. Chem. Soc. Abstracts of Papers, Boston, Mass., Apr. 5-10, 1959, p. 9-R.

Also published in Jour. Amer. Chem. Soc., v. 81: 6313-6319, Dec. 5, 1959.

There is essentially no isotope rate effect in the dehydrobromination by methoxide of protonated and deuterated cis-dibromoethene in methanol; under the same conditions hydrogen exchange with the solvent appears to be ca. 25 times faster than elimination at 26°. While methyl acrylate, maleic anhydride, ethyl cinnamate, methyl chloromaleate, 1,1-diphenylethene, triphenylethene, cis- and trans-stilbene do not exchange, cis- and trans-dichloroethene, cis- and trans-dibromoethene, trans-diiodoethene, tribromoethene, and ω-bromostyrene exchange protons for deuterium in basic deuterium oxide. Upper limits to the pK's of the 1,2-dihaloethenes are in the range 34-36. Lower limits to the activation energy for isomerization of vinyl carbanions formed from 1,2-dihaloethenes lie in the range 25-35 kcal/mol. In the light of these observations, a general mechanism of elimination reactions is proposed. (Contractor's abstract)

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Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

NEW METHYL RADICAL SOURCE IN THE GAS PHASE. MERCURY-SENSITIZED DECOMPOSITION OF METHYL MERCURIC CHLORIDE (Abstract), by T. Hirata, H. E. Gunning, and S. Sujishi. [1958] [1]p. [AF 49(638)48]   Unclassified

Presented at meeting of the Phys. and Inorg. Chem. Div. of the Amer. Chem. Soc., San Francisco, Calif., Apr. 13-18, 1958.

Published in 133rd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 2-Q - 3-Q.

A study has been made of the reaction of methyl mercuric chloride vapor with Hg $6(^3P_1)$ atoms at 200°C.

The principal products of the reaction have been shown to be calomel, ethane, and methane, with smaller amounts of higher hydrocarbons. The data are consistent with a primary process:

$$H_3CHgCl + Hg\ 6(^3P_1) \longrightarrow H_3CHg + HgCl$$

with the H_3CHg radicals decomposing into methyl radicals. The reaction is therefore a potential source for methyl radicals for free radical kinetic studies.

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Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

PHOTOCHEMICAL SYNTHESIS OF ENERGY RICH-COMPOUNDS, by S. Sujishi and T. Hirata. Final rept. Feb. 1, 1957-Aug. 31, 1958. Oct. 24, 1958 [67]p. incl. diagrs. tables, refs. (AFOSR-TR-59-7) (AF 49(638)48) AD 209160   Unclassified

The mercury photosensitized reaction of methylmercuric chloride was investigated. Methylmercuric chloride was prepared by neutralizing methylmercuric hydroxide which was obtained by adding alcoholic KOH to methylmercuric bromide. The melting point and the vapor pressure above room temperature were determined for methylmercuric chloride. Samples of methylmercuric chloride were thermally decomposed at various temperatures; up to 200°C, there was no noticeable thermal decomposition. Gaseous products were detected in a 90-min run at 236° C but were insufficient for analysis. Mass spectrometric data were obtained for the yields from a thermal decomposition reaction which was run at 260°C for more than 30 hr; the molar percentages were 67.3% H_3CCl, 16.5% CH_4, 7.7% C_2H_6, 2.1% H, and 1.0% C_3H_8. A photolysis reaction of methylmercuric chloride was considered negligible as compared with a sensitized reaction where substrate decomposition attained high values within 30 min. The presence of Hg during irradiation increased the quantity of products markedly as compared with the thermal and photolytic reactions. X-ray analyses of the solid products indicated only unreacted methylmercuric chloride and mercurous chloride. No higher alkylmercuric chlorides, such as ethylmercuric chloride, were encountered in the products. No evidence was obtained for a chain reaction.

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Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

THE CHEMISTRY OF SILICON AND GERMANIUM
HYDRIDES, by S. Sujishi. Final rept. Feb. 1, 1958-
Aug. 31, 1959, 111p. incl. diagrs. tables, refs. (AFOSR-
TR-59-137) (AF 49(638)276) AD 225925; PB 143572
Unclassified

The reactions of silyldimethylamine, methyldisilyl-
amine, and trisilylamine were studied with the strong
Lewis acids diborane, trimethylaluminum, and tri-
methylgallium. With diborane, the formation of silyldi-
methylamine-borane and methyldisilylamine-borane was
indicated but irreversible decomposition occurred at
0°C. With trimethylaluminum all 3 of the silylamines
formed 1:1 compounds, but irreversible decomposition
which led to the formation of silane was observed at or
near the melting points of the addition compounds. At
-78°, silyldimethylamine-trimethylgallium, and methyl-
disilyamine-trimethylgallium could be isolated; at or
near their melting points, these compounds also decom-
posed to form silane. Vapor pressure data were obtained
for silyldimethylamine-trimethylgallium, methyldisilyl-
amine-trimethylgallium, and silyldimethylamine-tri-
methyaluminum systems. Qualitative measures were
used to deduce the relative basicities of the methyl and
silylamines. A value of 11.1 kcal/mol was estimated
for the gas phase heat of dissociation of methyldisilyla-
mine-trimethylgallium. The existence of the 1:1 com-
plex, disiloxane-trimethylgallium was indicated at
-78.5°.

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Illinois Inst. of Tech. Dept. of Metallurgical Engineering,
Chicago.

AN INVESTIGATION OF FATIGUE PHENOMENA IN
METALS BY MEANS OF A RECRYSTALLIZATION
TECHNIQUE, by J. L. Peterson and N. H. Polakowski.
Final rept. Apr. 1959 [65]p. incl. illus. diagrs. (Tech-
nical rept. no. 1) (AFOSR-TR-59-91) (AF 18(603)68)
AD 220924; PB 143621   Unclassified

Experiments were conducted to determine the effect
of combined static cold working and fatigue on the re-
crystallization behavior of several polycrystalline
metals as indicated by the annealed grain size. The
relationship between the annealed grain size and un-
directional deformation was reaffirmed and the critical
deformation to initiate recrystallization was determined.
The most pronounced changes were observed in an-
nealed metals and especially in low carbon steel.
Metals deformed more than the initial amount for re-
crystallization were softened under the action of cyclic
strain to hardness levels corresponding to deformations
less than the critical amount required for recrystalliza-
tion. However, recrystallization could not be suppressed
in this manner. A substructure hypothesis was utilized
to explain the property changes resulting from the fa-
tigue of cold worked metals. A hypothesis based on pos-

sible polygonization and sub-structure formation in
statically deformed metals under cyclic stress was ad-
vanced to account for the different effects of fatigue
softening on mechanical properties on one hand and the
recrystallization capacity on the other. (Contractor's
abstract)

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Illinois Inst. of Tech. [Dept. of Metallurgical Engineering]
Chicago.

X-RAY INVESTIGATION OF IMPERFECTIONS IN SILI-
CON SINGLE-CRYSTALS (Abstract), by L. V. Azaroff
and R. H. Bragg. [1959] [1]p. (AF 49(638)425)
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
171, Mar. 30, 1959.

The determination of dislocation densities in single
crystals using an extension of the Guinier-Tennevin
transmission arrangement has been reported previous-
ly. It since has been found that significant results can
be obtained only if x-radiations having wavelengths
shorter than 0.70A are employed in such investigations.
This is consistent with the earlier results of Allison and
Parratt who observed that diffraction intensities from
freshly cleaved calcite crystals agreed with calcula-
tions based on the ideally perfect crystal for $\lambda > 0.70A$
but not for shorter wavelengths. A possible reason for
this is the dependence of extinction on wavelength. It
can be shown that the geometry of the diffraction arrange-
ment does not impose stringent restrictions on the thick-
ness of the crystal used so that the bulk rather than the
surface of a crystal can be investigated. Variations in
the dislocation density from 10^6 to 10^8 cm^{-2} have been
observed in regions of the same silicon crystal separated
by only a few millimeters. These results are in accord
with lifetime and noise measurements made on the same
crystals. It has also been found that commercial x-ray
tubes and diffractometers, with minor modifications,
can be used to obtain quantitative results.

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Illinois State Geological Survey. [Div. of Fluorine
Chemistry] Urbana.

[AROMATIC FLUORINE COMPOUNDS] by G. C.
Finger. Final rept. Sept. 1, 1954-Sept. 30, 1958. Dec.
29, 1958, 2p. (AFOSR-TR-59-3) (AF 18(600)985)
AD 261860   Unclassified

Many aromatic fluorine compounds can now be synthe-
sized by an aryl Cl-KF exchange reaction. The develop-
ment of this exchange reaction involved studies on (1)
the activation of halogen atoms in aromatic systems,

(2) the use of organic solvents, especially dimethyl formamide and dimethyl sulfoxide, in the exchange reaction, (3) the mechanics of the reaction and (4) factors governing the choice of metallic fluoride. Publications and lectures summarizing the results of this program are given. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

CAREFUL. A PILOT STUDY OF THE EFFECTS OF HEAVY TARGET LOAD ON HUMAN AND AUTOMATIC DECISION MAKERS, by H. W. Sinaiko and G. P. Cartwright. Sept. 1959, 35p. incl. illus. tables. (Rept. no. R-115) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-56695) AD 228109
Unclassified

A test was made of the hypothesis that heavy target loads would adversely affect a human tactical decision-maker while the same number of targets would not degrade the performance of an automatic system. A series of air defense exercises were conducted using the Cornfield system. Three levels of automaticity were introduced: (1) the system was programmed to run without any human intervention; (2) the fully automatic system had a CIC officer who could override computer decisions or make his own decisions if he chose to do so; and (3) a CIC officer had to make all decisions regarding threat evaluation and selection and assignment of weapons while the computers did only routine vectoring of interceptors. Results of the experiment did not support the hypothesis. Actually the more automatic versions of the system allowed more target penetrations and accomplished fewer kills than the least automatic mode. The results seemed to underscore the greater flexibility of the man who, in a close race, might tend to keep up the chase even though the probability of a successful kill was low. As the CIC officer gained experience and familiarity with the system he took more and more of the decision function from the computers. The ratio of target assignments to kills was lowest for the human system. (Contractor's abstract)

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Illinois U. [Dept. of Chemistry] Urbana.

ELECTRODEPOSITION OF RARE-EARTH METALS FROM AQUEOUS AND NON-AQUEOUS SOLUTIONS, by T. Moeller, P. A. Zimmerman and others. July 31, 1959, 24p. incl. tables, refs. (AFOSR-TR-59-75) (AF 18(600)1535) AD 220100   Unclassified

Presented at Symposium on Rare-Earth Metals, Amer. Inst. Mining, Metallurgical, and Petroleum Engineers, San Francisco, Calif., Feb. 18, 1959.

Electrodeposition of the rare-earth metals is possible in aqueous systems only with cathodes of very high hydrogen overvoltage (e.g., amalgams). Non-aqueous protonic solvents that are basic and combine the properties of high dielectric constant, low viscosity, and high heat of vaporization offer better possibilities. Many such solvents dissolve anhydrous rare-earth metal salts, but the resulting solutions show weak-electrolyte behaviors. Electrolysis never yields more than small quantities of the metals unless mercury is the cathode. (Contractor's abstract)

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Illinois U. [Dept. of Chemistry] Urbana.

RESEARCH ON CHEMISTRY AND ELECTROCHEMISTRY OF RARE-EARTH METAL SALTS IN BASIC SOLVENTS, by T. Moeller, G. W. Cullen and others. Final rept. Feb. 1, 1956-Apr. 30, 1959. June 15, 1959, 73p. incl. diagrs. tables, refs. (AFOSR-TR-59-98) (AF 18(600)1535) AD 218112; PB 142305
Unclassified

The reaction between anhydrous $NdCl_3$ and anhydrous Na(CNS) in DMF was studied conductometrically. The degree of dissociation of the electrolytes varied at different concentrations. Difficulties occurred in attempting to isolate $Nd(CNS)_3$ in solid form from the DMF solution. The reaction was conducted in anhydrous EtOH at room temperature. Solvents such as tetrahydrofuran, benzene, and cyclohexane failed to precipitate $Nd(CNS)_3$ from either the DMF or EtOH solutions. After the removal of NaCl, the filtrate was evaporated, and a powder-like pinkish-colored compound appeared, analyzed closely to $Nd(CNS)_3 \cdot 2C_2H_5OH$. Metathetical reaction studies showed that $NdCl_3$ and Na(CNS) do not react in stoichiometric ratio of 1:6. With an azeotropic distillation technique, rare earth acetates can be dehydrated in a DMF medium; the water can be removed by benzene. Compounds were prepared of the type $Ln(OAc)_3 \cdot DMF$ (where $Ln = Ce^{III}$, Pr, Nd, Sm, Eu, and Gd) and $Ln(OAc)_3$ (where $Ln = Dy(?)$, Ho(?), Er, Yb, Y, and La). The solvated rare-earth acetates, except Gd, melt over a small temperature range. However, the compounds lose the DMF of solvation at higher temperatures than the melting points, the desolvation being completed at about 200°C. X-ray diffraction patterns of the hydrated and dehydrated compounds were studied; the d-spacings, which were calculated from the patterns, showed differences between the 2 compounds.

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Illinois U. [Dept. of Chemistry] Urbana.

OBSERVATION ON THE RARE EARTHS. LXIX. AN ELECTROCHEMICAL INVESTIGATION OF ETHYL-ENEDIAMINE SOLUTIONS OF LANTHANUM NITRATE,

by T. Moeller and G. W. Cullen. [1959] [6]p. incl. illus. diagrs. tables, refs. (AF 18(600)1535) AD 221227
Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 10: 148-152, Apr. 1959.

The solubility of anhydrous lanthanum nitrate in ethylenediamine is markedly dependent upon the water content of the latter. Conductance data for both completely anhydrous solutions and those containing controlled quantities of water show generalized weak electrolyte behavior. Electrolyses of such solutions yield cathode deposits that apparently contain small quantities of elemental lanthanum. X-ray characterization of such deposits is negated by oxide absorption of radiation diffracted by the metal. Some of the techniques essential to handling materials under anhydrous conditions are described. (Contractor's abstract)

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Illinois U. Dept. of Chemistry, Urbana.

PRECISION NULL-POINT ATOMIC ABSORPTION SPECTRO-CHEMICAL ANALYSIS, by H. V. Malmstadt and W. E. Chambers. [1959] [6]p. incl. diagrs. tables, refs. (AFOSR-TN-59-986) (AF 18(603)137)
Unclassified

Also published in Anal. Chem., v. 32: 225-232, Feb. 1960.

A new type of atomic absorptiometer is described for the sensitive and accurate quantitative determination of certain elements, such as sodium and potassium. The oncentration of each sought-for element in an unknown solution is duplicated in a reference solution by an instrument which functions as a sensitive and specific null-point detector. The use of a null-point technique in conjunction with atomic absorption provides several advantages compared to measurement of absolute absorbance values. It enables exceptional precision, accuracy, sensitivity, and selectivity to be obtained with a low-cost instrument, provides self-standardization for each sample, and eliminates the need for linear response characteristics or working curves. Sodium and potassium were determined in the 1- to 100-ppm range with coefficients of variation of 0.1 to 0.3% in some cases and about 0.5% in most cases. Relative errors were the same order of magnitude as the precision. (Contractor's abstract)

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Illinois U. Dept. of Clinical Science, Chicago.

CHOLESTEROL METABOLISM, by A. C. Ivy. Final rept. Aug. 15, 1957-Jan. 14, 1958. July 1, 1959 [57]p. incl. diagrs. tables, refs. (AFOSR-TR-59-79) (AF 49-(638)242) AD 219391; PB 143736   Unclassified

Chemical analysis of the blood serum for cholesterol, and of the liver and arteries for cholesterol and total lipids were made on 638 1-wk old chicks fed for 12 wk a basal diet (B.D.) containing 23% protein, 3% fat and 0.5% cholesterol and a control group fed the B.D. only. The arteries were graded for the severity of macroscopic atheromatosis. Soya and safflower oil and tallow enhanced the hypercholesterolemic and atherogenic effects of cholesterol while stearic and palmitic acid slightly decreased these effects. Tallow fed alone and in the cholesterol diet caused a slight but significant rise in the former case and an even larger increase in the latter case. Intestinal capacity is apparently reached when the diet cholesterol is greater than 1% by weight. A 0.25% level is enough to cause an accumulation in the liver, blood serum and arteries. Correlations are made between diet cholesterol % and accumulation in humans. Heavy cholesterol feeding seems to elicit an adaptation to this diet but no mechanism is proposed.

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[Illinois U. Dept. of Mathematics, Urbana].

DEFORMATION AND MAPPING THEOREMS, by D. G. Bourgin. [1959] [19]p. incl. refs. (AF 18(603)32)
Unclassified

Published in Fundamenta Math. (Poland), v. 46: 285-303, 1959.

It is shown that a class of theorems, (Q), characterized in a general way as asserting that in the deformation of a manifold, M, a point set, P, satisfying a certain property, contains an element for which a prescribed real valued continuous function f taking on an assigned value, may be valid without (T), that is P contains a continuum joining points with t = 0 and those with t = 1. This can be done by replacing circles with n spheres, and without establishing (T), showing that there are n + 1 orthogonal points on intersection, for some t, of the fixed unit sphere with the deformed sphere corresponding to this t value. In connection with this, it is also shown that a general criterion for the existence of a common image point for the map of orthogonal k tuples of S^{n-1} to E^1, yielding the first general breakthrough on a problem of Knaster's and as a special case, for n a prime, the generalized Kakutani theorem.

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Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

THE KINETICS OF FORMATION OF A METASTABLE PHASE IN NON-EQUILIBRIUM SOLID SOLUTIONS OF GOLD AND NICKEL, by J. Cost. [1959] [48]p. incl. diagrs. refs. (AFOSR-TN-59-56) (AF 18(603)22) AD 206427; PB 139829   Unclassified

Solid solutions of Au and Ni are being investigated to determine the deviation of the solid solution from randomness, i.e., clustering of like atoms. The effects of various heat treatments were studied on the hardness and internal friction of the Au-Ni alloy. After quenching from 850°C, an alloy containing 15% Ni showed the largest increase in hardness; this hardness effect decreased as the Ni content increased to 50% when the effect was lost. For an alloy containing 30% Ni, the hardness increase phenomenon decreased rapidly for aging temperatures above 150°C. The effect of quenching rate was measured on 30% Ni specimens quenched from 850°C and annealed at 150°C. Vacuum quench gave a cooling rate of about 6°C/sec; the cooling rate for cold water quench is unknown but was considerably greater than that for oil quench, about 150°C/sec. Data on the change of hardness during a 150°C anneal for the same alloy quenched in oil from 675°, 850°, and 925°C indicated that the quench which presumably freezes in the smallest concentration of vacancies produces the greatest hardening. Internal friction was determined at 0.6 c for specimens of the 30% Ni alloy quenched from various temperatures and rapidly brought to an appropriate annealing temperature. Internal friction decreased with time during annealing from 250°C. An as-quenched specimen showed only one peak which was at 275°C whereas the annealed specimen had a peak at 375°C.

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Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

THEORY OF DISLOCATION CLIMB [I], by R. Thomson. Feb. 1959, 1v. incl. diagrs. refs. (AFOSR-TN-59-58) (AF 49(638)420) AD 209429; PB 138701 Unclassified

A model is constructed which describes the climb of edge dislocations in terms of the nucleation of new jogs from vacancy aggregates on the dislocations. It is shown that the climb of split dislocations can be described in terms of the same nucleation and growth phenomena as those which cause the simple edge to climb. The only difference is the size of the vacancy aggregate for which the jogs are well formed. It is suggested that small numbers of impurities should play only a minor role in jog nucleation, but should be concentrated at the nodal points of the network by the climb process. However, it seems that at low temperatures, the nodal points of a dislocation network become very efficient jog sources. It is suggested that for a simple screw dislocation, the climb process may be quite different from that for the edge dislocations, due to the possibility that the jogs on screw dislocations are non-localized. One of the parameters of our theory is the motion energy of a vacancy on the dislocation line, and an attempt is made to interpret the pipe diffusion experiments to obtain the vacancy mobility. The pipe diffusion discussion leads to a prediction that there is a considerable volume-wise relaxation in the core of the dislocation. The estimated volume change in copper

due to core relaxation is of the order of 1/2 at vol/atom length of the dislocation line. (Contractor's abstract)

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Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

THEORY OF DISLOCATION CLIMB [II], by R. Thomson. Feb. 1959, 17p. incl. diagr. (AFOSR-TN-59-59) (AF 49(638)420) AD 209430; PB 138706
Unclassified

A simplified model is constructed for a climbing edge dislocation in a crystal in equilibrium with a flux of vacancies from the lattice. The climb of the model can be completely solved in terms of the build-up of vacancy aggregates on the line. Two interesting ranges of solution exist, that corresponding to a finite supersaturation and that corresponding to quasi-equilibrium. Under the quench condition, the dislocation is able to absorb all the incident vacancies with only minor perturbations due to the nucleation of new jogs. In the anneal condition, the rate of climb is very sensitive to the energy of a nucleated jog, and only slow climb is predicted for dislocations like those of copper and gold where the jog energy is high. (Contractor's abstract)

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Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

SOME PROPERTIES OF VANADIUM AT SUBATMOSPHERIC TEMPERATURES, by J. A. Hren, C. M. Wayman, and T. A. Read. Sept. 15, 1959 [8]p. incl. diagrs. (AFOSR-TN-59-1003) (AF 49(638)420) AD 227357; PB 149278 Unclassified

Also published in Trans. Metall. Soc. AIME, v. 218: 377-379, Apr. 1960.

The nature of the resistivity-temperature relation and the proposed allotropy in V was investigated. Resistivity measurements were made on Ca-reduced V of 99.7% purity. The specimen and thermocouple were immersed in a Dewar vessel containing isopentane. A constant temperature was maintained for more than sufficient time to make the necessary measurements. Resistance measurements were made on specimens in the annealed, vacuum-degassed, and cold-worked condition. The results showed no indication of any sudden discontinuity; however, a deviation from linearity existed at about 200°K. The measurements on heating and cooling were in agreement. The dynamic Young's modulus was measured as a function of temperature for polycrystalline specimens of 99.7% purity. No discernible deviation from linearity was apparent. X-ray diffraction studies were conducted through the same temperature range. Results indicated that the suggested allotropy in V appears to be doubtful, at least in the temperature range examined. (ASTIA abstract)

684

Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

RADIATION LIMITED DISLOCATION MOTION IN CRYSTALS, by R. Thomson. [1959] [1]p. (AFOSR-TN-59-1097) [AF 49(638)420]   Unclassified

Published in Jour. Appl. Phys., v. 31: 617, Mar. 1960.

Thermal activation of dislocations across the Peierls energy barriers in crystals is discussed. Of particular interest here is the case of nearly zero average velocity while assuming that the external stress is smaller than the Peierls stress. It is assumed that the dislocation starts at the top of a Peierls hill and accelerates to the bottom due to the gain in self energy. The result is that in crystals with large Peierls energy, the observed critical shear stress where the dislocations become mobile cannot be due to a dynamic motion of the dislocation, but the dislocations must be thermally activated through the lattice hill-valley structure.

685

Illinois U. Dept. of Physics, Urbana.

EXCITON STATES IN IONIC CRYSTALS, by R. S. Knox and N. Inchauspé. June 1959 [23]p. incl. diagr. table, refs. (AFOSR-TN-59-556) (AF 18(600)662) AD 216751; PB 143004   Unclassified

Abstract published in Proc. 1959 Internat'l. Symposium on Color Centers in Alkali Halides, Oregon State Coll., Corvallis (Sept. 8-11, 1959) [Salem, Oregon State Board of Higher Education] 1959, p. 21.

Also published in Phys. Rev., v. 116: 1093-1099, Dec. 1, 1959.

Exciton states in ionic crystals are analyzed according to configurations allowed by cubic point symmetry. The "excitation" and "electron transfer" models of the exciton structure are re-introduced as 2 slightly different aspects of the same general group-theoretical problem. Predictions of these models concerning multiplicity of absorption peaks are shown to be essentially identical. A theory of the "halogen atom doublet" appearing in the experimental absorption spectra of certain alkali halide crystals is given and is used in a preliminary interpretation of the electronic structure of low-lying exciton states in these solids. (Contractor's abstract)

686

Illinois U. Dept. of Physics, Urbana.

PHOTOCONDUCTIVE HALL EFFECT IN SILVER BROMIDE, by D. C. Burnham. June 1959 [217]p. incl. diagrs. tables, refs. (AFOSR-TN-59-717) (AF 18(600)-662) AD 226402; PB 143598   Unclassified

The Hall mobility of electronic carriers in silver bromide was investigated in the low-temperature range. The sign of the dominant carrier is negative, and the Hall mobility of electrons varies from 150 cm^2/volt-sec at 125°K to about 29,000 cm^2/volt-sec at 6°K. The temperature dependence of the mobility seems to be intrinsic above about 33°K and agrees with that predicted by scattering due to optical and acoustic modes of lattice vibration. Optical modes are dominant at temperatures above 40°K, and the Debye temperature associated with these modes is 195° ± 15°K. Acoustic scattering apparently is dominant between 35° and 15°K. Some type of impurity scattering has an effect below 33°K; plausibility arguments and agreement with data indicate that this scattering may be due to ionized impurities. At temperatures above 19°K the effects of high magnetic fields are in agreement with a semi-classical theory which assumes isotropic scattering and a spherical energy-band structure. (Contractor's abstract)

687

Illinois U. Dept. of Physics, Urbana.

EXPERIMENTAL RESEARCH UPON THE ELECTRONIC PROPERTIES OF NON-METALLIC CRYSTALS. Final rept. Dec. 1959 [12]p. incl. refs. (AFOSR-TR-59-196) (AF 18(600)662)   Unclassified

This final report summarizes briefly the history and achievements of the research conducted under this contract. The technical reports and publications issued are listed.

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Illinois U. Dept. of Physics, Urbana.

CONFIGURATION INTERACTION IN ALKALI HALIDE PHOSPHORS, by R. S. Knox. Feb. 15, 1959 [59]p. incl. diagrs. tables, refs. (AFOSR-TN-59-232) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)689 and Office of Naval Research under Nonr-183412) AD 211647; PB 144892   Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Nov. 28-29, 1958.

Abstract published in Bull. Amer. Phys. Soc., v. 3: 358, Nov. 28, 1958.

Also published in Phys. Rev., v. 115: 1095-1106, Sept. 1, 1959.

It is shown that excited state wave functions of free activator ions do not provide a completely adequate basis for a quantitative theory of the luminescence of alkali halides activated by heavy metals. It is proposed that better zero-order wave functions may be obtained by allowing interaction between different types of states of excitation, and as a practical example of an electronic

configuration which can interact with excited activator configurations, the electron transfer states of the Seitz model are discussed in detail. These states have generally been ruled out because of the absence of a halogen-like doublet in the phosphor absorption spectra, but a closer analysis shows that the doublet character of the activator atom is of equal importance. Neither of the doublets is expected to appear explicitly in the spectra. A numerical estimate of the coupling between an excited activator 6s6p state and a typical electron transfer state indicates the possibility of strong interaction between these configurations. It is concluded that the Seitz model is capable of explaining recent experiments on excitation bands, polarization effects, and lattice structure dependence of absorption spectra, provided that more emphasis is placed on electron-transfer states or other excited states of the host crystal which can interact with excited activator configurations. (Contractor's abstract)

689

Illinois U. [Dept. of Physics] Urbana.

THE SELF ENERGY OF A HELICAL DISLOCATION, by R. de Wit. [1959] 22p. incl. refs. (AFOSR-TN-59-555) [AF 18(600)689] AD 216720   Unclassified

Also published in Phys. Rev., v. 116: 592-597, Nov. 1, 1959.

Kröner's energy expression is used in this theoretical calculation. The helical dislocation is assumed to have a uniform shape with the Burgers vector along its axis. The axial length of the helix is large compared to its radius and the radius is large compared to the dislocation "cross section", which is of the order of a Burgers vector. For a helix of many turns and arbitrary pitch an expansion in a Fourier cosine series is used. The self energy is found in terms of elementary functions and Kapteyn series of Bessel functions. In the limiting cases of a tightly wound helix (small pitch) and a nearly straight helix (large pitch) simple expressions result, which have a plausible physical explanation. For a tightly wound helix the dominant term represents the contribution from the cylindrical part of the helix, the first-order terms represent the influence of the size of the dislocation cross section and the second order terms represent the effect of the axial component of the helix. For the nearly straight helix the dominant terms represent the contribution from the straight screw part and the second-order terms are taken to give the interaction between the turns of the helix. Finally the correction in the self-energy when a return loop is present is considered. (Contractor's abstract)

690

Illinois U. Dept. of Physics, Urbana.

THEORETICAL STUDY OF THE PROPERTIES OF INSULATING AND CONDUCTING SOLIDS, by F.

Seitz. Final rept. Dec. 1, 1958-May 31, 1959. June 15. 1959, 7p. (AF 18(600)689)   Unclassified

A report of the progess made to date on various aspects of this study is made. Subjects discussed include the electronic structure of the V_k center, exchange polarization in atoms and paramagnetic ions, and nuclear magnetic shielding of H^1 and F^{19} nuclei in the HF molecule. Visiting consultants, who have published work under this contract, are listed and a brief review of the work done by those individuals permanently assigned to this project is made.

691

Illinois U. Dept. of Physics, Urbana.

NUCLEAR QUADRUPOLE INTERACTIONS IN ALKALI HALIDE MOLECULES, by T. P. Das and M. Karplus. [1959] [2]p. [AF 18(600)689]   Unclassified

Published in Jour. Chem. Phys., v. 30: 848-849, Mar. 1959.

Theoretical values of the nuclear quadrupole coupling constants e^2qQ for both nuclei in KCl, KBr, and RbCl are compared with experimental data. It is shown that the comparison improves if the effects of the induced dipole moments on neighboring ions are taken into account and the distance R for each molecule is taken as the value obtained from molecular beam work instead of the considerably larger value obtained from the sum of the ionic radii. In the comparison of experimental and theoretical figures for the negative ion nuclei, the theory apparently collapses for the signs are of the wrong value. It is believed that the electronic contribution to the e^2qQ can account for the discrepancy.

692

Illinois U. Dept. of Physics, Urbana.

THEORY OF NUCLEAR QUADRUPOLE INTERACTION IN BERYLLIUM METAL, by M. Pomerantz and T. P. Das. [1959] [9]p. incl. diagrs. refs. (In cooperation with California U., Berkeley AF 18(603)46) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(600)689] and Office of Naval Research)   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 251, Apr. 30, 1959. (Title varies)

Published in Phys. Rev., v. 119: 70-78, July 1, 1960.

See item no. 189 for abstract.

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Illinois U. Dept. of Physics, Urbana.

MAGNETIC PROPERTIES OF WATER MOLECULE, by
T. P. Das and T. Ghose. [1959] [11]p. incl. diagr.
tables, refs. [AF 18(600)689]   Unclassified

Published in Jour. Chem. Phys., v. 31: 42-52, July 1959.

The mass susceptibility x and proton magnetic shielding
factor σ for H_2O molecule are calculated using a local-
ized electron pair LCAO MO wave function. The para-
magnetic part of the susceptibility and a portion of the
paramagnetic part of σ are calculated by a variational
method used earlier for the H_2 molecule. The calcu-
lated value of x is found to be -0.687×10^{-6} in very
good agreement with the experimental value of -0.699
$\times 10^{-6}$. The calculated value of σ is, however, found
to be only -0.85×10^{-5} in rather poor agreement with
the experimental value of -2.97×10^{-5}. The causes
for this poor agreement are analyzed, and it is con-
cluded that the main reasons are (1) use of a rather
large ionic character (66%) for the OH bond obtained
from a curve of electronegativity difference versus
ionic character and (2) use of undistorted H-atom orbit-
als in the LCAO MO function. It is suggested that the
calculated value of σ would improve in the right direc-
tion if the effective charge for the H-atom orbital were
taken as greater than unity. The value of σ is recalcu-
lated with Ellison and Shull's "approximate treatment"
wave function and found to be -1.31×10^{-5}. The dis-
agreement with experiment in this case is ascribed to
cause (2). (Contractor's abstract)

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Illinois U. Dept. of Physics, Urbana.

A METHOD FOR MEASURING MAGNETIC FIELDS
IN SUPERCONDUCTORS, by H. R. Lewis, J. F.
Cochran and others. Nov. 1959 [16]p. incl. diagrs.
refs. (AFOSR-TN-59-1154) (AF 18(603)49)
AD 228738; PB 144568   Unclassified

Also published in Zeitschr. Phys.. v. 158: 26-34, Jan.
1960.

Conventional experiments on the magnetic properties
of bulk superconductors involve space averages over
distances largely compared with the penetration depth.
A nuclear technique is described which permits local
measurements of the variation of the magnetic field
within a bulk superconductor. The results, while in-
sufficient for determining the internal field distribution,
show the expulsion of flux from samples below the
critical temperature (Meissner effect). The influence
of extranuclear fields on a nuclear directional correla-
tion forms the basis of this method. When a nucleus
decays through successive emission of 2 gamma rays,

for example, the direction of the 2nd is related to that
of the first. This directional correlation is due to the
selection of a partially oriented sample of nuclei through
the observation of the 1st gamma ray in a given direc-
tion. The angular distribution of the 2nd gamma ray is
fixed to the nuclear orientation and hence, is related
to the direction of the 1st gamma ray. (Contractor's
abstract)

695

Illinois U. [Dept. of Physics] Urbana.

PHOTOCONDUCTIVE HALL EFFECT IN KCl, by F.
C. Brown and N. Inchauspé. May 1959, 2p. (AFOSR-
TN-59-553) (AF 49(638)579) AD 216728; PB 143005
          Unclassified

Abstract published in Proc. Internat'l. Symposium on
Color Centers in Alkali Halides, Oregon State Coll.,
Corvallis (Sept. 8-11, 1959), [Salem] Oregon State Board
of Higher Education, 1959, p. 12.

A study is made of the Hall effect for carriers re-
leased by light over a temperature range of $4°$ to $114°K$
in additively colored crystals of KCl, containing vari-
ous concentrations of F-centers. The photoconductivity
for microsecond pulses of light varies with temperature.
It appears that electrons are scattered primarily by
optical vibrations of the lattice at temperatures above
$50°K$. It is indicated that the F-centers are relatively
weak scattering centers.

696

Illinois U. [Dept. of Physics] Urbana.

HALL MOBILITY OF HOLES IN AgBr, by R. C. Hanson
and F. C. Brown. July 1959 [9]p. incl. diagr. table,
refs. (Technical note no. 2) (AFOSR-TN-59-752)
(AF 49(638)579) AD 219995   Unclassified

Also published in Jour. Appl. Phys., v. 31: 210-211,
Jan. 1960.

Conflicting evidence for the mobility of holes in polar
crystals such as the silver halides is reviewed. Obser-
vations of the Hall effect for added carriers indicate that
the holes are responsible for the observed increase in
conductivity and that the mobility of holes is much greater
than the mobility of ionic defects but substantially
less than the mobility of electrons in the tempera-
ture range of $25°$ to $150°C$. The conductivity, σ, of a crystal
at a given temperature was found to increase by an
amount, $\Delta\sigma$, upon admitting bromine or chlorine gas.
Tests made on samples of different thickness and purity
indicate that the phenomena is a volume effect and that
the excess conductivity disappears when the halogen is
pumped off. The Hall voltage was found to be linearly
dependent upon magnetic and applied electric fields and
independent of frequency in the range of frequencies
where the impedance of the preamplifier is much larger
than the crystal impedance.

697

Illinois U. [Dept. of Physics] Urbana.

ELECTRONIC PROCESSES IN THE SILVER HALIDES
AT LOW TEMPERATURE, by F. C. Brown and K.
Kobayashi. [1959] [3]p. incl. diagrs. refs. (AFOSR-
3996) (AF 49(638)579)   Unclassified

Presented at 1958 Internat'l. Conf. on Semiconductors,
Rochester U., N. Y., Aug. 18-22, 1958.

Also published in Jour. Phys. and Chem. Solids, v. 8:
300-302, Jan. 1959.

An explanation is given as to why measurements over
a wide range of temperatures by transit time techniques
in the case of AgCl and AgBr do not agree with expec-
tations. It was expected that with decreasing tempera-
ture, electron mobility would increase. However,
drift mobility was reportedly found to be small at low
temperatures and to have a maximum in the vicinity of
50 to 90°K. Multiple trapping effects are ascribed as
the cause of the drift mobility. Scattering by imperfec-
tion, although present, is ruled out. The results are
arrived at by analyzing the Hall effect which is independ-
ent of trapping effects and rise to a very high value at
low temperatures. Results showing that electron mo-
bility decreases below 35°K and is still smaller below
15°K are presented.

698

Illinois U. Dept. of Psychology, Urbana.

ISSUES IN THE USE OF AN ANALOG-DIGITAL DATA
SYSTEM FOR THE MEASUREMENT OF TRACKING
BEHAVIOR, by C. E. Webber and J. A. Adams. Apr.
1960, 33p. incl. diagrs. tables. (AFOSR-TN-59-528)
(AF 49(638)371) AD 245064; PB 152703
                                        Unclassified

Tracking data collected by an analog-digital data
system and processed with a digital computer is recom-
mended as a solution for certain research restraints
imposed by the traditional methods of measuring track-
ing behavior. An experiment on system parameters
performed entirely on a digital computer, evaluated
sampling rate and number of digits per reading of stimu-
lated tracking error functions for time on target meas-
ures. The Sampling Theorem recommending a sampling
rate twice that of the highest component frequency in
the analog signal is sound for time on target computa-
tions, but somewhat lower rates appear acceptable for
many applications. Empirical tracking data obtained
with an analog-digital data system is presented. (Con-
tractor's abstract)

699

Illinois U. [Dept. of Psychology] Urbana.

HUMAN TRACKING BEHAVIOR, by J. A. Adams. [1959]
[25]p. incl. diagr. table. (AFOSR-TN-59-1070) [AF 49-
(638)371] AD 254757   Unclassified

Also published in Psychol. Bull., v. 58: 55-79, Jan. 1961.

A critical review and analysis is presented of the re-
search, issues, and points of view associated with human
behavior in 1- and 2-dimensional tracking tasks. It is
suggested that 3 fundamental topics must be given more
attention before an adequate theory of tracking behavior
can be formulated: (1) An attempt must be made to de-
fine the allowable variations in input, both in type and
functional form, as well as the characteristics of the
control system used for responding. (2) Recognition
must be given to the presence and interaction of sev-
eral overt and intervening response and stimulus clas-
ses, and how these factors act to determine the charac-
teristics of the measured motor response. (3) More in-
terest should be channeled toward multidimensional
tracking tasks having 2 or more stimulus sources in the
same or different sense modalities, and corresponding
dimensions in the control system for response to each
source.

700

Illinois U. Electrical Engineering Research Lab., Urbana.

RECTANGULAR AND CIRCULAR MILLIMETER WAVE-
GUIDES, by P. D. Coleman and R. C. Becker. [1959]
[2]p. incl. diagrs. tables. [AF 18(603)62]
                                        Unclassified

Published in Electronics, v. 32: 50-51, May 1, 1959.

Rectangular and circular waveguides are now commer-
cially available for the frequency range 26.5 to 350 kmc,
11.5 to 0.857-mm wavelength, covering the upper range
of applicability of conventional microwave techniques.
The mechanical and electrical characteristics of these
waveguides are given, including the nonstandard and
military types.

701

Illinois U. Electrical Engineering [Research Lab.] Urbana.

FEEDING RF POWER FROM A SELF-EXCITED,
PULSED SOURCE INTO A HIGH-Q RESONANT LOAD,
by H. A. Spuhler, R. J. Kenyon, and P. D. Coleman.
[1959] [1]p. incl. diagr. [AF 18(603)62]
                                        Unclassified

Published in I.R.E. Trans. on Microwave Theory and
Tech., v. MIT-7: 391, July 1959.

A high-power ferrite isolator system is described

which is capable of feeding 78% of the available power from a 5586, S-band megawatt magnetron into a microwave cavity having an unloaded Q of 14,400. The performance of this ferrite system is compared to the series tee and shown to result in 38% increase in power with no reduction in stability characteristics.

702

Illinois U. [Electrical Engineering Research Lab.] Urbana.

DIPOLAR MAGNETODYNAMIC FERRITE MODES, by W. H. Steier and P. D. Coleman. [1959] [2]p. incl. diagrs. (AF 18(603)62) Unclassified

Published in Jour. Appl. Phys., v. 30: 1454-1455, Sept. 1959.

The results of an experimental and theoretical investigation of the dipolar magnetodynamic modes of a ferrite rod between 2 conducting planes are reported. It is pointed out that the metal capped ferrite rod offers advantages in coupling compared to a ferrite body in space. These modes include propagation effects and hence the ferrite can be large compared to the wavelength. These factors are pertinent in the consideration of ferrite modes for use in parametric amplifiers and frequency multipliers. A more detailed account of the same subject will be given in a later report.

703

Illinois U. Electrical Engineering Research Lab., Urbana.

LEAST-SQUARES APPROXIMATION FOR BOTH MAGNITUDE AND PHASE BY RATIONAL FUNCTIONS, by K S. Fu. Feb. 9, 1959, 68p. incl. diagrs. refs. (Technical note no. 6) (AFOSR-TN-59-71) (AF 49-(638)63) AD 209846; PB 140446 Unclassified

A method is presented to approximate both magnitude and phase within a given band. The specified magnitude and phase characteristics, either in the form of a function or in terms of a graphical plot, are approximated by a rational function in the sense of minimizing the least-squares error. Preassignment of pole locations and error improvement by proper selection of poles are described. The approximation method is extended to the time-domain approximation and the simplification of a transfer function by an RC (or RL) function or an all-pole function. (Contractor's abstract, modified)

704

Illinois U. Electrical Engineering Research Lab., Urbana.

A CORRELATION BETWEEN CLASSICAL AND POLE-ZERO SENSITIVITY, by J. J. Mikulski. Feb. 20, 1959, 85p. incl. diagrs. tables, refs. (Technical note no. 5) (AFOSR-TN-59-72) (AF 49(638)63) AD 209847; PB 140236 Unclassified

The correlation existing between the over-all sensitivity of a network or system function and sensitivities of the poles and zeros, or roots, of that function was established. Root sensitivity is extended to the case of a nonlinear dependence of the coefficients, and so introduces a concept of a second-order sensitivity that is applicable and useful in the classical sensitivity definition. The nature of the frequency dependence of the classical sensitivity is utilized to derive the root sensitivities. An extension of the sensitivity concept to multiple roots is made possible through the correlation established. All information about the multiple root sensitivity present in the classical sensitivity function is used in the correlation, and an approximation is allowed to the root variation, owing to finite future parameter changes. The theory developed is illustrated and tested by means of a set of examples obtained from the field of passive network synthesis. Study is made of the roots of a function which may appear when the parameter varies, but are not present for the nominal parameter value. A study is made of the sensitivities when n parameters are allowed to vary simultaneously, in order to practically apply the theory to network or system theory. The concept of sensitivity is introduced into the time domain.

705

Illinois U. Electrical Engineering Research Lab., Urbana.

CONTRIBUTIONS TO TRANSISTOR-RC NETWORK SYNTHESIS, by B. R. Myers. Feb. 20, 1959, 104p. incl. diagrs. refs. (Technical note no. 7) (AFOSR-TN-59-73) (AF 49(638)63) AD 209848; PB 140237 Unclassified

A survey was made of existing techniques and philosophies. A new, functional symbolic representation of the equivalent circuit of a junction transistor was introduced. The concept of negative impedance conversion was extended to converters with a conversion ratio of other than minus one. Methods of realizing the sub-class of RL driving-point impedance functions by transistor-RC means are discussed. Some new methods of transfer function synthesis are presented. Of these, the most significant is a method for exact synthesis of a single pair of complex poles of transmission, which utilizes only one transistor, and a simple but powerful method for unrestricted pole realization. This method was extended to the simultaneous realization of complex zeros, including zeros in the right-half plane, and unrestricted poles. Some methods of realizing non-positive real driving-point impedances are presented. (ASTIA abstract, modified)

706

Illinois U. Electrical Engineering Research Lab., Urbana.

ACTIVE NETWORK SYNTHESIS BY LATTICE REDUCTION, by R. E. Thomas. May 15, 1959, 95p. incl. diagrs. tables, refs. (Technical note no. 8) (AFOSR-TN-59-584) AD 217031; PB 143515 Unclassified

Development efforts are concerned with an active RC synthesis procedure which begins with the synthesis of a symmetric lattice. For active elements the negative impedance converter (NIC) is used exclusively. The exclusive use of the NIC is convenient since the NIC may be studied and perfected as an independent problem. That is, a function has been assigned to the active elements which is independent of the synthesis process. Due account is taken of such things as impedance levels and biasing provisions but it is seen that biasing resistance can almost always be built into the lattice in the synthesis process. The various NIC-type networks are not covered here. For these purposes the NIC is merely a 2 port device which presents a input immittance which is the negative of the load immittance. The ideal NIC behavior can be attained to a degree which is compatible with the approximations in the passive elements which will be used. In brief, as a synthesis tool the NIC is a practical device in the fullest sense of the word. (Contractor's abstract)

707

Illinois U. Electrical Engineering Research Lab., Urbana.

ON THE SYNTHESIS OF TIME VARYING LINEAR SYSTEMS, by J. B. Cruz, Jr. Aug. 7, 1959, 96p. incl. diagrs. refs. (Technical note no. 9) (AFOSR-TN-59-866) (AF 49(638)63) AD 226580; PB 144311
Unclassified

It is shown that any multi-input-multi-output linear system may always be represented by a set of single-input-single-output linear subsystems connected properly. Attention is focused on some properties of single-input-single-output linear systems which are generally time varying. These properties are exploited in developing synthesis procedures for time-varying linear systems with specifications in the time domain, frequency domain, and general λ domains. In connection with synthesis in a general λ domain, compatible systems are defined. The techniques for fixed linear systems in the frequency domain apply to compatible time-varying linear systems in an appropriate λ domain. The characterization or system functions for all the models considered belong to the class of separable functions 1st treated by Bendat. Necessary and sufficient conditions are derived for the exact realization of certain classes of functions. However, a much wider class of specified system functions may be expanded in terms of a set of orthogonal and realizable functions. It is well known that if the series is truncated, the approximation is best in the sense of minimum integral square error. The basic time-varying element used in most of the models is a time-varying gain amplifier. The approximation of the time-varying gain amplifier by periodically operated switches, sinusoidal time-varying amplifiers, and sequentially gated amplifiers is discussed. (Contractor's abstract)

708

Illinois U. Electrical Engineering Research Lab., Urbana.

TWO THEOREMS IN MULTI-WEIGHTED SUMS, AND THEIR APPLICATION IN THE STABILITY ANALYSIS OF ACTIVE LINEAR SYSTEMS, by B. R. Myers. Nov. 5, 1959, 17p. incl. diagrs. (Technical note no. 10) (AFOSR-TN-59-1096) (AF 49(638)63) AD 231383; PB 145558
Unclassified

The first theorem shows that the collection of all normalized, nonnegatively multiweighted sums of a finite set of vectors belonging to an arbitrary finite-dimensional vector space is contained in the convex hull of the vertex vectors of the normalized weights. The second theorem states a sufficient condition under which the collection is complete, i.e. such that there is no point in the convex hull which is not a point of the sum. Two corollaries of this theorem identify particular types of sum for which the collection is complete. Applications of the theorems in the stability analysis of active linear systems with multi-parameter variance leads to a useful graphical method which might be described as a generalization of Nyquist's criterion for stability. (Contractor's abstract)

709

Illinois U. Electrical Engineering [Research Lab.] Urbana.

DESIGN OF COMBINATIONAL SWITCHING CIRCUITS USING AN ITERATIVE CONFIGURATION, by D. L. Epley. [1959] [23]p. incl. diagrs. refs. (AFOSR-3847) [AF 49(638)63]
Unclassified

Also published in Proc. Fourth Midwest Symposium on Circuit Theory, Marquette U., Milwaukee, Wis., Dec. 1959, p. M-1 - M-23.

The design of an iterative network structure which can handle an appreciable number of variables, which contains several switching functions, and whose action can be easily described by a simple verbal statement is discussed. The overall design procedure entails 4 steps: (1) construction of a state or flow table for the typical cell, (2) assignment of carry-variables, (3) construction of a typical cell, and (4) modification of the end cells. Design examples are given.

710

Illinois U. [Electrical Engineering Research Lab.] Urbana.

AN EXTENSION OF PRONY'S METHOD TO FREQUENCY DOMAIN APPROXIMATION, by J. B. Cruz, Jr. [1959] [12]p. incl. diagr. (AFOSR-3848) [AF 49(638)63] AD 289308
Unclassified

Also published in Proc. Fourth Midwestern Symposium on Circuit Theory, Marquette U., Milwaukee, Wis., Dec. 1959, p. H-1 - H-12.

In approximating a specified function H(s) by H*(s) corresponding to a realizable network, the criterion of least integral square error in the frequency domain is intimately connected with an expansion of H(s) in an orthogonal set of rational functions $\{\Phi_K(s)\}$. For a specified error tolerance, the necessary number of terms in the expansion may be large because $\{\Phi_K(s)\}$ is arbitrary. In this study, the Prony method which has been originally applied to time domain approximations will be extended to frequency domain approximations, in an attempt to make the number of poles of H*(s) small. The method is to "fit" a homogeneous differential equation to the "natural" frequencies of the system. The residues at the chosen poles are then optimized in the least integral square sense on the $j\omega$ axis. An example is presented to illustrate the procedure. (Contractor's abstract)

711

Illinois U. [Electrical Engineering Research Lab.] Urbana.

RECENT ADVANCES IN ACTIVE NETWORK SYNTHESIS, by M. E. Van Valkenburg. [1959] [13]p. incl. diagrs. refs. (AFOSR-3850) [AF 49(638)63]
AD 289311   Unclassified

Also published in Fourth Midwest Symposium on Circuit Theory, Marquette U., Milwaukee, Wis., Dec. 1959, p. N-1 - N-13.

There are indications that active network synthesis has come of age. In the telephone industry, for example, transistor-RC networks have only recently replaced passive LC networks in some applications. This paper outlines recent developments in realization methods and performance criteria. In particular, the work at Illinois U. is reviewed, including that of Chien, Myers, and Thomas relating to realization, and by Kuo and Mikulski on sensitivity. This work is related to the important contributions of Linvill, Yanagisawa, and Horowitz. (Contractor's abstract)

712

Illinois U. Electrical Engineering [Research Lab.] Urbana.

A GENERALIZATION OF THE IMPULSE TRAIN APPROXIMATION FOR TIME-VARYING LINEAR SYSTEM SYNTHESIS IN THE TIME DOMAIN, by J. B. Cruz, Jr. [1959] [2]p. incl. diagrs. (AFOSR-3852) (AF 49(638)63)   Unclassified

Also published in I.R.E. Trans. on Circuit Theory, v. CT-6: 393-394, Dec. 1959.

A simple procedure is described for approximating the impulse response of a time-varying linear system by a series of impulse planes. A common system specification is the impulse response $h(t,\tau)$ which is the output

when the input is a unit impulse $\delta(t-\tau)$. The instant of observation is t and the impulse is at τ. The approximation and realization of a given $h(t,\tau)$ is discussed.

713

Illinois U. [Electrical Engineering Research Lab.] Urbana.

TRANSISTOR-RC NETWORK SYNTHESIS, by B. R. Myers. [1959] [10]p. incl. diagrs. refs. (AFOSR-3853) (AF 49(638)63)   Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 18-21, 1959.

Also published in I.R.E. WESCON Convention Record, Pt. 2: 65-74, 1959.

Several methods of transfer function realization are presented. The most significant of these is a method for realizing unrestricted complex poles of transmission. The power of the method lies in its simplicity, and in the fact that the synthesis is from one end of the network, so that the synthesizer is able to maintain control over the poles of the driving-point function. The negative elements which arise are all accommodated in a single shunt branch across the output terminals, realizable by a single NIC. A simple extension of this method, utilizing topologically-generated zero-producing sections, enables the simultaneous realization of complex zeros, including zeros in the right-half plane, and unrestricted poles. Two methods for general transfer function synthesis, a method for exact realization of a single pair of poles of transmission which utilizes only one transistor, and a method for synthesizing a complex pole pair when the network terminations are specified, are also given. (Contractor's abstract)

714

Illinois U. Electrical Engineering [Research Lab.] Urbana.

WHAT IS NEGATIVE IMPEDANCE? by B. R. Myers. June 5, 1959, 2p. (AFOSR-3854) [AF 49(638)63]
                                             Unclassified

Also published in Jour. Inst. Elec. Engineers (London), v. 5: 471-472, Aug. 1959.

Comments are made on an article by M. O. Williams [Jour. Inst. Elec. Engineering (London), v. 5: 169, 1959] defining impedance as the ratio of the r.m.s. current which is produced thereby, and that it should be denoted by the symbol Z. It is pointed out in the present note that the foregoing definition is incomplete and that in steady-state analysis and cisoidal time-functions, impedance of a 2-terminal circuit is equal to the constant of proportionality which relates the cisoidal voltage drop across the 2 terminals to the cisoidal current which flows through the circuit from the terminal of

assumed higher potential. This definition is held to be
purely mathematical and negates the necessity to speci-
fy that the voltages and currents be r.m.s. quantities.

715

Illinois U. [Electrical Engineering Research Lab.] Urbana.

A USEFUL EXTENSION OF THE NYQUIST CRITERION
TO STABILITY ANALYSIS OF MULTILOOP FEEDBACK
AMPLIFIERS, by B. R. Myers. [1959] [18]p. incl.
diagrs. (AFOSR-3855) (AF 49(638)63) AD 289310
Unclassified

Also published in Proc. Fourth Midwest Symposium on
Circuit Theory, Marquette U., Milwaukee, Wis., Dec.
1959, p. J-1 - J-18.

A simple graphical solution to the problem of examin-
ing system stability when several parameters are al-
lowed to vary simultaneously is presented. This solu-
tion might be regarded as an extension of the Nyquist
criterion in that the behavior of the characteristic
equation of the system is examined along the radian
frequency axis in the s-plane. The method involves
plotting only a finite number of Nyquist diagrams; a
system with n variable parameters requires at most

(2^n-1) separate Nyquist plots, and in many practical
cases less than half of this number are sufficient. The
main disadvantage of the method is that it leads to a
criterion which in the general case is merely suf-
ficient. In many practical cases, however, it turns out
that the criterion is both necessary and sufficient.
(Contractor's abstract, in part)

716

[Illinois U. Electrical Engineering Research Lab., Urbana]

THE ACTIVE CONSTANT-RESISTANCE LATTICE, by
R. F. Thomas. [1959] [11]p. incl. diagrs. tables.
(AFOSR-3858) [AF 49(638)63] Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill.,
Oct. 12-14, 1959.

Also published in Proc. Nat'l. Electronics Conf., v. 15:
727-737, 1959.

A major practical difficulty associated with most meth-
ods of active RC synthesis is the difficulty of obtaining
proper alignment. A useful procedure for reducing the
alignment problem is cascade synthesis and one method
of cascade synthesis is the constant-resistance lattice.
The passive constant-resistance lattice technique is
extended to active networks in which the available net-
work elements are positive and negative resistors,
nd capacitors. A method is presented for synthesizing
constant-resistance sections which realize a pair of
estricted zeros and a pair of left-half plane poles.
ee procedures are givn for reducing the lattice to

an unbalanced equivalent 2-port made up of resistors,
capacitors, and negative impedance converters (NIC).
NIC biasing requirements are met by inserting resis-
tance into the lattice at an appropriate stage of the de-
composition process. Sensitivity properties of the ac-
tive lattice are analyzed and it is shown that proper
evaluation can be made only in terms of classified sen-
sitivity since the poles of the constant-resistance lat-
tice always have infinite root sensitivity. The proce-
dure for controlling the sensitivity properties of the
lattice is largely one of trial and error but the results
are competitive with other methods of RC-NIC syn-
thesis. Several examples of sensitivity computations
are given to illustrate the theory. (Contractor's
abstract)

717

Illinois U. Electrical Engineering Research Lab., Urbana.

ELECTRONIC HEATING AND BREAKDOWN OF
SEMICONDUCTORS IN MICROWAVE FIELDS. AN
INVESTIGATION OF MICROWAVE DUPLEXER
SWITCHING MECHANISMS, by K. H. Seeger. Oct. 1,
1958, 47p. incl. diagrs. tables, refs. (Technical rept.
no. 1) (AFOSR-TN-59-57) (Sponsored jointly by Air
Force Office of Scientific Research under AF 49(638)-
417 and Signal Corps under DA 36-039-sc-73150)
AD 209428; PB 156089 Unclassified

A research program was conducted to investigate the
use of semiconductors for a TR microwave switch. A
semiconductor switch using germanium at liquid helium
temperature was found superior to gas-filled TR tubes
in respect to nondestructive breakdown. Because of
the inconvience of the low temperature, investigations
were made with germanium with deep levels at liquid
nitrogen temperature. In addition, with ordinary ger-
manium of various impurity concentrations the electron
energy transfer mechanism including optical and acous-
tical phonon scattering was studied at both high and low
microwave power levels between 80°K and 300°K. Elec-
tron-electron scattering seems to dominate the energy
transfer to the lattice, since the high-field mobility
apparently depends on the carrier concentration. The
experimental data are in agreement with those obtained
by dc methods. This suggests that the relaxation time

of the carriers is smaller than 5×10^{-12} sec. (Con-
tractor's abstract)

718

Illinois U. Electrical Engineering Research Lab., Urbana.

EFFECT OF ION BOMBARDMENT ON SEMICONDUC-
TOR SURFACES, by S. R. Arnold. Mar. 20, 1959, 95p.
incl. diagrs. refs. (Technical note no. 1) (AFOSR-TN-
59-131) (AF 49(638)417) AD 210839; PB 139999
Unclassified

Measurements of surface properties of etched Ge

surfaces were conducted before and after bombardments by 500- and 1000-v oxygen ions. Simultaneous photoconductance and field effect measurements were made in vacuum at a room temperature in an effort to correlate surface lattice disorder with the surface state structure. Bombardment had the general effect of increasing the surface state density without causing major changes in the trapping structure. Comparison of changes in surface recombination with changes in overall charge localized in fast states indicated that the density of the dominant recombination centers in etched surfaces may be more than an order of magnitude smaller than commonly reported. Evidence is presented to suggest that the ability of conventional field effect experiments to measure the densities of the dominant recombination centers in such surfaces may be open to question. Surface recombination velocity behavior is roughly indicative of a dominant recombination center located 5 to 6 kT above mid-gap.

719

Illinois U. Electrical Engineering Research Lab., Urbana.

THE CONDUCTANCE OF A CLEANED GERMANIUM SURFACE, by W. Portnoy and P. Handler. Mar. 20, 1959, 75p. incl. diagrs. refs. (Technical note no. 2) (AFOSR-TN-59-132) (AF 49(638)417) AD 210840; PB 139993   Unclassified

The conductivity and field effect mobility of the carriers in the region of the space charge of a cleaned germanium surface were measured as a function of various gas ambients and as a function of temperature. The carriers in the region of the space charge at a germanium surface, cleaned by argon sputtering and annealing, were p-type in character and exhibited the characteristics of a degenerate gas. Adsorption of water vapor on the surface decreased this p-type space charge region while atomic hydrogen enhanced it. Adsorption of oxygen first enhanced the p-type region and then decreased it. The p-type region arises from the nature of the germanium surface atoms. These atoms act as acceptors by trapping an electron from the bulk into their unfilled orbitals at the surface. The measurements of the excess conductivity associated with this region of space charge as a function of temperature substantiated the degeneracy of the valence band by showing only a very slight variation over the range 77° to 300°K. Rough estimates indicated that the number of holes in the region of the space charge does not change by more than a factor of two over the temperature range investigated.

720

Illinois U. Electrical Engineering Research Lab., Urbana.

EFFECT OF HEAVY DOPING ON THE DIFFUSION OF IMPURITIES IN SILICON, by M. F. Millea. July 15, 1959, 45p. incl. diagrs. tables, refs. (Technical note no. 3) (AFOSR-TN-59-460) (AF 49(638)417) AD 215265; PB 143673   Unclassified

The diffusivities of P, Sb, Sn and In in "intrinsic" (10^{15} impurity atoms/cm^3 or less), heavily doped n-type (5 x 10^{19} atoms/cm^3), and heavily doped p-type (2 x 10^{20} atoms/cm^3) silicon have been measured to obtain information on the way diffusion takes place. The measured diffusivities of P and Sb in n-type are twice their values in intrinsic silicon; their diffusivities in p-type are one half those in intrinsic silicon. These changes are in the direction expected for vacancy diffusion. The diffusivity of Sn in n-type is about 50% larger than in intrinsic, whereas in p-type it is about equal to that in intrinsic silicon. Opposite changes are found for the diffusivity of indium; it is about 6 times larger in p-type and about 50% lower in n-type than in intrinsic silicon. Possible diffusion mechanisms for substitutional impurities in silicon are discussed in the light of these and other data. (Contractor's abstract)

721

Illinois U. Electrical Engineering Research Lab., Urbana.

MICROWAVE INDUCED CARRIER MULTIPLICATION IN GERMANIUM, by K. [H.] Seeger. [1959] [2]p. incl. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)417] and Signal Corps)   Unclassified

Published in Jour. Appl. Phys., v. 30: 443-444, Mar. 1959.

Experiments on impact ionization in germanium using dc fields are reported. It is shown that the microwave power transmission of n-type germanium is +, at first porportional to the incident power. The data is compared to other results in the field.

722

Illinois U. Electrical Engineering Research Lab., Urbana.

MICROWAVE FIELD DEPENDENCE OF DRIFT MOBILITY IN GERMANIUM, by K. [H.] Seeger. [1959] [6]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)-417] and Signal Corps)   Unclassified

Published in Phys. Rev. v. 114: 476-481, Apr. 15, 1959.

At lattice temperatures between 80 and 300°K, electrons and holes in germanium have been heated by microwaves, with an extension to high microwave fields of the technique developed by Morgan. The microwave frequency was 34.67 kmc/sec. The effect of carrier densities between 10^{13} and 10^{16}/cm^3 has been investigated. At large microwave fields E (up to about 10^4 volts/cm in amplitude) the mobility μ, relative to the mobility μ_0 at zero field, is proportional to $E^{-\gamma}$; the exponent γ is

smaller for purer samples. These microwave measurements agree with previous dc field measurements.

At small values of E, $(\mu_0-\mu)/\mu_0 E^2 = \alpha$ is field independent. The variation of α with lattice temperature T has been measured. In the range of pure lattice scattering, $\alpha(T) \propto \mu_0^2 T^x$; exp $x = (n/n_0)^{0.67}$ where $n_0 = 1.7 \times 10^{14}$ cm^{-3} for electrons and 1.0×10^{14} cm^{-3} for holes. This dependence on carrier density suggests that carrier-carrier interaction plays an important role in the carrier-phonon scattering mechanism. (Contractor's abstract)

723

Illinois U. [Electrical Engineering Research Lab.] Urbana.

EFFECT OF OXYGEN IN SILICON ON PHOSPHORUS DIFFUSION, by J. L. Hartke. [1959] [2]p. incl. diagr. refs. (AF 49(638)417)   Unclassified

Published in Jour. Appl. Phys., v. 30: 1469-1470, Sept. 1959.

The diffusion coefficient of phosphorus in silicon was measured for silicon samples with concentrations of oxygen differing by several orders of magnitude. No variation with oxygen content was found, indicating that there was no combination of oxygen with the diffusing phosphorus.

724

Illinois U. Electrical Engineering [Research Lab.] Urbana.

A NEW LOOK AT LIGHT, by D. F. Holshouser. [1959] [11]p. incl. illus. diagrs. [AF 49(638)556]
                                        Unclassified

Also published in Bridge of Eta Kappa Nu, v. 55: 5-9, 1959.

The use of the range of visible light as a frequency to carry communications is discussed. The arguments most often presented against the potential use of light are stated. They include the following: (1) Sunlight and other sources of noise at light frequencies together with the scattering of light by the atmosphere make it extremely difficult to achieve reasonable signal-to-noise ratios in the transmission of information by light carrier. (2) Light sources are incoherent. (3) Light is difficult to amplitude modulate at high frequencies or to frequency modulate at any frequency. These arguments are discussed and ways to overcome them pointed out. The advantages of light source utilization are shown also including the fact that light has a fine modulation frequency range. The ways to modulate the light source itself are pointed out. The Kerr effect is also discussed. The problems that it creates are shown to be surmountable. It is added that the modulation at microwave frequencies is too expensive to be

more than a laboratory tool now, but the accomplishments demonstrated here do serve to note the potentialities for the use of light as a medium of communication.

725

Illinois U. Engineering Experiment Station, Urbana.

COMPRESSIBLE NON-ISOENERGETIC TWO DIMENSIONAL TURBULENT ($Pr_t = 1$) JET MIXING AT CONSTANT PRESSURE. AUXILIARY INTEGRALS HEAT TRANSFER AND FRICTION COEFFICIENTS FOR FULLY DEVELOPED MIXING PROFILES, by H. H. Korst and W. L. Chow. Jan. 1959 [12]p. incl. diagrs. (ME Technical note no. 392-4) (AFOSR-TN-59-380) (AF 18(600)392) AD 213685; PB 139852
                                        Unclassified

Definitions and graphical presentation of auxiliary functions, calculated on a high speed digital computer (ILLIAC), pertaining to the 2-dimensional non-isoenergetic turbulent jet mixing problem are presented. Theoretical friction coefficients and Stanton numbers for such mixing regions are given. The results especially facilitate the treatment of jet-slipstream interaction (base pressure and base temperature problem). (Contractor's abstract)

Imperial Coll. of Science and Tech. (Gt. Brit.).
see London U. Imperial Coll. of Science and Tech. (Gt. Brit.).

726

Indiana U. Dept. of Chemistry, Bloomington.

CORRELATION ENERGY IN THE HYDROGEN MOLECULE, by H. Shull. [1959] [10]p. incl. tables, refs. (AFOSR-340) (In cooperation with Uppsala U. (Sweden) AF 61(514)1200) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)318, Alfred P. Sloan Foundation, National Science Foundation, and Research Corporation)   Unclassified

Also published in Ann. Acad. Regiae Scient. Upsaliensis, v. 3: 65-74, 1959.

The correlation energy of the hydrogen molecule is considered as related to the He atom and to the infinitely separated atoms, and it is shown that one can obtain a consistent qualitative picture of the electron-electron interaction in the molecular bond in this way. In particular, the molecule approaches very closely the united atom He in nature. The bond can be described as roughly 98.4% Σ_g, 1.0% Σ_u, and 0.5% π in character, with smaller amounts of higher terms. The analysis demonstrates the importance of the hitherto much neglected angular correlation terms, which will, for example, probably play an important role in the discussion of hindered rotation. Finally, it seems unlikely that the

concepts of ionic and covalent character as usually de-
fined have further utility in the description of the 2-
electron homopolar bond. (Contractor's abstract)

727

Indiana U. Dept. of Chemistry, Bloomington.

NATURAL SPIN ORBITAL ANALYSIS OF HYDROGEN
MOLECULE WAVE FUNCTIONS, by H. Shull. [1959]
[9]p. incl. tables, refs. (AFOSR-341) (In cooperation
with Uppsala U. (Sweden) AF 61(514)1200) (Sponsored
jointly by Air Force Office of Scientific Research under
AF 49(638)318, Alfred P. Sloan Foundation, National
Science Foundation, and Research Corporation)
Unclassified

Also published in Jour. Chem. Phys., v. 30: 1405-1413,
June 1959.

Approximate wave functions for the hydrogen molecule
ground state previously available in the literature are
analyzed quantitatively into approximate natural spin
orbital functions with particular attention to the cor-
responding occupation numbers. The analysis demon-
strates the very great similarity of all such trial wave
functions, and especially the largely molecular orbital
nature of the wave function. In addition it shows a close
relationship between the molecular orbital and valence
bond functions, and the importance for allowing for an-
gular correlation of the electrons by including terms
dependent upon the azimuthal coordinate. The analysis
particularly demonstrates that approximate natural
spin orbital occupation numbers are nearly invariant
under a wide variety of choices of basis functions, and
therefore are particularly suitable for comparison of
different approximate functions and for discussion of
their respective properties. (Contractor's abstract)

728

Indiana U. Dept. of Chemistry, Bloomington.

SINGLE-CENTER WAVE FUNCTION FOR THE HY-
DROGEN MOLECULE, by S. Hagstrom and H. Shull.
[1959] [9]p. incl. tables, refs. (AFOSR-342) (Sponsored
jointly by Air Force Office of Scientific Research under
AF 49(638)318, Alfred P. Sloan Foundation, National
Science Foundation, and Research Corporation)
Unclassified

Also published in Jour. Chem. Phys., v. 30: 1314-1322,
May 1959.

The ground state of the hydrogen molecule is studied
using an expansion based on a single center, the molecu-
lar midpoint, with basis orbitals constructed from as-
sociated Laguerre functions with a single orbital ex-
ponent. The convergence of the expansion is studied
by systematic addition of terms and is found to be slow.
The best wave functions attained have energies of
-1.15086 (38 axially symmetric terms), and -1.16141

(44 terms). The results are shown to be very similar
to those obtained by using Slater orbitals with nonintegral
principal quantum number both from the energy incre-
ments observed and from a natural spin orbital occupa-
tion number analysis. It is concluded that the slow con-
vergence probably results from failure to represent
adequately the singularities at the nuclei, and that further
use of single-center expansions in diatomic problems
(except at very small internuclear distances) seems un-
profitable, irrespective of what set of orbitals is used
as a basis. (Contractor's abstract)

729

Institut de Recherches Scientifiques et Techniques du
Centre-Ouest, Poitiers (France).

RESEARCH ON EXPERIMENTAL INVESTIGATION
OF VARIABLE CIRCULATION AROUND AN ASPIRATED
CYLINDER. [1959] [40]p. incl. illus. diagrs. tables.
(Rept. no. E1/573) (AFOSR-TR-59-105) (AF 61(514)-
1379) AD 162109; AD 225389; PB 144295
Unclassified

The conditions necessary to obtain maximum lift and
lift/drag ratio were determined for a porous cylinder
arranged to permit the aspiration of the surface lami-
nar sub-layer. The method used to create a particular
circulation consisted in (assuming complete suppres-
sion of the laminar layer) shifting the transition point,
normally behind the cylinder, through an angle θ to the
right or left. This was obtained by a deflector fin
which caused flow of air away from the aspirating sur-
face. Two variations in procedure were also studied:
(1) the fin was replaced by a small arc of surface devoid
of aspiration pores thus allowing the flow to separate;
and (2) aspiration was provided on 1 side of the cylinder
only, allowing separation flow on the other side. Two
series of tests were actually run. An infinitely long
cylinder was simulated by fixing vane plates of diam
triple that of the cylinder to the cylinder ends. The first
series of tests was run with a cylinder 3 meters long
by 0.90 m in diam, and measurements were taken of the
total forces on cylinder, vane plates and deflector fin.
The second series, of a more theoretical nature, was
run using a cylinder 1 m in length by 0.30 m in diam.,
with only the forces on the cylinder being measured.
The vane plates and deflection fin were independently
fixed, and since they were not in contact with the cylin-
der, were not weighed. (Contractor's abstract)

730

[Institute for Advanced Study, Princeton, N. J.]

A SINGULAR BOUNDARY VALUE PROBLEM FOR A
NON-SELF-ADJOINT DIFFERENTIAL OPERATOR, by
R. R. D. Kemp. [1958] [16]p. [AF 18(600)1109]
Unclassified

Published in Canad. Jour. Math., v. 10: 447-462, 1958.

The subject of this paper is the eigenfunc. on expansion theory associated with the operator $L = -d^2/dx^2 + g(x)$, where $g(x)$ is a complex-valued function such that $(x^2 + 1)^{1/2} |g(x)|$ is integrable over $(-\infty, \infty)$. It is found that there is a function $W(s)$, analytic for Im $s > o$ and continuous for Im $s \geq o$, such that the squares of its zeros in Im $s > o$ constitute a bounded set which is the point spectrum of L. The continuous spectrum is the set of all real non-negative numbers. An expansion theorem is obtained by a method involving contour integration. (Math. Rev. abstract)

731

Institute for Advanced Study, Princeton, N. J.

ON u" + $(1 + \lambda g(x))u = 0$ FOR $\int_0^\infty |g(x)| dx < \infty$, by R. R. D. Kemp and N. Levinson. June 1959, 6p. (AFOSR-TN-59-643) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1109 and Office of Naval Research) AD 220344; PB 145297
Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 82-86, Feb. 1959.

If $g(x) \in L^1 (0, \infty)$ and $u(x,\lambda)$ is the solution of u" + $(1 + \lambda g(x))u = 0$ which satisfies the initial conditions $u(0) = 0$, $u'(0) = 1$, then there are functions $r(\lambda)$ and $\Theta(\lambda)$ such that $\lim_{x \to \infty} \{u(x,\lambda) - r(\lambda) \sin [x + \Theta(\lambda)]\}$ for real λ. It is shown that $r(\lambda)$ and $\Theta(\lambda)$ are real analytic on the real axis if $g(x)$ is real, and that $r(\lambda) > 0$. The nearest singularity of r and Θ to the origin is at least a distance $\log 2[\int_0^\infty |g(x)| dx^{-1}]$ from $\lambda = 0$, and the singularities are determined by the zeros of 2 entire functions. (Contractor's abstract)

732

Institute for Advanced Study, Princeton, N. J.

ANOTHER CUTPOINT THEOREM FOR PLANE CONTINUA, by F. B. Jones. Oct. 1959, 4p. (AFOSR-TN-59-1123) (AF 18(600)1109) AD 229960; PB 145485
Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 556-558, Aug. 1950.

If p and q are points of different components of the interior M. then some point x of M cuts p from q in M. In the given situation there is a point x of M which belongs to every subcontinuum of M which contains both p and q. It is not necessary that p and q belong to the same interior component if no point of M cuts between them. But it is necessary that both p and q belong to the closure of some interior component. If the closure of no interior component of M contains both p and q, then some point x of M cuts p from q in M. (Contractor's abstract)

733

Institute for Advanced Study, Princeton, N. J.

A PLANE CONTINUUM NO TWO OF WHOSE NON-DEGENERATE SUBCONTINUA ARE HOMEOMORPHIC: AN APPLICATION OF INVERSE UNITS, by R. D. Anderson and G. Choquet. [1959] [7]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1109 and National Science Foundation)
Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 347-353, June 1959.

It is shown by constructive proof that there exists a plane continuum M such that (1) no subcontinuum of M separates the plane, (2) no 2 nondegenerate subcontinua of M are homeomorphic, and (3) M does not contain uncountably many disjoint nondegenerate subcontinua. A modification of the construction is suggested to yield a continuum M' such that (1) every nondegenerate subcontinuum of M' separates the plane, and (2) no 2 nondegenerate subcontinua of M' are homeomorphic. Further suggested modification of construction leads to a continuum M'' such that (1) no nondegenerate subcontinuum of M'' is embeddable in the plane, (2) no 2 nondegenerate subcontinua of M'' are homeomorphic, and (3) M'' does not contain uncountably many disjoint nondegenerate subcontinua. (Math. Rev. abstract)

734

Institute for Advanced Study, Princeton, N. J.

AFFINE-REGULAR POLYGONS INSCRIBED IN PLANE CONVEX SETS, by B. Grünbaum. Feb. 1959, 6p. incl. refs. (AFOSR-TN-59-207) (AF 49(638)253) AD 211661; PB 142005
Unclassified

The possibility of inscribing affine-regular polygons in nondegenerate plane convex sets is considered. Any boundary point of such a set is the vertex of an inscribed affine-regular pentagon, and there exist inscribed affine-regular pentagons having one side parallel to any given direction. An affine-regular octagon may be inscribed in any centrally symmetric convex set. (Contractor's abstract)

735

Institute for Advanced Study, Princeton, N. J.

ON INTERSECTIONS OF SIMILAR SETS, by B. Grünbaum. Mar. 1959, 15p. incl. refs. (AFOSR-TN-59-391) (AF 49(638)253) AD 214511; PB 142002
Unclassified

Some aspects on the intersections of convex sets are
discussed. To any convex compact set K, 2 numbers
h(K) and H(K) are associated and defined as follows:
h(K) is the least cardinal n such that whenever a family
$x = \{x_\alpha + K\}$ of mutually intersecting translates of K is
given, there exist n points such that each member of x
contains at least 1 of them, and H(K) is the least cardi-
nal n such that whenever a family $x = \{x_\alpha + \lambda_\alpha K\}$ of mu-
tually intersecting translates of sets homothetic to K is
given, there exist n points such that each member of x
contains at least 1 of them. H(K) and h(K) are invari-
ant under nonsingular affine transformations of K and
remain unchanged if $K \subseteq E^h$ is imbedded in a space of
higher dimension (E^k is the k-dimensional Euclidean
space). Using this notation, the results are stated as
follows: If K is a circle, then h(K) = 3; h(K) = 1 for
$K \subseteq E^n$ if and only if K is a parallelohedron. H(K) = 1
also. The finiteness is established for $h_n = \max \{h(K);$
$K \subseteq E^n\}$ and $H_n = \max \{H(K); K \subseteq E^n\}$. H(K) and h(K)
are considered for centrally symmetric $K \subseteq E^2$. Some
unsolved problems are discussed, and some conjec-
tures are offered.

736

Institute for Advanced Study, Princeton, N. J.

INTRINSIC OPERATORS IN THREE-SPACE, by V. L.
Shapiro. May 1959, 16p. (AFOSR-TN-59-499)
(AF 49(638)253) AD 215924; PB 146213   Unclassified

Also published in Pacific Jour. Math., v. 9: 1257-1267,
1959.

The following theorem is proved: let D be a domain in
Euclidean 3-space and let v be a continuous vector
field defined in D. Then a necessary and sufficient
condition that v be locally in D the gradient of a poten-
tial of a distribution with continuous density, is that
the intrinsic curl of v be zero in D, and the intrinsic
divergence of v be continuous in D.

737

Institute for Advanced Study, Princeton, N. J.

A VARIANT OF HELLY'S THEOREM, by B. Grünbaum.
Sept. 1959, 9p. incl. refs. (AFOSR-TN-59-980)
(AF 49(638)253) AD 228283; PB 144477   Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 517-
522, Aug. 1960.

The following modification of Helly's theorem on in-
tersections of convex sets is established, together
with some related results. Let K, a subset of Euclide-
an space, be the union of a finite number of disjoint,
compact, convex sets. Then there exists an integer

N = N(K) with the following property: For any family
$\{K_\alpha\}$ where each K_α is the transform of K by a
non-singular affine transformation T_α (depending on
α), if any N of the sets K_α have a non-empty intersec-
tion, then the intersection of all the sets K_α is not
empty. Examples show that none of the underlined
conditions may be dropped. (Contractor's abstract)

738

Institute for Advanced Study, Princeton, N. J.

ON A PROBLEM OF L. FEJES-TÓTH, by B. Grünbaum.
Sept. 1959, 3p. (AFOSR-TN-59-981) (AF 49(638)253)
AD 228282; PB 144471   Unclassified

Also published in Amer. Math. Monthly, v. 67: 882-884,
Nov. 1960.

In Euclidean 3-space, a point is "hidden" by a set of
spheres (which do not contain the point) if any ray issu-
ing from the point intersects at least 1 of the spheres.
Fejes-Tóth established that 6 congruent, non-intersect-
ing spheres may hide a point. A proof is given that 5
congruent non-intersecting spheres may not hide a
point. (Contractor's abstract)

739

Institute for Advanced Study, Princeton, N. J.

COMMON TRANSVERSALS FOR FAMILIES OF SETS,
by B. Grünbaum. Oct. 1959, 12p. incl. refs. (AFOSR-
TN-59-1036) (AF 49(638)253) AD 228281; PB 145069
                              Unclassified

Also published in Jour. London Math. Soc., v. 35: 408-
416, Oct. 1960.

Let a family K of compact, convex sets be given. Con-
ditions on K are investigated for which the existence
of a straight line intersecting all the members of K re-
sults from the assumption that for every k-membered
sub-family of K, where k is a suitable fixed integer,
there exists a straight line intersecting all the mem-
bers of the subfamily. (Contractor's abstract)

740

Institute for Advanced Study, Princeton, N. J.

DIFFERENCE METHODS FOR PARABOLIC PARTIAL
DIFFERENTIAL EQUATIONS, by M. Lees. Sept. 1959,
27p. incl. refs. (AFOSR-TN-59-1039) (AF 49(638)253)
AD 229968; PB 145304   Unclassified

A general method is introduced and applied for deter-
mining the stability and convergence of difference
schemes for parabolic equations with non-constant

coefficients. The method is applied to an important subclass of the 2 and 3 level difference schemes currently in use for approximating solutions of parabolic equations. Applications to non-linear equations are also considered. (Contractor's abstract)

741

Institute for Advanced Study, Princeton, N. J.

INTEGRATION OF THE GOURSAT PROBLEM BY DIFFERENCE METHODS, by M. Lees. Oct. 1959, 18p. (AFOSR-TN-59-1109) (AF 49(638)253) AD 229917; PB 145318   Unclassified

Finite difference methods are used to solve the Goursat problem for linear and quasi-linear hyperbolic equations in characteristic form. In addition to existence and uniqueness theorems, several approximation theorems are derived. The results are based on an integral inequality for the solutions of the Goursat problem which is similar to the well-known energy inequality for hyperbolic equations. (Contractor's abstract)

742

Institute for Advanced Study, Princeton, N. J.

UNIQUE CONTINUATION FOR PARABOLIC DIFFERENTIAL EQUATIONS AND INEQUALITIES, by M. Lees and M. H. Protter. Oct. 1959, 21p. (AFOSR-TN-59-1110) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)253 and National Science Foundation) AD 229957; PB 145317
                                                          Unclassified

Also published in Duke Math. Jour., v. 28: 369-382, Sept. 1961.

Unique continuation theorems are proved for parabolic equations and inequalities. These continuation theorems have the following form: if a solution of a parabolic equation (or inequality) exists in a region and vanishes in a subregion, then it vanishes in the original region. As a consequence of 1 of the continuation theorems, the uniqueness of the 1st mixed, initial-boundary value problem for negative time is proved. (Contractor's abstract)

743

Institute for Advanced Study, Princeton, N. J.

ON POLYHEDRA IN E^3 HAVING ALL FACES CONGRUENT, by B. Grünbaum. Oct. 1959 [5]p. (AFOSR-TN-59-1129) (AF 49(638)253) AD 229958; PB 145487
                                                          Unclassified

Also published in Bull. Research Council Israel, v. 8F: 215-218, Apr. 1960.

The following problem was recently proposed by H. Steinhaus: Do there exist polyhedra which have (1) n congruent faces where n is odd? (2) n congruent faces where n > 30 but there are no triangular faces? In this report the answer to the 2nd question is shown to be positive, the answer to the 1st question is shown to be negative, and the following theorem is proved: If all faces of a complex polyhedra in Euclidean 3-space are congruent, then the polyhedron has an even number of faces.

744

Institute for Advanced Study, Princeton, N. J.

ON SOME PROPERTIES OF CONVEX SETS, by B. Grünbaum. Nov. 1959, 4p. (AFOSR-TN-59-1157) (AF 49(638)253) AD 229959; PB 145490   Unclassified

Also published in Colloq. Math. (Poland), v. 8: 39-42, 1961.

A conjecture of H. Steinhaus on the diameters of plane sections of convex bodies in E^3 is disproved, and a positive result of a related nature is established. The conjecture reads: Prove that through each point inside a closed convex surface there is passing such a plane that this point lies on 1 of the longest chords of the curve of intersection.

Institute for the Study of Rate Processes, Salt Lake City, Utah
     see Utah U. Inst. for the Study of Rate Processes, Salt Lake City.

Institute of Air Flight Structures, New York
     see Columbia U. Inst. of Air Flight Structures, N. Y.

745

[Instituto de Investigacion de Ciencias Biologicas, Montevideo (Uruguay).]

BEHAVIOURAL AND EEG EFFECTS OF TONES "REINFORCED" BY CESSATION OF PAINFUL STIMULI, by J. P. Segundo, C. Galeano and others. [1959] [27]p. incl. illus. diagrs. (AFOSR-TN-59-1144) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)585 and Rockefeller Foundation)
                                                          Unclassified

Also published in Proc. Symposium on Brain Mechanisms and Learning, Paris (France) [1960] Oxford, Blackwell Scientific Publications, 1961, p. 265-291. (AFOSR-1191)

Experiments were performed on cats with chronically implanted electrodes in which application and subtraction of prolonged subcutaneous stimuli (SS) induced

variable but characteristic electrographic (in somatic sensory cortex) and behavioral patterns. During training stage I, a tone (T) was presented repeatedly until rendered inoperant (habituation). During stage II, SS was consistently interrupted 2-5 seconds after T initiation. A learning process was established by this 'reinforcement' of indifferent T with interruption of pain and cats eventually came to react to T in a consistent fashion. Behavioral responses to T initiation (during SS) resembled those to SS substraction (without previous T) and consisted in head, eye and/or limb movements, frequently carrying from a 'tense' to a 'relaxed, natural' position. Electrographically (and even under Flaxedil) T masked potentials evoked by SS on contralateral sensory cortex; amplitude and duration of individual waves were reduced markedly (initial spike was resistant). T effects were compared electrogra ically as to quality, intensity and distribution with results induced by application of other agents known to reduce cortical evoked potentials (e.g., SS voltage reduction; EEG 'activating' influence as brain stem stimulation or presentation of novel, intense or conditioned sounds). T effects exhibited specificity: non-reinforced tones of different frequency become ineffectual; T influence could be restricted to the somatic sensory areas. T application was followed by EEG 'activation', generalized or localized (to sensory cortices and to nucleus medialis dorsalis of thalamus); delayed and transitory reinforcement of slow rhythms also occurred. Experiments indicated that changes (behavioral, EEG) induced by painful stimuli are subject to variations 'spontaneous' and provoked; they indicated, moreover, that learned issues established through adequate training are significant. (Contractor's abstract)

746

Instituto de [Investigacion de] Ciencias Biológicas, Montevideo (Uruguay).

SOMATIC FUNCTIONS OF THE NERVOUS SYSTEM, by J. P. Segundo and C. Galeano. [1959] [40]p. incl. refs. (AFOSR-TN-59-1145) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(636)-565 and Rockefeller Foundation) AD 244780
Unclassified

Also published in Ann. Rev. Physiol., v. 22: 433-472, 1960.

Research upon certain problems, such as receptor activation, motoneurons, sensory controls, spinal mechanisms, sleep and wakefulness, and central brainstem, issuing from important aggregations of experimental data, posed in a coherent fashion, and set within the scope of present day techniques, has continued to yield its usual significant contribution. But outside of these fields, novel facts or shrewd comments indicated other lines of investigation, notably the exploration of dendrites, initial, and terminal axons, the study of interactions between adjacent receptors or neurons, mathematical analysis of unitary discharge patterns, and the

utilization of refined techniques on free unanesthetized animals. Along these routes lie promising and perhaps eventually rewarding fields of endeavor. (Contractor's abstract)

747

Instituto de Quimica Fisica, Madrid (Spain).

KINETICS OF THE SULPHURATION OF METALLIC SURFACES, by J. Llopis, J. M. Gamboa, and L. Arizmendi. Annual rept. no. 2, May 1959, 43p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-597) (AF 61-(514)1329) AD 217160; PB 143661   Unclassified

The kinetics of the surface reaction of copper with solutions of diphenylthiourea in xylene has been followed by the radiochemical method. The kinetic law of the film growth is linear with time, and the energy of activation is $\Delta H^* = 14.2$ kcal/mol. In the reaction of diethyl trisulfide solutions with copper, the growth kinetic law is linear with time, and the activation energy is $\Delta H^* = 17.5$ kcal/mol. The films of sulfide formed are at 1st coherent and show interference colors; however, black circular stains soon appear and the corrosion rate increases appreciably with time. The influence of free sulfur in mixed xylenic solutions has been studied, and these experiments show that the rate of formation of the film increases with S concentration. (Contractor's abstract)

748

Instituto de Quimica Fisica, Madrid (Spain).

KINETICS AND MECHANISM OF THE DEHYDROGENATION OF ISO-PROPYL ALCOHOL ON Cr_2O_3, by J. F. Garcia de la Banda and G. Kremenić Orlandini. Nov. 1956, 51p. incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-59-36) (AF 61(514)1330) AD 209208; PB 136709   Unclassified

Also published in Anal. Real Soc. Espan. Fís. Quím., v. 55B: 465-476;477-492, May 1959.

The kinetics of the reaction of dehydrogenation of isopropyl alcohol on Cr_2O_3 at 350, 360, 410, 440, 470, and 500°C was studied by means of a differential reactor. Isopropyl alcohol-acetone-hydrogen mixtures were studied with catalyst pellets, using a technique which allowed for the results to be reduced to those obtained with powder catalysts. The Arrhenius plot for all isopropyl alcohol-acetone mixtures gave 2 different straight lines, one defined by the points corresponding to the reaction rates measured at 350, 380, and 410°C, and the other by those corresponding to 440, 470, and 500°C. The reaction rate first decreased with increasing partial pressure of H, then increased, from a certain value of the pressure depending on the reaction mixture and the temperature, and finally went through a minimum and decreased again. Fourteen possible reaction mechanisms

and their corresponding rate equations were considered in the analysis of the experimental results. The most probable mechanism is one with 2 equal active centers in which isopropyl alcohol, acetone, and hydrogen are all adsorbed, the rate-determining step being the surface reaction.

749

Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

COMBUSTION OF SPRAYS IN AN OXIDIZING ATMOS-PHERE, by G. Millan, S. Sanz, and I. Da Riva. [1959] [36]p. incl. diagrs. table, refs. (AFOSR-TN-59-818) (AF 61(514)734-C) AD 225647; PB 147142
Unclassified

Also published in Proc. Fifth Internat'l. Cong. of Combustion Engines; Diesel Engines and Gas Turbines up to 1500 HP, Wiesbaden (Germany) (June 13-19, 1959), [Paris, CIMAC] 1959, p. 273-293.

The mathematic representation of the statistical size distribution of droplets injected into the combustion chamber of diesel engine and a gas turbine, is discussed. After consideration is given to some of the distributions proposed by other Technical Sciences (Meteorology - Gravimetrology, etc), the Mugele Evans distribution is selected as the most adequate for the problem. The combustion of a spray under ideal conditions is analyzed. It as assumed for it that each droplet burns in accordance with a theoretical law whose validity has been experimentally verified for a few simple cases-isolated droplets at rest or in motion, set of droplets in motion whose relative positions remain invariable, etc. The particular cases considered are the following: combustion at the beginning and end of the injection. Combustion at an instant sufficiently far in time from both the above cases. Combustion of a volume injected instantaneously as approximately occurs in a diesel engine and, finally, superposition of isolated successive injections. The scaling of atomizers and combustion chambers is analyzed. (Contractor's abstract)

750

Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

COMBUSTION OF MONOPROPELLANT DROPLETS. THEORETICAL RESULTS, by C. S. Tarifa and P. Pérez del Notario. Dec. 15, 1958, 1v. incl. diagrs. tables. (AFOSR-TN-59-463) (AF 61(514)997) AD 215268; PB 140776
Unclassified

In the present work the following problems have been studied: (1) Extension of the integration method for overall reactions of nth order and Lewis-Semenov numbers different from one. (2) Comparison of the results for 2nd order chemical kinetics with those obtained by means of numerical integration of the equations. (3) Results of the investigation for 1st and 2nd order chemical kinetics. Study of the principal variables of the process: burning rates, evaporation constants, flame front radius, reaction zone thickness, maximum temperatures, etc., in functions of the principal parameters that influence the process, such as initial diameter of the droplet, activation energy, temperature at the infinite, pressure, etc. (4) Numerical application for the hydrazine, taking the decomposition reaction model proposed by Adams and Stock. (Contractor's abstract)

751

Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

DISTRIBUTION OF RADICALS IN LAMINAR FLAMES. I. CRITERIUM OF VALIDITY OF THE STEADY STATE ASSUMPTION, by G. Millán and I. Da Riva. Jan. 31, 1959 [36]p. incl. diagrs. refs. (AFOSR-TN-59-626) (AF 61(514)997) AD 217811; PB 143173
Unclassified

It is demonstrated that the applicability of the steady state assumption depends on the value of a certain dimensionless parameter, in which the effects of reaction and diffusion of the radicals are combined. Besides, a method of recurrence is developed which enables successive approximations for the distribution the radicals to be obtained from that corresponding the steady state. Finally a study is made of a mathematical model which, preserving all the properties of the flame, enables an easy comparison of the exact solution with the approximate ones obtained by means of the proposed methods. (Contractor's abstract)

752

Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

DISTRIBUTION OF RADICALS IN LAMINAR FLAMES. II. APPLICATION OF THE CRITERIUM OF VALIDITY OF THE STEADY STATE ASSUMPTION TO SEVERAL FLAMES, by I. Da Riva and G. Millán. Jan. 31, 1959 [52]p. incl. diagrs. tables, refs. (AFOSR-TN-59-627) (AF 61(514)997) AD 217812; PB 143172
Unclassified

An application of the criterium on the validity of the steady state assumption (item no. 751, Vol. III) to various cases corresponding to flames studied by different authors. For it, the differential equation deduced for the concentration of the radical is integrated by means of the perturbation method set out in the above mentioned reference. With a view to simplifying the numerical calculation, the concentration of the principal species and of the radicals distinct from that under consideration, if existent, have been approximated by means of appropriate functions. The two first perturbations were

normally sufficient to evaluate the accuracy with which the steady state assumption enables the concentration of the radicals to be calculated. The criterium set out makes it possible to prove that the steady state assumption is sufficiently approximate to calculate the concentration of the radicals in the following cases: ozone flame, hydrogen radical in the hydrogen-bromine flame and, hydrogen flame. On the contrary, in the case of the bromine radical in the hydrogen-bromine flame and particularly in the hydrazine flame, the parameter for the validity of the assumption is very small and consequently the method of perturbations does not converge and the steady state assumption for the concentration of the radicals gives large deviations with respect to their actual distributions. (Contractor's abstract)

753

Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

AN EXPERIMENTAL INVESTIGATION ON THE COMBUSTION OF MONOPROPELLANT DROPLETS, by P. Pérez del Notario and C. S. Tarifa. Jan. 20, 1959 [24]p. incl. illus. diagrs. tables. (AFOSR-TN-59-628) (AF 61(514)997) AD 217813; PB 143171 Unclassified

An investigation was made to obtain the velocities of combustion of monopropellant droplets within an inert atmosphere. Combustion of droplets of N_2H_4, ethyl nitrate, and of a mixture of HNO_3 and amyl acetate could not be obtained in an N atmosphere by operating at ambient pressure at furnace temperatures of about 1000°C. The evaporation constants obtained in N coincided approximately with the theoretical results for evaporation of droplets in the absence of combustion. Combustion was achieved by introducing a mixture of O and N into the furnace; the ignition temperature diminished appreciably upon increasing the proportion of O. Upon ignition the values of the evaporation constants increased abruptly above those obtained in an N atmosphere; the values thereafter increased in a continuous manner as the temperature of the atmosphere of the furnace rose. The form of the functions k = f(T), when k is the evaporation constant and T is the furnace temperature, in the combustion processes could not be determined exactly because of the dispersion of the results. The results which were qualitatively similar were obtained for N_2H_4 and ethyl nitrate. (Contractor's abstract)

754

Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

COMBUSTION OF FUEL SPRAYS, by G. Millán, I. Da Riva, and S. Sanz. Jan. 31, 1959 [27]p. incl. diagrs. table. (AFOSR-TN-59-629) (AF 61(514)997) AD 217814 Unclassified

The method proposed by Probert (Philos. Mag., v. 37: 94-105, Feb. 1946) for the study of the evaporation of sprays is applied to the analysis of the combustion of a fuel spray burning in an oxidizing atmosphere. The study is applied to various typical cases, corresponding to the starting and the stopping of the injection, as well as to the continuous functioning, and to the case of periodical injections of short duration. The Rosin-Rammler function of size distribution, used by Probert, is substituted here by that of Mugele-Evans, which by limiting the maximum size of the droplets, enables a better approximation to the real distributions. Some general conclusions of a qualitative nature are obtained regarding the most suitable characteristics of a spray. The great influence that the distribution function and the medium size of the droplets have on the processes under consideration, is also shown. The lack of experimental data constitutes an important difficulty in judging the validity of the model considered. (Contractor's abstract)

755

Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

[COMBUSTION OF SPRAYS, DROPLETS AND FLAMES], by G. Millán. Final rept. Aug. 1, 1956-Jan. 31, 1959. Feb. 25, 1959, 9p. incl. refs. (AFOSR-TR-59-68) (AF 61(514)997) AD 217815; PB 143152

Unclassified

Studies of homogeneous combustion were made to contribute to the theoretical study of the characteristics of the laminar flames, by taking the existing semi-analytical methods as the starting point and including some nonsteady cases, such as ignition of a combustible and homogeneous gaseous mixture, as well as others of flame with heat losses. An investigation was also made of the combustion of monopropellant droplets and of fuel sprays. A semianalytical method was developed for evaluating flames of 1st and 2nd order reactions. The basis of the method consists of approximating, by means of an exponential function, the fractional flux of the reactants. The applicability of the steady state assumption for the computation of the distribution of radicals in the study of flames with chain reactions was investigated. Attempts were made to analyze the flammability of a determined homogeneous combustible mixture at rest when a nucleus of the same was heated instantly up to a high temperature. A theoretical study was performed on a fuel spray in an oxidizing atmosphere by applying the Probert method, but using the Mugele-Evans statistical distribution function of the size of the droplets. The combustion of monopropellant drops was studied by considering diffusion and approximating the chemical kinetic process by means of over-all reactions. The principle parameter controlling the combustion was the dimensionless relation of the activation energy to the reaction heat.

756

Instituto Nacional de Tecnica Aeronautica Esteban
Terradas, Madrid (Spain).

A THEORETICAL INVESTIGATION OF THE COMBUS-
TION OF LIQUID BIPROPELLANT DROPLETS, by
C. S. Tarifa and P. Pérez del Notario. Apr. 11, 1960
[73]p. incl. diagrs. tables, refs. (Technical note no. 1)
(AFOSR-TN-59-975) (AF 61(052)221) AD 244459
Unclassified

Combustion of droplets of bipropellant systems consist-
ing of a fuel (oxidizer) droplet within the vapors of an
oxidizer (fuel) is studied considering chemical kinetics
and equal or different molecular weights of the chemi-
cal species. The problem is solved by integrating the
differential equations of the process by means of an ap-
proximated analytical method, and the approximation
furnished by such method is verified by integrating nu-
merically the equations of the process for several rep-
resentative cases. The principal variables of the proc-
ess, e.g. burning rates, flame/droplet radius ratio, and
maximum temperature, are expressed as functions of
the dimensionless product of the pressure multiplied by
the droplet radius, for several values of the main param-
eters of the process, i.e. activation energy, temperature
of the surrounding atmosphere, etc. Several important
conclusions are obtained, e.g. that when either the pres-
sure or the droplet radius tend towards infinity, results
coincide with those obtained by assuming that the reac-
tion rate is infinitely fast, and that there exist mini-
mum values of either the pressure or the droplet radi-
us under which combustion is not possible. These
theoretical conclusions have been experimentally veri-
fied. (Contractor's abstract)

757

Iowa State [U. of Science and Tech.] Ames.

THE ASYMPTOTIC BEHAVIOR OF SOLUTIONS OF
PENDULUM-TYPE SOLUTIONS, by G. Seifert. [1959]
[12]p. incl. diagrs. refs. (AF 18(603)51)
Unclassified

Published in Ann. Math., v. 69: 75-87, Jan. 1959.

This report is concerned with the asymptotic behavior
of solutions $(\theta(t), z(t))$ of a system of differential equa-
tions of the form $\dot\theta = z, \dot z = g(\theta) - \alpha f(\theta)z + p(t)$. Here α
is a positive constant, and the functions f, g, and p sat-
isfy the following conditions: (1) $f(\theta) > 0$, $f(\theta + 2\pi) = f(\theta)$, $g(\theta) + 2\pi) = g(\theta)$ for all θ; (2) p(t) and the deriva-
tives $g''(\theta)$ and $f'(\theta)$ are continuous everywhere; (3)
there exists a constant k such that $|p(t)| < k$ for all t,
and that each of the equations $g(\theta) \pm k_i = 0, 0 \le k_i \le$
k, has simple roots. The autonomous system is stud-
ied; i.e., system with p(t) = 0 identically. The case
where p(t) is non-constant and in particular of period
τ is also treated.

758

Iowa State [U. of Science and Tech.] Ames.

TEMPERATURE DEPENDENCE OF SOUND DISPERSION
IN HALO-METHANE GASES, by R. Amme and S.
Legvold. [1959] [5]p. incl. diagrs. tables, refs. (AF 18-
(600)1496) Unclassified

Published in Jour. Chem. Phys., v. 30: 163-167, Jan.
1959.

Sound dispersion has been examined in eight halo-
methane gases near 100°C and 200°C, and four near
300°C. The observed relaxation times have been used
along with data obtained previously at room temperature
to calculate the vibrational collision lifetimes over this
temperature range. The results have been compared
with theoretical predictions of Schwartz and Herzfeld
which used an attractive term in the potential to help
account for the effect of long-range forces. Agreement
is good, although several lifetimes at room temperature
appear somewhat small. (Contractor's abstract)

759

Iowa State [U. of Science and Tech. Statistical Lab.] Ames.

SOME FAMILIES OF CONTAGIOUS DISTRIBUTIONS, by
S. K. Katti and J. Gurland. [1959] 46p. incl. tables, refs.
(AFOSR-TN-59-4) (AF 49(638)43) AD 208184;
PB 143362 Unclassified

An attempt is made to find forms of theoretical distri-
butions based on realistic biological models, which pro-
vide a good fit for the type of data that are collected,
and which prove feasible for developing suitable tech-
niques for the analysis of data. The work includes:
(1) a study of some families of contagious distributions
from the point of view of their derivation; (2) compari-
son of these distributions using characteristics such as
skewness, kurtosis, and the ratio of frequencies; (3) the
estimating of parameters by various methods in order
to gain some empirical evidence about their relative
merits; and (4) comparison of fits using chi-square to
see if any general conclusions can be suggested on an
empirical basis regarding the best fit.

760

Iowa State [U. of Science and Tech. Statistical Lab.] Ames.

SIZE AND POWER OF TESTS USING SOME OPTICAL
WELCH-TYPE STATISTICS, by R. S. McCullough and
J. Gurland. [1959] 26p. incl. diagrs. tables, refs.
(AFOSR-TN-59-177) (AF 49(638)43) AD 211317;
PB 142235 Unclassified

By using a finite series representation of the distribu-
tion of a certain class of statistics, and by utilizing
other techniques, 2 types of statistics are developed
for testing the hypothesis of the equality of the means

of 2 normal populations, using small sample sizes. One type of statistic, called unilateral, effectively controls the size of the test under variance heterogeneity, if it is known a priori that the variance of one specified population is greater than that o: the other. The 2nd type of statistic, called bilateral, controls the size when there is no a priori knowledge of the population variances. Tables are included specifying both types of statistics, and giving size and power. (Contractor's abstract)

761

Iowa State U. of Science and Tech. [Statistical Lab.] Ames.

ON THE ABSOLUTE DIFFERENCE AND ABSOLUTE DEVIATION OF DISCRETE DISTRIBUTIONS, by S. K. Katti. [1959] 28p. (AFOSR-TN-59-178) (AF 49(638)-43) AD 211318; PB 142236   Unclassified

Let X_1 and X_2 be two independent random variables with probability generating functions (p.g.f.), $g_1(z)$ and $g_2(z)$, respectively. Let the probability of obtaining $X_1 = i$ and $X_2 = i$ be denoted by P_i and Q_i. The definition of the mean difference and the mean deviation may be regarded as particular cases of the more generalized ones, defined as: (1) $\Delta_r = \Sigma\Sigma |i-j| r P_i Q_j$
$ i\ j$
and (2) $\delta_r = \Sigma |i-m| r P_i$ where m is any arbitrary
$ i$
number and the summations are with respect to all the admissible values of the random variables X_1 and X_2.

Methods are presented for obtaining general expressions for Δ_r and δ_r through the use of moment generating functions. Some illustrations are given to indicate the feasibility of these methods in determining the values of Δ_r and δ_r. (Contractor's abstract)

Israel Inst. of Tech., Haifa.
          see Technion-Israel Inst. of Tech., Haifa.

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Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy).

MAGNETIC VISCOSITY DUE TO INTERSTITIAL ATOMS ANCHORED IN DISLOCATIONS. MAGNETIC VISCOSITY DUE TO MOTION OF DISLOCATIONS, by G. Biorci, A. Ferro, and G. Montalenti. Oct. 1958 [62]p. incl. illus. diagrs. tables, refs. (Technical note no. 2a) (AFOSR-TN-59-85) (AF 61(514)1331) AD 210145; PB 150695   Unclassified

The correspondence between mechanical and magnetic relaxation was shown to be valid when interstitial atoms of carbon in iron diffuse in highly distorted regions close to dislocations. The values of the diffusion constants obtained from magnetic measurements are in

agreement with those obtained from internal friction: $Q = 32,000$ cal/gr at., $\tau_0 = 10^{-13}$ sec. The specimens were iron sheets loaded with carbon, cold rolled at 7% and aged at room temperature. The magnetic viscosity due to dislocations and its correspondence with mechanical relaxation were examined. The specimens were of pure iron of different origin. Each specimen was composed of very few crystals, so that each could be considered as a single crystal. Above 320°C the well annealed Armco specimens show a viscosity field of about 0.5 A/m. The correspondence with mechanical relaxation and the shape of the curve of the magnetic relaxation vs field strength seem to prove that the observed magnetic viscosity is due to motion of dislocations. The single crystals cold rolled at 2% have a viscosity field appearing at lower temperatures and remarkably larger than in the annealed specimens.

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Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy).

MAGNETIC VISCOSITY IN IRON DUE TO CARBON ATOMS ANCHORED IN DISLOCATIONS, by G. Biorci, A. Ferro, and G. Montalenti. [1959] [4]p. incl. diagrs. refs. [AF 61(514)1331]   Unclassified

Published in Jour. Appl. Phys., v. 30: 1732-1735, Nov. 1959.

A specimen of iron containing 0.01% of C in solid solution was cold worked by 7% and aged at room temperature. After this treatment it shows a new peak of magnetic viscosity at 180°C. The diffusion process giving rise to the peak is controlled by an activation energy of about 32,000 cal/g atom and a time constant at infinite temperature of about 10^{-14} sec. These figures agree with those of a peak of internal friction observed in similar specimens by Kê and by Köster, and interpreted as due to diffusion of C atoms in the surroundings of the dislocations. Hence the peak magnetic viscosity can be related to the same mechanism. (Contractor's abstract)

764

Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy).

EXPERIMENTS ON THE SURFACE ELECTRICAL CONDUCTION IN METALS (FINAL PART), by G. Bonfiglioli and R. Malvano. [1959] [26]p. incl. diagrs. (Technical note no. 2a) (AFOSR-TN-59-86) (AF 61-(514)1333) AD 210148   Unclassified

Experimental results are given, concerning surface conductivity measurements made on Au, Sb, Bi, and Cu films, the measurements having been carried on at different temperatures between about -20 and +80 °C.

The existence of localized surface states at the interface metal/dielectric appears confirmed, and tentative values of the trap depths concerned with them are given. A formalism is developed which furnishes a 1st approach to a phenomenological interpretation of the so-called surface mobility. (Contractor's abstract)

766

Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy).

OPTICAL MICROSCOPY EXAMINATION OF THE SURFACE OF GERMANIUM SINGLE CRYSTALS, by G. Bonfiglioli, A. Ferro, and A. Mojoni. [1959] [11]p. incl. illus. tables. (Technical note no. 1d) (AFOSR-TN-59-958) (AF 61(514)1333) AD 226423; PB 143962
Unclassified

Results are presented of (optical) microscopy observations of etching patterns on Ge single crystals. Several specimens of different origin and characteristics were examined, and the micrographs obtained are given a brief comment. Some consideration is given to the values obtained for the etch pits density/unit area, and for 2 specimens, such a parameter is correlated with the excess carrier's lifetime with reasonable results. An interpretation is offered, on the grounds of very evident photographic proofs, of the so-called primary structure in CP4 - etched Ge. It is shown that such a structure is due to the progressive rounding off of the etch pits which belonged to dislocations ending on lattice planes already taken away by the etchant. (Contractor's abstract)

766

Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy).

SENSITIVE CIRCUIT FOR THE DETECTION OF SMALL EFFECTS OF RESISTANCE MODULATION, by G. Bonfiglioli and R. Malvano. [1958] [2]p. incl. diagr. (AFOSR-TN-59-1074) (AF 61(514)1333) AD 230375
Unclassified

Also published in Rev. Scient. Instr., v. 29: 788-789, Sept. 1958.

A synchronous demodulation circuit is described in which a zero beat frequency is obtained and detected by a dc instrument whenever the resistance element to be examined is supplied with ac and subjected at the same time to a modulating agent of the same frequency. It is pointed out that for a symmetrical choice of the reactances, the value of the dc potential drop at the terminals of the modulated resistance R is given by
$V = \langle R.I_r \rangle A_v = (I_0 R_0 k \cos \alpha)/4$ where I_0 means amplitude of the supply current, $R(t) = R_0 (1 + k \cos \omega t)$ represents the undulated resistance examined, and α is the phase difference between $R(t)$ and the bridge current.

767

Istituto Elettrotecnica Nazionale "Galileo Ferraris", Turin (Italy).

FURTHER INVESTIGATIONS ON THERMOLUMINESCENCE AND F CENTERS, by G. Bonfiglioli, P. Brovetto, and C. Cortese. [1959] [14]p. incl. diagrs. tables. (Technical note no. 2d) (AF 61(514)1333) AD 232065; PB 145674
Unclassified

This note is concerned with investigations both experimental and theoretical which consisted of the recording and analyzing of glow curves and separate peaks of light. Several salts were investigated: alkali halides (NaF, NaI, NaBr, KI, KCl, KBr) and $CaCO_3$ (calcite form) and K_2SO_4, of which activation energy curves were made on NaF, NaBr, KCl, and KBr. One result of the work consists of the extension of the results already established for NaCl to the case of KCl. This is the identification of luminophor centers as V_2 and V_3 centers. Some preliminary remarks are also presented about the meaning of thermal dissociation energy for F centers. It is shown that, to measure this quantity, the methods followed thus far are unsuitable, because the correct kinetics of the process is not taken into account. The 2nd order kinetics, through F and V centers recombination must lead to different interpretations and appears first to be able to give a basis for accounting for the results of thermal bleaching experiments.

768

Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy).

AN EXPERIMENT ON THE POSSIBLE DEPENDENCE OF SUPERCONDUCTIVE TRANSITION TEMPERATURE ON THE SURFACE CHARGE DENSITY, by G. Bonfiglioli and R. Malvano. [1959] [9]p. incl. diagrs. (Technical note no. 3a, suppl.) (AFOSR-TN-59-1234) (AF 61(514)1333) AD 232074; PB 145673
Unclassified

The present note discusses gathering electric charges on the surface of a superconductor by means of a transverse electrostatic field leading to a change in the transition temperature. A short description of the experiment performed is given, which actually turned out to be negative, or, at least, inconclusive. (Contractor's abstract)

769

Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy).

THEORY OF THE ISOTHERMAL BLEACHING OF F CENTERS PRODUCED BY IRRADIATION IN ALKALI HALIDES, by G. Bonfiglioli, P. Brovetto, and C.

Cortese. [1959] [14]p. incl. diagrs. table. (Technical
note no. 3d) (AFOSR-TN-59-1315) (AF 61(514)1333)
AD 232060; PB 145681   Unclassified

A quantitative interpretation of the thermoluminescence
of irradiated alkali halides is applied to account for the
experimental results on thermal bleaching of the optical
density in the materials. The calculations fit well with
experiment and indicate that the presence of several
species of V-centers is responsible for the interpreta-
tion difficulties.

770

Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

SURFACE STATES IN METALS, by G. Bonfiglioli and
R. Malvano. [1959] [6]p. incl. diagrs. (AFOSR-J33)
[AF 61(514)1333] AD 297150   Unclassified

Published in Phys. Rev., v. 115: 330-335 July 15, 1959.

This paper deals with measurements of conductivity
modulation in metals by an electric field. The meas-
urements have been performed using a new technique,
which permits reaching an accuracy sensibly higher
than that obtained in experiments already published.
Measurements on Au, Sb, and Bi films have been carried
out at different temperatures between about -20° C and
+ 80°C. The existence of localized and conducting "sur-
face states" at the metal/dielectric interface seems to
be experimentally confirmed. (Contractor's abstract)

771

Istituto Nazionale di Ottica, Florence (Italy).

ON THE ELECTRICAL RESPONSE OF THE HUMAN
EYE TO RED STIMULI OF DIFFERENT TIME DIS-
TRIBUTION OF LUMINANCE, by L. Ronchi. [1958]
[2]p. incl. diagr. table, refs. (AF 61(052)17)
                                        Unclassified

Published in Jour. Opt. Soc. Amer., v. 48: 437-438,
July 1958.

The responses to red stimuli presenting different dis-
tributions of time luminance are compared. The height
of the x-wave seems to be independent of time distribu-
tion of the light stimulus while the height of the b-wave
is greater, the greater the time of variation of the lu-
minance. The latencies to peak of both waves are
greater with a slowly rising stimulus than with a steep
stimulus.

772

Istituto Nazionale di Ottica, Florence (Italy).

ON THE BEHAVIOR OF THE HUMAN ERG OVER A

WIDE RANGE OF LUMINANCES, by L. Ronchi. [1959]
[13]p. incl. diagrs. tables, refs. (AFOSR-TN-59-119)
(AF 61(052)17) AD 210424; PB 139642
                                        Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13:
449-461, Sept.-Oct. 1958.

The behavior of the human ERG (electroretinogram) ob-
tained by stimulating the dark-adapted human retina
with stimuli (blue, green, or white) lasting 25 msec
(or more) is studied over a wide range of luminances.
Peculiar effects are noticed at high levels, beyond the
saturation level of the scotopic b-wave. The inhibition
of rods over cones seems to be loosened, and the re-
sponse shows a mixed photopic scotopic activity;
further, an unexpected enhancement of the b-wave is
found before the start of the inhibition of the cones over
the rods. At middle levels (that is for heights ranging
between 100 and 500 μv), three types of b-waves may
appear, in response to a given stimulus: slow, steep
short latency, and steep long latency. The last type is
more frequent for blue than for green, and it seems to
inhibit the x-wave in a lesser degree than the other types
of responses. (Contractor's abstract)

773

Istituto Nazionale di Ottica, Florence (Italy).

MAY PSYCHOLOGICAL FACTORS INFLUENCE THE
ELECTRORETINOGRAPHIC RESPONSE?, by M. Bittini
and L. Ronchi. [1959] [2]p. (AFOSR-TN-59-120)
(AF 61(052)17) AD 210425   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13:
417-418, Sept.-Oct. 1958.

Some facts concerned in the course of electroretin-
ographic recordings carried out on 2 subjects suggest
that the electroretinographic response may be influenced
by psychological factors. This hypothesis, which has as
its theoretical basis centrifugal control, may explain
the differences concerning the presence of a consensual
response in the unstimulated eye.

774

Istituto Nazionale di Ottica, Florence (Italy).

ON THE FUSION CONDITIONS OF A COLORED
FLICKERING FIELD, by M. Bittini. [1959] [7]p. incl.
diagrs. refs. (AFOSR-TN-59-121) (AF 61(052)17)
AD 210426   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 442-
448, Sept.-Oct. 1958.

The behavior of the critical luminance (L_c) for a fre-
quency varying between about 6 and 60 pulses/sec, for
1° colored test field located either at the fovea or at

10° in the periphery was investigated. Both a sequence of saw-tooth stimuli and a sequence of rectangular stimuli were used. In extrafoveal vision the pulse shape is found to affect the L_c of a green flickering test field, while with blue and red light the effect disappears. The contribution of rods to the so-called cone branch of the curve, obtained by plotting critical flicker frequency against luminance, is discussed. (Contractor's abstract)

775

Istituto Nazionale di Ottica, Florence (Italy).

ON THE QUESTION OF THE EXISTENCE OF ROD-LIKE-CONES IN THE HUMAN RETINA, by L. Ronchi and M. Bittini. [1959] [8]p. incl. refs. (AFOSR-TN-59-333) (AF 61(052)17) AD 213654   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 538-545, Nov.-Dec. 1958.

The possiblity is discussed that the so-called rod-like-cones represent, at least for the human retina, the result of an interaction between the classical rods and the extra-foveal cones, peculiarly sensitive to blue. (Contractor's abstract)

776

Istituto Nazionale di Ottica, Florence (Italy).

ON THE FACTORS WHICH INFLUENCE THE HUMAN SCOTOPIC ELECTRORETINOGRAM AT DIFFERENT LUMINANCE LEVELS, by M. Bittini and L. Ronchi. [1959] [6]p. incl. diagrs. tables. (AFOSR-TN-59-334) (AF 61(052)17) AD 213655   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 318-323, July-Aug. 1958.

An investigation is made on how factors such as the total time of variation of the luminance and the behavior of the time derivative of luminance influence the human scotopic electroretinogram. The first factor is found to influence the response to green (but not to blue) stimuli; the amount of the effect is noticeable at low levels and decreases when luminance is increased. The latter factor seem to be unimportant at any level for both colors. The results are discussed in terms of the cues for brightness discrimination furnished by the electroretinographic response.

777

Istituto Nazionale di Ottica, Florence (Italy).

THE TOTAL TIME OF VARIATION OF THE LUMINANCE AS FACTOR AFFECTING THE HUMAN

SCOTOPIC ELECTRORETINOGRAM, by L. Ronchi. [1959] [2]p. incl. diagr. (AFOSR-TN-59-335) (AF 61(052)17) AD 213656   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 517-518, Nov.-Dec. 1958.

It is thought that the time of variation of the luminance should be considered as a factor influencing the green scotopic b-wave at submaximal levels. By taking into account the fact that the same does not happen with blue light, it is emphasized that the system responsible for the scotopic b-wave shows 2 main groups with different time constant values.

778

Istituto Nazionale di Ottica, Florence (Italy).

ON THE CORRECTION OF THE DISTORTED ELECTRORETINOGRAPHIC RECORDS, by M. Bittini. [1959] [5]p. incl. diagrs. table. (AFOSR-TN-59-336) (AF 61(052)17) AD 213657   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 533-537, Nov.-Dec. 1958.

A description is given of a method to be followed for correcting the distorted electroretinograms recorded by the aid of a capacitance coupled amplifier. The correction is then applied to the results of some recent researches. (Contractor's abstract)

779

Istituto Nazionale di Ottica, Florence (Italy).

BASIC RESEARCH IN THE FIELD OF VISION. PART 1. VISION WITH STABILIZED RETINAL IMAGES, by A. Fiorentini and A. M. Ercoles. PART 2. EFFECT OF THE ILLUMINATION OF ONE EYE ON THE APPARENT BRIGHTNESS OF A FIELD SEEN BY THE OTHER EYE, by A. Fiorentini and T. Radici. PART 3. ON THE INFLUENCE OF THE TIME LUMINANCE DISTRIBUTION ON THE REACTION OF THE DARK-ADAPTED RETINA. PSYCHOPHYSICAL AND ELECTRORETINAL INVESTIGATION, by L. R. Rositani and M. Bittini. Final rept. Nov. 1958, 28p. incl. diagrs. table, refs. (AFOSR-TR-59-14) (AF 61(052)17) AD 210473; PB 139642   Unclassified

Some specific effects of contrast and of interaction which arise due to a variation of the light stimulus with time were investigated. From this general field 3 different topics were selected and the program was accordingly divided into 3 parts. The first research was undertaken to extend some previous investigations, on the role of eye movements in vision. Suppression of movement of retinal images was shown to have detrimental effects on border contrast. Part 2 concerned the mutual interaction of the 2 eyes. It was found that strong illumination of 1 eye depressed brightness sensation of the other eye

when the latter was illuminated with lower intensity.
This binocular inhibition seemed to be independent of
the retinal location of the inhibiting stimulus, and to de-
pend on the relative intensity of illumination at the 2
eyes. Part 3 was an investigation of the influence of the
time variation of the luminance on fusion conditions and
on electroretinal response. The results obtained sug-
gest some practical applications. For increasing the
visibility of a light signal it was necessary not only to
use a flashing light, but to minimize the ratio of the
blue components of the light source to the other com-
ponents. The vision of images with diffused boundaries
could be improved if their illumination pulsed near the
fusion, and the pulse shape, the color of light, and the
luminance level were suitably selected.

780

Istituto Nazionale di Ottica, Florence (Italy).

ON THE INFLUENCE OF THE INCOMPLETE ADAP-
TATION OF THE PERIPHERAL RETINA ON THE
SPEED OF READING, by L. Ronchi and E. Ascarelli.
[1959] [8]p. incl. diagrs. (AFOSR-TN-59-543) (AF 61-
(052)80) AD 215559   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14:
53-62, Jan.-Feb. 1959.

Changes in the speed of reading during the adaptation
to light of the peripheral retina are investigated. The
level of the peripheral field is mesopic, while that of
the centrally viewed test-field is a moderate photopic
level. A series of complex troubles are tested after
the onset of the peripheral field, which are felt for
several minutes, and consist of both facilitation and
inhibition effects, lesser for a blue than for a green
peripheral field. (Contractor's abstract)

781

Istituto Nazionale di Ottica, Florence (Italy).

IS IT POSSIBLE TO MEASURE THE CONTRAST EN-
HANCEMENT OF A FIGURE WITH "QUASI PER-
CEPTIVE CONTOURS"? by G. F. Mori. [1959] [3]p.
incl. diagr. table. (AFOSR-TN-59-777) (AF 61(052)80)
AD 220032   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14:
137-139, Mar.-Apr. 1959.

This preliminary report discusses the role played by a
contour in determining the perception of a figure. The
mechanisms responsible for perceiving the geometrical
contour, even though portions of it are lacking, are ana-
lyzed. An attempt is made to measure the contour using
different illumination strengths, and the conclusions of
the tests are discussed.

782

Istituto Nazionale di Ottica, Florence (Italy).

MAY OCULAR TREMOR EVOKE FLICKER SENSA-
TION? by L. Ronchi. [1959] [2]p. (AFOSR-TN-59-773)
(AF 61(052)80) AD 220033   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14:
140-141, Mar.-Apr. 1959.

The phenomenon observed when black and white parallel
stripes are presented on a field is reported. The ob-
servation is called "apparent movement" or "contrast
enhancement" by some researchers. The thin luminous
stripes separated by large dark stripes on a field is the
particular case studied in this report. It is stated that
in this case the above effects disappear, and an evident
flicker sensation is noticed. Values for the curve ob-
tained by plotting the critical flicker frequency against
luminance are stated. It is pointed out that ocular trem-
or, that is eye movement in relation to retinal action,
and eye movements and visual perception, are the prob-
able origin of the flicker sensation. The 2 conditions
required to perceive the flicker are high contrast and
light adaptation. The latter indicates that the cones play
a role in the determination also.

783

Istituto Nazionale di Ottica, Florence (Italy).

ON THE INFLUENCE OF SYMPAMINE ON A PECUL-
IAR RETINAL FUNCTION, by G. Salvi. [1959] [5]p.
incl. diagrs. (AFOSR-TN-59-779) (AF 61(052)80)
AD 225610   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14:
142-146, Mar.-Apr. 1959.

The effect of sympamine on the critical flicker fusion
is investigated. A small retinal area (10° nasal) is
stimulated by a sequence of pulses either rectangular
or triangular. Before the absorption, fusion occurs at
a critical luminance greater for the rectangular than
for the triangular pulses. After the absorption (either
systemic or local) such effect follows a complex be-
havior, and for the dosage considered in this research,
about 30 min must elapse after absorption before at-
taining accurate visual responses (for peripheral
vision at least). (Contractor's abstract)

784

Istituto Nazionale di Ottica, Florence (Italy).

VISIBILITY OF THE MACH BANDS AS A FUNCTION
OF FIELD LUMINANCE, by A. M. Ercoles and A.
Fiorentini. [1959] [6]p. incl. diagrs. (AFOSR-TN-59-
781) (AF 61(052)80) AD 220031   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14:
230-235, May-June 1959.

The visibility of a subjective contour (Mach band) was
investigated as a function of luminance. It was found
that the dark Mach band is visible at levels lower than
the luminance threshold for the bright Mach band. At
high levels, however, the luminance gradient required
for the perception of the dark band is greater than the
luminance gradient required for the bright band. (Con-
tractor's abstract)

785

Istituto Nazionale di Ottica, Florence (Italy).

ON THE DISCREPANCY BETWEEN PSYCHOPHYSICAL
AND ELECTRORETINOGRAPHIC SATURATION OF
THE RETINAL MECHANISMS, by L. Ronchi and A.
Tassinari. [1959] [5]p. incl. diagrs. refs. (AFOSR-TN-
59-782) (AF 61(052)80) AD 220034   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14:
250-254, May-June 1959.

It is known that when the ERG is recorded by the micro-
electrode technique, the size of the response decreases
when the distance from the anterior surface of the retina
is increased. This fact suggests that the retina behaves
like an amplifier, with, say, 3 stages. The 3rd stage on-
ly is referred to a peculiar structure (the ganglion cell
layer). The electroretinographic response (recorded
by the aid of the corneal electrode technique) is com-
pared to the output after the 1st 2 stages, the psycho-
physical response to the overall output. This model
seems to account for the fact that the electroretinograph-
ic rod saturation occurs at luminances higher than

those determining the psychophysical rod saturation.
(Contractor's abstract)

786

Istituto Nazionale di Ottica, Florence (Italy).

BLUE-GREEN RESPONSES AT MESOPIC LUMINANCES,
by L. Ronchi. [1959] [8]p. incl. diagrs. (AFOSR-TN-
59-1136) (AF 61(052)80) AD 232081   Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14:
384-391, July-Aug. 1959.

As suggested by a working hypothesis concerning the
retinal mechanisms, some experiments (both electro-
retinographic and psychophysical were performed in
order to study the response of the eye when, in the me-
sopic range of luminances, blue and green lights im-
pinge contemporaneously on the retina. Expectations
were fulfilled and the decrease of both probability of
contrast perception and height of the b-wave was tested
when some blue radiation was added to green, or vice
versa. The results emphasized are: (1) At low levels
the electroretinographic response, with decreasing lu-
minance, decreases more rapidly in the case of blue-
green stimulation than either blue or green stimulation.
(2) The electroretinographic response to either blue or
green stimulation does not show a smooth decrease with
decreasing luminance. (3) The electroretinographic re-
sponse is less pronounced after the adaptation to a green
field than after adaptation to a blue-green field. (4) The
probability of perception of limited contrast, at mesopic
levels, under blue or green stimulation follows a com-
plex behavior. (5) The addition of some blue light to a
green field decreases the probability of perception of
contrast.

James Forrestal Research Center, Princeton, N. J.
see Princeton U. James Forrestal Research Center,
N. J.

737

Johns Hopkins U. Dept. of Aeronautics, Baltimore, Md.

PLASMA DYNAMICS, by F. H. Clauser. Final rept.
Aug. 1959, 75p. incl. diagrs. (AFOSR-TR-59-125)
(AF 18(600)671) AD 229510; PB 144732 Unclassified

Also published in Proc. Durand Centennial Conf. on
Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-
8, 1959), New York, Pergamon Press, 1960, p. 305-
343. (AFOSR-TR-59-108)

The 1-dimensional, steady flow of a gas consisting of
particles all having the same sign of their electrical
charge is explored. The question of what dynamical
equations govern such a flow is discussed, and these
equations are solved without sacrificing their nonlinear
character. The full range of behavior from zero Mach
number to infinite Mach number is explored as is the
full range of the effect of external electric fields on the
flow. It is found that the non-linearity of the equations
introduces several fundamental new concepts to fluid
mechanics. It is also found that under some conditions
a number of radically different flows can exist for
exactly the same set of boundary conditions. Under
other conditions, no flows whatever exist that fit the
boundary conditions. (Contractor's abstract)

788

Johns Hopkins U. Dept. of Aeronautics, Baltimore, Md.

VELOCITY AND TEMPERATURE FLUCTUATION
MEASUREMENTS IN A TURBULENT BOUNDARY
LAYER DOWNSTREAM OF A STEPWISE DISCONTI-
NUITY IN WALL TEMPERATURE, by D. S. Johnson.
[1959] [12]p. incl. diagrs. refs. (AF 18(600)671)
AD 240004 Unclassified

Presented at annual meeting of the Amer. Soc. of Mech.
Engineers, New York, Nov. 30-Dec. 5, 1958.

Also published in Jour. Appl. Mech., v. 26: 325-336,
Sept. 1959.

Results are presented of an experimental investigation
of the coexisting thermal and velocity fluctuation fields
in a turbulent boundary layer downstream of a small
stepwise discontinuity in wall temperature. The statis-
tical behaviors of several relevant fluctuating quantities
were obtained at a typical cross section of the boundary
layer in the region where the thermal boundary layer
has not yet reached the free stream. The instantaneous
surface of demarcation between heated and unheated
fluid was found to be sharp and distinct at all points,
resulting in intermittent temperature fluctuation signals
well within the fully turbulent region of the momentum

boundary layer. From the measurements at 1 section,
the balances of turbulent kinetic energy and of turbulent
temperature fluctuations across the boundary layer have
been evaluated. In addition, the distribution of the local
turbulent Prandtl number (ratio of the turbulent diffu-
sivities of momentum and heat) through the boundary
layer was obtained; it is not constant and varies between
limits of 0.8 and 1.2. (Contractor's abstract)

789

Johns Hopkins U. Dept. of Aeronautics, Baltimore, Md.

ON SUPERSONIC WIND TUNNELS WITH LOW FREE-
STREAM DISTURBANCES, by M. V. Morkovin. [1959]
[6]p. incl. diagr. refs. (Sponsored jointly by Air Force
Office of Scientific Research under [AF 18(600)1121]
and Office of Naval Research) Unclassified

Presented at summer Conf. of Appl. Mech. Div., Amer.
Sec. Mech. Engineers, Troy, N. Y., June 18-20, 1959.

Published in Jour. Appl. Mech., v. 26: 319-324, Sept.
1959.

Measurements in supersonic wind tunnels have become
almost routine in the last decade and yet little is known
about the free-stream disturbances, which are present,
and about the means of minimizing them. The present
note outlines the problems of minimizing the mean as
well as the unsteady variations of velocity and tempera-
ture and gives guidance where the trends are clear. It
is found that in many wind tunnels the free-stream fluc-
tuations are likely to be dominated by aerodynamic
sound in the sense of Lighthill and by shivering Mach
waves. Only conjectures can be offered on the means of
minimizing the resulting sound intensity at the present
time. (Contractor's abstract)

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Johns Hopkins U. Dept. of Aeronautics, Baltimore, Md.

ANOTHER UNSTEADY TURBULENT BOUNDARY
LAYER, by H. Tennekes. May 1959 [43]p. incl. diagrs.
refs. (AFOSR-TN-59-600) (AF 49(638)496) AD 217177;
PB 142245 Unclassified

An investigation of a zero mean pressure gradient tur-
bulent boundary layer, subjected to sinusoidal free stream
oscillations, was undertaken by S. K. F. Karlsson
(Johns Hopkins U., Dept. of Aeronautics, 1958). It was
found that this boundary layer responded, within experi-
mental scatter, linearly. A comparison was made of
Karlsson's data with the results of Lighthill (Proc. Roy.
Soc., v. 224A: 1-23, June 1954) for the corresponding
laminar layer. Linearity of response being a remarkable
feature, it was decided to subject the boundary layer to
another free stream transient. A simple step function
type transient was chosen. A preliminary discussion of
the response of a turbulent boundary layer to this tran-
sient is given. A simple electronic analog computer

for linear synthesis of the response of the boundary layer to free stream transients, based on Karlsson's data, is discussed. (Contractor's abstract)

791

Johns Hopkins U. [Dept. of Aeronautics] Baltimore, Md.

A THEORY OF NEARLY LINEAR SYSTEMS, by F. H. Clauser. [1959] [75]p. incl. diagrs. (AFOSR-TN-59-1133) (AF 49(638)496) AD 229276; PB 144779
Unclassified

Presented at First Internat'l. Conf. of the Internat'l. Federation of Automatic Control, Moscow (USSR), 1960.

Also published in Automatic and Remote Control, v. 1: 218-232, 1960.

A theory is developed which permits the usual concepts of impedance and admittance to be applied to nonlinear systems, but the impedances and admittances now become matrices whose components give not only the response to the multiple frequencies that are present in nonlinear systems, but also the intercoupling of these frequencies as well. Numerous examples are used to show that the method can treat a wide variety of problems such as subharmonic and superharmonic resonance, oscillator lock-in, parametric ampification, superregeneration, rectification, modulation and the like. (Contractor's abstract)

792

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

A PHYSICO-CHEMICAL STUDY OF THE SYSTEM DIPHENYLMETHANE-DIPHENYL ETHER, by R. H. Dettre. [1959] [18]p. incl. diagrs. tables, refs. (Technical note no. 4) (AFOSR-TN-59-309) (AF 18(600)765) AD 213241
Unclassified

Also published in Jour. Phys. Chem., v. 64: 67-70, Jan. 1960.

Freezing point, density, viscosity and refractive index values are reported for the system diphenylmethane-diphenyl ether over the entire range of composition. Activity coefficients, volume changes on mixing and excess free energies of mixing have been calculated. The volumes of mixing are compared with those calculated from the excess free energies of mixing. The experimental fluidities are compared with those obtained from various theoretical considerations. The results show that the system exhibits slight negative deviations from ideal behavior. (Contractor's abstract)

793

Johns Hopkins U. [Dept. of Chemistry] Baltimore, Md.

DEVELOPMENT OF AN AUTOMATIC METHOD FOR THE DETERMINATION OF HEAT CAPACITIES OF ORGANIC LIQUIDS AND THEIR RECORDING ON PUNCH CARDS, by D. H. Andrews. Final rept. June 1, 1953-May 31, 1959. June 1959, 20p. incl. refs. (AFOSR-TR-59-71) (AF 18(600)765) AD 218785
Unclassified

A calorimeter was developed with automatic recording and computing equipment. The calorimeter was designed to operate normally with continuous heating but with the possibility that measurements could be made with a discontinuous heating method for comparing the 2 patterns of precision. The adiabatic control consists of a single junction and a simple heating coil on a thermal shield. The single junction provides an electrical potential which is amplified and recorded on a continuous strip-chart recording potentiometer. The recording pen controls a servomechanism for regulating the heat to the adiabatic shield. The necessary data are automatically prepunched on IBM cards which are later collected and fed into a computer. The computer makes the necessary calculations and prints a table of heat capacity/mol as a function of mean temperature of each interval.

794

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

IODINE NQR SPECTRUM OF BORON TRIIODIDE, by W. G. Laurita and W. S. Koski. [1959] [11]p. incl. refs. (AFOSR-TN-59-191) (AF 18(600)1526) AD 260255
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 3179-3182, July 5, 1959.

Consideration is given to the experimental measurement of the quadrupole coupling constant (eQq_{zz} in which e is the proton charge) and the asymmetry parameter (N), and their relation to the nature of the chemical binding in BI_3. Comparison is also made with the corresponding parameters in the other boron trihalides.

795

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

MECHANISMS OF ISOTOPIC EXCHANGES IN THE BORON HYDRIDES, by W. S. Koski. June 1959 [18]p. incl. diagrs. tables, refs. (Technical note no. 11) (AFOSR-TN-59-613) (AF 18(600)1526) AD 217400; PB 142986
Unclassified

Also published in Advances in Chem. Ser., No. 32: 78-87, 1961.

Evidence has been accumulated for at least 3 mechanisms by which isotopic exchange proceeds in the boron hydrides. In the diborane self-exchange the reaction appears to involve borane as an entity, and the ratio of deuterium rate to boron rate is 3. In the $B_2D_6 - B_5H_9$ exchange the rate-determining step is the reaction of borane with the terminal hydrogens of pentaborane. The bridge hydrogens are not involved at all. A similar situation exists in the diborane-deca-borane exchange. In the $B_2D_6 - B_5H_{11}$ reaction the fraction-order kinetics indicate that the B_5H_{11} is fragmenting. All of the borons and all of the hydrogens in both molecules are participating in the exchange. Only 1 rate of exchange has been observed, but there is experimental evidence that exchange can proceed by an intramolecular mechanism. In the case of the $B_2D_6 - B_4H_{10}$ reaction i has at least 2 mechanisms of isotopic exchange and evidence has been obtained for an exchange that proceeds by an intramolecular mechanism. The intramolecular process is an indication of the lability of the hydrogens and the borons in some of the less stable boron hydrides. (Contractor's abstract)

796

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

FAR INFRARED SPECTRA OF SOME SYMMETRIC TOP MOLECULES, by D. W. Robinson and D. A. McQuarrie. [1959] [15]p. incl. tables. (AFOSR-TN-59-967) (AF 49(638)468) AD 229729; PB 145308
Unclassified

Also published in Jour. Chem. Phys., v. 32: 556-569, Feb. 1959.

Pure rotational spectra out to 30 cm^{-1} are presented of the gaseous molecules CH_3CN, CH_3CCH, HCF_3 and $(CH_3)_3N$. These spectra are interpreted in the view of the rotational constants previously determined from microwave data. The heretofore undetermined value of D_J for CH_3CN has been estimated to be 1.45 x 10^{-7} cm^{-1}, the value of D_{JK} for $(CH_3)_3N$ is shown to be positive, and intensity distribution in the high -J subbands of the oblate top, HCF_3, has been estimated to have its center at K = 17. (Contractor's abstract)

797

Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

RECENT WORK ON FAMILIES OF PERIODIC SOLUTIONS OF DIFFERENTIAL EQUATIONS, PART 1. SINGULAR SOLUTIONS OF SYSTEMS OF REAL ANALYTIC EQUATIONS, PART II. THE STROMGREN-WINTNER PRINCIPLE ON THE TERMINATION OF FAMILIES OF PERIODIC SOLUTIONS, PART III, by D. C. Lewis, Jr. June 30, 1959, 61p. incl. refs. (AFOSR-TR-59-70) (AF 18(600)665) AD 225355; PB 143151
Unclassified

A comprehensive survey is given of an attempted global theory of perturbation for periodic solutions of systems of differential equations containing a parameter. The systems of differential equations considered are of the form: $dx/dt = f(x,t,\mu)$, where x and f are vectors, and t and μ are real variables. f is always assumed to be at least of class C' in x, t, and μ. Various other topics of independent interest related to this theory are also treated. (Contractor's abstract)

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Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

THREE NOTES: 1. ON OSCILLATORS WITH LARGE FREQUENCIES. 2. ON THE RATIO $f(t + cf^{-\alpha}(t))/f(t)$. 3. ON FUNCTIONS REPRESENTABLE AS A DIFFERENCE ON CONVEX FUNCTIONS, by P. Hartman. Feb. 1959, 10p. incl. refs. (Technical rept. no. 9) (AFOSR-TN-59-114) (AF 18(603)41) AD 210399; PB 139939
Unclassified

Note 3 also published in Pacific Jour. Math., v. 9: 707-713, 1959.

On oscillators with large frequencies: Proof is presented of the theorem: If q(t) is continuous for $t \geq 0$, is monotone, $q(t) \to \infty$ as $t \to \infty$ and log q(t) is of regular growth, then all solutions of $d^2x/dt^2 + q(t)x = 0$ tend to 0 as $t \to \infty$. On the ratio $f(t + cf^{-\alpha}(t))/f(t)$: In the asymptotic integration theory of $\frac{d^2x}{dt^2} \pm f(t)x = 0$, the results proved imply that $\log (f(u)/f(v))/(1 + \int_u^v f^\alpha(s)ds) \to 0$ as u, v $\to \infty$ and $\int^\infty f^\alpha(t)dt = \infty$ are equivalent to $f(t + cf^{-\alpha}(t))/f(t) \to 1$ as $t \to \infty$. On functions representable as a difference of convex functions: Let D, E be open, convex sets in E^m, E^n respectively. Let y = y(x) map D into E and let each component of y(x) be a difference of convex (d.c.) function. Let g(y) ge a scalar d.c. function on E. Then g(y(x)) is a d.c. function on D, i.e., if $y_1(x)$, $y_2(x)$ are scalar d.c. functions on D, so is the product $y_1(x)y_2(x)$ and the quotient $y_1(x)/y_2(x)$ if $y_2 \neq 0$.

799

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

ON SPHERICAL IMAGE MAPS WHOSE JACOBIANS

DO NOT CHANGE SIGN, by P. Hartman and L. Nirenberg. Mar. 1959, 28p. incl. refs. (Technical rept. no. 10) (AFOSR-TN-59-549) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)-41 and Office of Naval Research under N6ori-20101) AD 216659; PB 144340   Unclassified

Also published in Amer. Jour. Math., v. 81: 901-920, Oct. 1959.

Mappings $p = p(x)$ are considered of an n-dimensional x region into n-dimensional p space with a Jacobian $J(x)$ which does not change sign. A map $p = p(x)$ is called a gradient map if $p(x)$ is locally a gradient. One of the theorems proved, for example, states that a gradient map $p = p(x)$ with a Jacobian which does not change sign is monotone in the sense that the boundary of the image set is contained in the image of the boundary. Analogous results are valid for the spherical image mapping of an n-dimensional hypersurfaces immersed in (n + 1)-dimensional Euclidean space. Applications of the results of the first part are discussed;for example, there are obtained an n-dimensional generalization of the Rado (von Neumann) theorem on saddle surfaces, a characterization of complete hypersurfaces of constant zero curvature in Euclidean spaces as cylinders, and, for n = 2, properties of the x sets grad $z(x)$ = constant if the Hessian determinant of z is identically zero. (Contractor's abstract)

800

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

ON UNIQUENESS QUESTIONS FOR HYPERBOLIC DIFFERENTIAL EQUATIONS, by J. P. Shanahan. May 1959, 16p. (Technical note no. 11) (AFOSR-TN-59-650) (AF 18(603)41) AD 230932; PB 145568   Unclassified

Also published in Pacific Jour. Math., v. 10: 677-688, 1960.

The uniqueness, existence, and convergence of successive approximations are considered for a solution of an initial value problem, where $z_{xy} = f(x,y,z,z_x, z_y)$ and $z(x,0)$ and $z(0,y)$ are assigned. Analogues of the Nagumo and Kamke criteria in the theory of ordinary differential equations are obtained. The method employed is related to the arguments used by Viswanatham (Jour.   .an Math. Soc., v. 16: 1952) to prove the convergen   _ successive approximations for ordinary differential equations under conditions similar to those in Kamke's general uniqueness theorem. (Contractor's abstract)

801

Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

A LEMMA IN THE THEORY OF STRUCTURAL STA-

BILITY OF DIFFERENTIAL EQUATIONS, by P. Hartman. [1959] 13p. (Technical note no. 12) (AFOSR-TN-59-1106) (AF 18(603)41) AD 230927; PD 145513   Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 610-620, Aug. 1960.

Let T be the local (real) map T: $x^1 = Ax + X(x)$, where A is a constant square matrix with eigenvalues a_j satisfying $|a_j| \pm 0,1$ and $X(x)$ is of class C^1 for small $|x|$ satisfying $X = o(|x|)$ as $x \to 0$. A topological map R: $u = u(x)$ of a vicinity of x = 0 onto a vicinity of u = 0 is shown such that RTR^{-1} is the linear map $u^1 = Au$. This result is then used to show that if, in the system of differential equations (*) $x' = \Gamma x + F(x)$, Γ is a square matrix with eigenvalues γ_j satisfying Re $\gamma_j \pm 0$, $F(x)$ is of class C^2 for small x, and $F(x) = o(|x|)$ as $|x| \to 0$, then there exists a topological map R: $u = u(x)$ of a vicinity of x = 0 onto a vicinity of u = 0 mapping solution paths of (*) onto those of the linear system $u' = \Gamma u$.

802

Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

ON LOCAL HOMEOMORPHISMS OF EUCLIDEAN SPACES, by P. Hartman. [1959] 28p. incl. refs. [Technical note no. 13] (AFOSR-TN-59-1107) (AF 18(603)41) AD 230963; PB 145514   Unclassified

Presented at Symposium on Ordinary Differential Equations, Mexico City, Sept. 1959.

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 220-241, 1960.

A system of real ordinary equations near an equilibrium point is studied. The normal form for a local homeomorphism T: $x^1 = Ax + X(x)$ of a vicinity of x = 0 into a vicinity of $x^1 = 0$ is considered where A is a constant matrix with eigenvalues $a_1,...,a_N$; where $|a_j| \neq 0,1$ and $X(x)$ has uniformly Lipschitz continuous partial derivatives which vanish at x = 0. The main result is to the effect that if the linear part of T is a contraction, that is, if $0 < |a_j| < 1$ for j = 1,...,N, then there exists a C^1 map R: $x \to u$ such that RTR^{-1} is the linear map $u^1 = Au$. No algebraic conditions are imposed on the a_j. R is constructed in several steps: each step corresponds to a distinct number in the set $|a_1|,...,|a_N|$ and involves the introduction of an invariant manifold and successive approximations. The main result remains correct if the assumption that T is a contraction is replaced by the assumption that the numbers less than 1 in the set $|a_1|,...,|a_N|$ are "nearly equal" and that those greater than 1 are

"nearly equal." An example shows that, in general, the main result can be false if N = 3 even if T is analytic (if it is only assumed that $|a_j| \neq 0,1$). (Contractor's abstract)

803

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

ON LOCAL AND GLOBAL PROPERTIES OF CONVEX SETS AND HYPERSURFACES, by R. Sacksteder. Nov. 1959 [43]p. incl. refs. (Technical note no. 14) (AFOSR-TN-59-1294) (AF 18(603)41) AD 231782; PB 145774
Unclassified

In the 1st chapters, there is obtained a generalization of a theorem of Tietze characterizing convex sets by local properties. This result is used in the 2nd chapter to prove the main result: Let S be a (sufficiently smooth) isometric immersion of a complete r-dimensional Riemannian manifold M^n in a Euclidean space E^{n+1} with the intrinsic property that the 2nd fundamental form of S is semi-definite at every point and definite at some point. Then S is the boundary of a convex body (although if M^n is not complete, S need not even be locally convex). The 3rd chapter deals with a number of topics. Examples are given to show that theorems of Hilbert and Weyl, concerning extrema of principle curvatures or of mean and Gauss curvatures at non-umbilic points, are false without suitable smoothness assumptions. (Contractor's abstract)

804

Johns Hopkins U. Dept. of Mechanical Engineering, Baltimore, Md.

PROBABILITY DENSITY MEASUREMENT WITH AN ELECTRODE MOUNTED IN THE FACE OF A CATHODE-RAY TUBE, by H. Lien. [1959] [3]p. incl. diagrs. (AFOSR-TN-59-992) (AF 49(638)248)
AD 235193   Unclassified

Also published in Rev. Scient. Instr., v. 30: 1100-1102, Dec. 1959.

A small electrode mounted inside the face of a cathode-ray tube gives a window comparable to its own dimensions when the bias voltages are set so that secondary electron emission current dominates. Under these conditions the device can be used for measurement of probability densities of random signals. (Contractor's abstract)

805

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

RECOMBINATION BETWEEN ELECTRONS AND

HELIUM MOLECULAR IONS (Abstract), by D. E. Kerr and C. S. Leffel, Jr. [1959] [1]p. [AF 18(600)363]
Unclassified

Presented at Eleventh Annual Gaseous Electronics Conf., New York, Oct. 22-25, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 113, Mar. 6, 1959.

Simultaneous measurements of electron density in and radiation from the decaying plasma following a pulsed discharge in helium has permitted identification of the principal ion as He^+ at pressures below about 3 mm Hg, and He_2^+ above 3 mm. At the higher pressures, the radiation is predominantly from the He_2 molecule, and is believed to result from recombination between electrons and He_2^+ ions. Although under these conditions diffusion represents the predominant electron-loss mechanism, an upper limit can be set for the total recombination coefficient, which we believe to be considerably less than 10^{-8} cm^3/sec. Absolute light intensity measurements permit estimates of a lower limit of recombination coefficient, which are found to be about 3×10^{-10} cm^3/sec. This range is considerably smaller than has been reported by others. Detailed investigation of emitted light as a function of pressure and electron density permits comparison of several recombination mechanisms and discussion of the effects of collision quenching of excited states. The central question, still not satisfactorily resolved, concerns the mechanism of formation of these states.

806

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

THE USE OF S-MATRIX POLES IN THE DETERMINATION OF PARITIES, by G. Feldman and T. Fulton. May 11, 1959 [7]p. incl. diagrs. (AFOSR-TN-59-421) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)143 and National Science Foundation) AD 214142   Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 64-66, July 1, 1959.

Recently it has been conjectured (S. Madelstam, Phys. Rev., v. 112: 1344, 1958) that there exist dispersion relations in momentum transfer variables. It has been suggested that an approximation to these relations could be used in order to determine such physical quantities as parities, coupling constants, etc. This approximation consists of extracting the contribution of certain single particle intermediate states to S-matrix elements, and analyzing the experimental data on the assumption that these contributions predominate. Some potential difficulties inherent in such an analysis are pointed out.

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Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

K$^-$ ABSORPTION IN HELIUM. I. (Abstract), by J.
Leitner, E. M. Harth and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143], Atomic Energy Commission, and Office of Naval Research)   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
25, Jan. 28, 1959.

The Duke U. liquid helium bubble chamber was exposed to a low energy K$^-$-beam at the Berkeley bevatron. The chamber is situated in a magnetic field of 14.3 kilogauss. In about 90,000 pictures we observed about 9,000 K$^-$ - mesons of which about 2500 were stopped in the chamber. The following features of the K$^-$-helium interaction are being studied: (1) the neutral to charged hyperon production ratio, (2) relative numbers of Λ°'s produced both directly and by $\Sigma^\circ - \Lambda^\circ$ conversion, (3) angular correlations in Λ° decay, pertinent to the question of parity conservation in Λ° production, (4) hyperfragment production rates. Preliminary scanning shows that Λ° production predominates over charged Σ production; this is expected from the large $\Sigma^\circ - \Lambda^\circ$ conversion observed in K$^-$ absorption in deuterium.

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Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

K$^-$ ABSORPTION IN HELIUM. II. RELATIVE K$^-$-Λ PARITY (Abstract), by A. Pevsner, F. Anderson and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143], Atomic Energy Commission, and Office of Naval Research)   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
25, Jan. 28, 1959.

In the Duke helium bubble chamber K$^-$ exposure described above preliminary evidence has been found for the existence of a $_\Lambda$He^4 hyperfragment. The interpretation of the event as K$^-$ + He^4 $\rightarrow$ $_\Lambda$He^4 + π^- is based on the observation of a stopping K$^-$-meson from which emerges a π^- of momentum 252 ± 12 mev/c collinear (± 2°) with a stub of range 0.62 ± 0.08 cm. Kinematic calculations lead one to expect a π^--momentum of 257 mev/c and a stub of range 0.60 cm. Details of the measurement will be discussed as well as some low probability sources of ambiguity. The existence of the reaction K$^-$ + He^4 $\rightarrow$ $_\Lambda$He^4 + π^- has bearing on the relative

K$^-$ - Λ° parity if it is assumed that parity is conserved in the reaction, that all particles in the reaction have spin 0, and that no bound excited states of the $_\Lambda$He^4 exist. Under these assumptions existence of the above reaction would lead to the assignment of negative relative parity of the K$^-$ and Λ°. The foregoing assumptions and conclusions will be discussed more fully.

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Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

CONTRIBUTION OF A CONSERVED VECTOR CURRENT TO THE β-γ ANGULAR CORRELATION FROM INNER BREMSSTRAHLUNG IN β DECAY (Abstract), by D. Fivel and T. Fulton. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(603)143] and National Science Foundation)
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
39, Jan. 28, 1959.

Calculations have been made of the β-γ angular correlation from inner bremsstrahlung in the β decay of B^{12} and N^{12}, assuming a V-A interaction with a conserved vector current. The expected 2 correction terms are found. They are functions of the β and γ energies and of the relative angle. The B^{12} and N^{12} angular correlations differ only in the relative sign of the correction term proportional to the "weak magnetic moment" of the transition. The ratio of these angular correlations therefore differs from unity by a term proportional to the "weak magnetic moment." Due to the contributions of the meson cloud, this moment is $\sqrt{2}$ times the magnetic moment of the corresponding γ transition in C^{12} if charge independence is assumed. For photons above 5 mev the ratio differs from unity by more than 0.07. Detailed results of the calculations will be presented. Coulomb, relativistic, and nuclear bremstrahlung corrections will also be discussed.

810

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

RADIATIVE DECAYS OF THE PION (Abstract), by L. E. Evans. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)-143] and National Science Foundation)   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
39, Jan. 28, 1959.

The discovery of the decay $\pi \to e + \nu$ with approximately the predicted abundance still leaves unsettled the question of the general nature of the interaction responsible for pion decay. Both a direct pion-lepton coupling and an intermediate coupling via the V-A four-fermion interaction give a branching ratio of 12.7×10^{-5} for electron decay relative to muon decay. The decay $\pi \to \mu + \nu + \gamma$, about 10^{-4} as probable as the nonradiative process, was investigated in an attempt to find effects which distinguish between these 2 coupling schemes. Matrix elements were obtained by invariance agruments similar to those of Treiman and Wyld. Energy spectra, angular correlations, and polarization effects will be discussed.

811

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

DECAY OF K^- MESONS (Abstract), by C. Meltzer, M. M. Block and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143], Atomic Energy Commission and Office of Naval Research)   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 288, Apr. 30, 1959.

Exposures of the Duke U. helium bubble chamber to the slow K^- beam of the Berkeley bevatron have been scanned for K^- decays in flight. A preliminary sample has yielded to date about 300 K^- decays among a total of about 3000 K^- traversals of the chamber. The observed τ branching ratio of about 5% is in good agreement with the K^+ results. Data on other branching ratios and lifetime of the K^- will be presented.

812

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

PRELIMINARY RESULTS REGARDING HIGH ENERGY INTERACTIONS OF π^- IN A He-BUBBLE CHAMBER, by M. [M.] Block, [E.] B. Brucker and others. [1959] [2]p. [AF 18(603)143]   Unclassified

Presented at Conf. of the Italian Phys. Soc., Palermo, Nov. 6-11, 1958.

Published in Nuovo Cimento, Series X, v. 12: 642-643 June 16, 1959.

Interactions of 1.1, 1.8, and 2.4 gev/c negative pions with He have been studied at Duke U. with the aim of

determining the relative and absolute parities of K^+ and K^0. Preliminary results gave a value of 110 mb for the total interaction cross section of 1.8 gev/c negative pions. The cross sections for elastic scattering and for y^0 production were about 5 and 1 mb, respectively. From the 1st diffraction minimum of the scattering distribution, a value of 2×10^{-13} cm was obtained for the nuclear radius of He. The total interaction cross section of 1.1 gev/c negative pions on He was about 135 mb.

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Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

OBSERVATION OF He^4 HYPERFRAGMENTS FROM K^--He INTERACTIONS. THE K^--$_\Lambda$ RELATIVE PARITY, by M. M. Block, E. B. Brucker and others. [1959] [2]p. incl. table. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143], Atomic Energy Commission, and Office of Naval Research)   Unclassified

Published in Phys. Rev. Ltrs., v. 3: 291-292, Sept. 15, 1959.

The Duke U. helium bubble chamber was exposed to a separated low-energy K^- beam. Approximately 2500 K^- interactions at rest were obtained. In a partial scan, evidence was found for the production of He^4 hyperfragments in the reaction of $K^- + He^4 \to {}_\Lambda He^4 + \pi^-$. The relative K^--$_\Lambda$ parity can be inferred from the reaction if it is assumed that parity is conserved, the spins of K^- and $_\Lambda He^4$ are zero, and no bound excited states of $_\Lambda He^4$ exist. The K^--$_\Lambda$ relative parity was established to be negative.

814

Johns Hopkins U. Dept. of Physics, Baltimore, Md.

CLASSICAL RADIATION FROM A UNIFORMLY AC-CELERATED CHARGE, by T. Fulton and F. Rohrlich. [1959] [19]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(603)143] and National Science Foundation)
Unclassified

Published in Ann. Phys., v. 9: 499-517, Apr. 1960.

The old and much-debated question, whether a charge in uniform acceleration radiates, is discussed in detail and its implications are pointed out. Many contradictory statements in the literature are analyzed and those answers which can be given on the basis of the

standard classical Maxwell-Lorentz equations are presented. Although the questions that remain open are difficult and fundamental, some simple results can be proved: Contrary to claims in some standard sources (Pauli, von Laue), a charge in uniform acceleration does not radiate. The radiation rate is finite, invariant, and constant in time in the instantaneous rest system. There is no contradiction of this fact with either the principle of conservation of energy or the principle of equivalence. Finally, the group of conformal transformations is found to be not physically meaningful. (Contractor's abstract)

815

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

MONOCHROMATICALLY EXCITED FLUORESCENCE IN RARE EARTH SALTS, by F. Varsanyi and G. H. Dieke. [1959] [5]p. incl. illus. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)535] and Atomic Energy Commission)
Unclassified

Published in Jour. Chem. Phys., v. 31: 1066-1070, Oct. 1959.

Monochromatic excitation, continuously variable in wavelength, makes it possible to analyze in detail the excitation of the fluorescence spectra of rare earth salts. This is a very sensitive method for studying the coupling of the electronic levels with the lattice vibrations. When a crystal contains several kinds of rare earth ions their fluorescence spectra are excited independently of each other. (Contractor's abstract)

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Johns Hopkins U. [Dept. of Physiology] Baltimore, Md.

RECEPTIVE FIELDS OF SINGLE NEURONES IN THE CAT'S STRIATE CORTEX, by D. H. Hubel and T. N. Wiesel. [1959] [18]p. incl. diagrs. refs. (AF 49(638)-499)
Unclassified

Published in Jour. Physiol. (London), v. 148: 574-591, Oct. 1959.

Recordings were made from single cells in the striate cortex of lightly anesthetized cats. The retinas were stimulated separately or simultaneously with light spots of various sizes and shapes. In the light-adapted state, cortical cells were active in the absence of additional light stimulation. Receptive fields were usually divided into mutually antagonistic excitatory and inhibitory regions. A light stimulus covering the whole receptive field was relatively ineffective in driving most units, owing to the mutual antagonism between these 2 regions. It was found that a spot of light often gave greater and stronger responses for some directions of movement than for others. In some units these asymmetries could be interpreted in terms of receptive

field arrangements. In a binocular unit, excitatory and inhibitory regions of the 2 receptive fields interacted and summation and mutual antagonism could be shown just as within a single receptive field.

817

Johns Hopkins U. [Inst. for Cooperative Research] Baltimore, Md.

SHOCK WAVE-TURBULENCE INTERACTION, INVESTIGATIONS IN A SHOCK TUBE, by J. E. Werner. Final rept. May 1959 [134]p. incl. diagrs. refs. (AFOSR-TR-59-46) (AF 18(600)757) AD 214847; PB 142303
Unclassified

Various aspects of the shock-turbulence interaction problem were investigated analytically and experimentally. The model of a cellular vortex field with a discrete front convected through a shock wave was studied theoretically. Expressions were derived for the unsteady pressure disturbance on the downstream face of the shock, and the displacement of the shock wave itself as the vortex field is carried through it by the mean flow. The interaction of a shock with a random velocity fluctuation field was also considered. The relationship between pressure fluctuation and shock displacement was explored. In particular the pressure fluctuation level is found to depend on shock displacement, turbulence scale, and turbulence intensity. Techniques for measuring these 3 quantities in a shock tube are the subject of the experimental work. The constant temperature hot-wire anemometer was used to measure turbulence intensity, spectra and scale, while shock displacement measurements were made with the aid of shadowgraph pictures. A comparison was made between measured and theoretically derived shock displacement, and order of magnitude agreement is found. (Contractor's abstract)

818

Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

LAMELLAR GRATING FAR-INFRARED INTERFEROMETER, by J. Strong and G. A. Vanasse. [1959] [6]p. incl. illus. diagrs. table. (AFOSR-TN-59-696) (AF 18-(600)1307) AD 248846
Unclassified

Also published in Jour. Opt. Soc. Amer., v. 50: 113-118, Feb. 1960.

A new variable-groove-depth grating-type interferometer that was used to obtain experimental interferograms and spectra for short and long wavelengths ($\lambda < 15\,\mu$ to $\lambda > 4$mm), together with its construction and performance is described. (Contractor's abstract)

819

Johns Hopkins U. Lab. of Astrophysics and Physical
Meteorology, Baltimore, Md.

INTERFEROMETRIC SPECTROSCOPY IN THE FAR
INFRARED, by J. Strong and G. A. Vanasse. [1959]
[7]p. incl. diagrs. refs. (AFOSR-3645) (AF 18(600)-
1307)   Unclassified

Also published in Jour. Opt. Soc. Amer., v. 49: 844-
850, Sept. 1959.

Michelson's visibility technique for obtaining spectral
distributions interferometrically in the visible region
is compared with the new far-infrared interferogram
method. The scanning function for the lamellar-grating
type interferometric modulator that is used for the far-
infrared region has been derived. Its theoretical reso-
lution limit is compared with the spectrum estimate ob-
tained from experimental results with a microwave
source. Discrepancies between the derived spectrum
estimate, obtained by a finite Fourier series expansion,
and the true spectrum are discussed. A simple tech-
nique, due to Rayleigh, is invoked to avoid distortion of
the spectrum due to the so-called Gibbs phenomenon.

A spectrum of H_2O extending from 8 to 60 cm^{-1} (λ =
1250 to 167 μ) illustrates the application of Rayleigh's
method. (Contractor's abstract)

820

Johns Hopkins U. Lab. of Astrophysics and Physical
Meteorology, Baltimore, Md.

FAR INFRARED SPECTRA OF H_2O and H_2S TAKEN
WITH AN INTERFEROMETRIC SPECTROGRAPH, by
G. A. Vanasse, J. Strong, and E. [V.] Loewenstein.
[1959] [2]p. incl. diagrs. (AF 18(600)1307)
                                         Unclassified

Published in Jour. Opt. Soc. Amer., v. 49: 309-310,
Mar. 1959.

A large (12-in. aperture) interferometric spectrograph,
constructed at Johns Hopkins U. for far infrared spec-
troscopy, is described. The figure of merit for this
type of spectrograph is $M = n\lambda_c/f$, where n = no. of
grating grooves, λ_c = cutoff wavelength, and f = ratio
of collimator focal length to modulator diam. The val-
ue of the cutoff wavelength is determined by the lamel-
lar grating's groove spacing and the slit width, and ap-
propriate optical filters must be used to insure that no
radiation of shorter wavelength reaches the detector.
In the absence of noise, λ_c determines the spacing of
the sampling points.

821

Johns Hopkins U. [Lab. of Astrophysics and Physical
Meteorology] Baltimore, Md.

PURE ROTATION SPECTRA OF HCN AND NH_3 (Ab-
stract), by G. A. Vanasse and E. V. Loewenstein. [1959]
[1]p. [AF 18(600)1307]   Unclassified

Presented at meeting of the Opt. Soc. Amer., New York,
Apr. 2-4, 1959.

Published in Jour. Opt. Soc. Amer., v. 49: 512, May
1959.

Spectra of HCN and NH_3 between 100 and 500 μ, with
a resolution of 0.5 wave number, have been obtained
with the large interferometric modulator at the Johns
Hopkins U. The values of B obtained are compared with
the accepted values. The conditions under which the
spectra were taken, as well as the instrument and the
method of transformation are described.

822

Johns Hopkins U. [Lab. of Astrophysics and Physical
Meteorology] Baltimore, Md.

FAR INFRARED TRANSMISSION AND OPTICAL CON-
STANTS OF QUARTZ AND SAPPHIRE (Abstract), by
E. V. Loewenstein. [1959] [1]p. [AF 18(600)1307]
                                          Unclassified

Presented at meeting of the Opt. Soc. Amer., Ottawa
(Canada), Oct. 8-10, 1959.

Published in Jour. Opt. Soc. Amer., v. 49: 1138-1139,
Nov. 1959.

Transmission spectra of several samples of quartz and
sapphire have been obtained in the wavelength region
beyond 100μ, using the far infrared interferometric
modulator of the Johns Hopkins U. All the samples
were plane parallel pieces, and the resulting channel
spectra can be analyzed for n and k. With the aid of the
work of Williams (Jour. Opt. Soc. Amer., v. 49: 1138,
Nov. 1959), the values of the constants may be estimated
directly from the interferogram. If the constants do not
vary too rapidly across the range investigated, the es-
timates are quite accurate. One of the quartz samples
was the window of the Golay detector, which showed a
strong channel spectrum despite the fact that it was in
an f/1 beam. The interpretation of the sapphire channel
spectrum in terms of optical anisotropy is discussed.

823

Johns Hopkins U. Lab. of Astrophysics and Physical
Meterology, Baltimore, Md.

THEORETICAL STUDIES OF INTENSITY, LINE WIDTH

AND LINE SHAPE IN RESOLVED INFRARED SPEC-
TRA, by W. S. Benedict. Final rept. Sept. 1, 1955-Aug.
31, 1958, 1v. incl. illus. diagrs. tables, refs. (AFOSR-
TR-59-61) (AF 18(600)1557) AD 216657: AD 264224
Unclassified

A number of detailed advances in the understanding
of the spectra of NH_3 and H_2O are reported. The most
significant are: improved structural constants and har-
monic potential constants for ammonia; recognition of
numerous new interaction effects in the fine structure
of NH_3 bands; a striking case of anomalous intensity
in the weak binary combination band $\nu_2 + \nu_4$ of NH_3;
line width measurements in vibration-rotation bands
of NH_3 that are qualitatively in accord with the theory
of quasi-resonant collision broadening; absence of
asymmetry or shift in NH_3 lines in the infrared re-
gion at pressures up to 1 atm; discovery of infrared
lines due to H_2O^{18} and H_2O^{17} in the solar spectrum
through the terrestrial atm; and calculations of line
width for H_2O-N_2 collisions that appear capable of pro-
viding reliable correlations of experimental absorption
data and transmission function for atmospheric water
vapor. Several publications emanating from the re-
search performed during this study are included: item
no. JHU.19: 001-003, Vol. I; JHU.19:004, 005, 008, 009,
Vol II; and item no. 824, Vol. III.

824

Johns Hopkins U. Lab. of Astrophysics and Physical
Meteorology, Baltimore, Md.

CALCULATION OF LINE WIDTHS IN H_2O-N_2 COL-

LISIONS, by W. S. Benedict and L. D. Kaplan. [1959]
[12]p. incl. diagrs. tables, refs. (In cooperation with
Massachusetts Inst. of Tech., Cambridge) (Sponsored
jointly by Air Force Office of Scientific Research
under AF 18(600)1557 and Office of Naval Research)
Unclassified

Anderson's general theory of collision line broadening
has been applied to H_2O-N_2 encounters. The only
attractive force was assumed to be that between the
H_2O dipole, $\mu = 1.87 \times 10^{-18}$ esu, and the N_2 quadrupole
qN_2, an adjustable parameter. A second adjustable pa-
rameter, b_m, the distance of closest approach, includes
the effects of all other forces. The IBM 704 was used
in the calculation. Effects of varying the parameters
were noted for a number of lines. and in the final cal-
culation, which yielded the widths of all significant type
B transitions up to $J'' = 13$, parameters $qN_2 = 2.62 \times$
10^{-26} esu and $b_m = 3.2A$ which give an exact fit of the
observed width of the microwave line $6_{-5}-5_{-1}$, were
adopted. The temperature dependence of the line width
over the range 220-2400°K, and the effects of vibration-
rotation interactions were also calculated. At 300°K
widths vary from 0.11115 cm^{-1} atm for 1_1-1_{-1} to
0.03200 cm^{-1} atm^{-1} for $14_{-13}-13_{-13}$, there being a
general decrease in width with increasing J, and at a
given J, decreasing width with increasing τ. (Contrac-
tor's abstract)

825

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

BIOPHYSICAL INVESTIGATIONS OF THE MINERAL PHASE IN HEALING FRACTURES, by U. Nilsonne. 1959 [77]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-993) (AF 61(052)15 and AF 61(052)21) AD 227570   Unclassified

Also published in Acta Orthopaed. Scand., suppl. no. 37: 5-81, 1959.

The present work is a study at microscopic and ultra-structural levels of the mineralization process in experimentally obtained diaphyseal fractures in rats and dogs. The theoretical background to the absorption of monochromatised x-ray radiation in bone and callus tissue is described. It is reported that mineralization, as described in the callus region, starts in the periosteal callus and spreads out over the callus area, exhibiting large local variances in the degree of mineralization in different structures. Mineralized structures spanning the fracture gap were observed in the microradiograms considerably later than the macro x-ray pictures gave reason to suppose. Mineralization, which was quite consistent with the observed distribution of bone salt during the development of the callus, proceeds most rapidly during the 1st weeks of the fracture healing period and swifter in the periosteal callus near the fracture ends than in the callus area. The x-ray crystallographic investigation shows that the bone salt occurs as hydroxyapatite in every stage of the development of the callus. The autoradiographic studies with isotope Sr^{90} show that the isotope has the greatest affinity to the least mineralized callus areas, and the significance of this fact is so discussed.

826

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

DETERMINATION OF STRONTIUM IN BONE BY X-RAY FLUORESCENCE SPECTROSCOPY, by G. Höglund. [1959] [5]p. incl. diagr. tables, refs. (AFOSR-TN-59-1007) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)15 and National Institutes of Health)   Unclassified

Also published in Exper. Cell Research, v. 17: 565-569, 1959.

A method is described for determination of strontium in bone by x-ray fluorescence. The strontium content of various human bones was determined and found to average about 100 parts per million, which is comparable with values obtained by other investigators using more complicated procedures. No significant difference was found in the strontium content between tibiae and vertebrates nor between sexes. The method described

is accurate, simple, and rapid and extremely well suited for the determination of strontium in bone. Fallout of radio-active fission products from nuclear weapon testing has focused attention upon the concentration of strontium-90 in bone and the hazards inherent in this process. Investigations aimed at evaluating and reducing this hazard require an accurate procedure for determining strontium in bone. Simplicity and rapidity of analysis would be added advantages. (Contractor's abstract)

827

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

RESEARCH REPORT FOR 1958, by A. Engström. [1959] [17]p. (AFOSR-TN-59-340) (AF 61(052)21) AD 264326; PB 143071   Unclassified

An account of the scientific activity under the above contract is reported. The larger part of this report deals with the development of techniques and their applications to the study of the fine structure of the central nervous system with the aim to correlate structure and function. Paralleling this area of investigation is a study to formulate certain general theories regarding information transfer in minute structures along with certain metabolic tracer studies. It is the aim of this project to bring together this related data for a composite report.

828

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

DYNAMICAL ASPECTS OF A METHOD IN TRACER KINETICS, by P. E. Bergner. [1959] [10]p. incl. diagrs. (AFOSR-TN-59-341) (Bound with its AFOSR-TN-59-340; AD 264326) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)-21 and National Institutes of Health) AD 213661
                                              Unclassified

Also published in Exper. Cell Research, v. 17: 328-335, May 1959.

The problems of tracer kinetics, particularly non-specified precursor substance situations that require analysis of the entire biological organism, are discussed. For example, how can a substance such as calcium be characterized? It is concluded that the method used, as outlined in this study can only be used upon isolated problems.

829

Karolinska Inst. [Dept. of Medical Physics] Stockholm (Sweden).

CORRELATING STUDIES ON CORTICAL ACTIVITY

AND STRUCTURE, by P. Valleala. [1959] 3p. (AFOSR-TN-59-557) (AF 61(052)21) AD 264125
Unclassified

The cortical activity investigations of this author are reported. Among the results reviewed is the fact that injury potentials are not responsible for the activity recorded. It is also stated that by plotting the integrated activity against depth of microelectrode position typical "potential profiles" of the different cortical regions can be obtained. Plans for future investigations are also mentioned.

830

Karolinska Inst. [Dept. of Medical Physics] Stockholm (Sweden).

INVESTIGATIONS ON THE EXCITATION MECHANISM IN THE OLFACTORY EPITHELIUM AND ON THE TRANSMISSION PROCESSES IN THE OLFACTORY SYSTEM, by D. Ottoson. [1959] 3p. (AFOSR-TN-59-558) (AF 61(052)21) AD 264124 Unclassified

The mechanisms of olfactory stimulation are examined. It is reported that a great number of odorous compounds were examined and as a measure of their olfactory stimulating efficiency, the magnitude of the receptor potential was recorded. It is found that aliphatic alcohols have increasing stimulating ability up to a certain maximum with increasing chain length. A similar increase exists for aldehydes and ketones, but fatty acids show a less regular relationship. It is also found that the olfactory bulb response is composed of two successive deflections. Plans for future investigations are also included.

831

Karolinska Inst. [Dept. of Medical Physics] Stockholm (Sweden).

STUDIES ON EXCITATION PROCESSES IN THE INSECT EYE, by C. G. Bernhard and D. Ottoson. [1959] 2p. (AFOSR-TN-59-559) (AF 61(052)21) AD 264126
Unclassified

The opinion that there should be a reduction of the fusion frequency after removal of the optic ganglion in "fast insect eyes" is investigated. It is shown that removal of the ganglion does not change the flickering ability of the retinal cells. These observations would mean that results based on flickering experiments cannot be taken as evidence for an efferent ganglio-retinal influence in the insect eyes.

832

Karolinska Inst. [Dept. of Medical Physics] Stockholm (Sweden).

STUDIES ON THE RELATIONSHIP BETWEEN OLFAC-

TORY STIMULATING EFFECTIVENESS AND PHYSICO-CHEMICAL PROPERTIES OF ODOROUS COMPOUNDS, by D. Ottoson. [1958] [15]p. incl. diagrs. refs. (AFOSR-TN-59-1006) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)21 and Swedish Medical Research Council) Unclassified

Also published in Acta Physiol. Scand., v. 43: 167-181, 1958.

The relationship between the olfactory stimulating effectiveness and the chemical and physical properties of a number of odorous compounds were studied. As a measure of the efficiency the magnitude of the slow potential evoked in the olfactory mucosa in the frog was taken. Aliphatic alcohols of equimolar concentrations were found to be increasingly stimulating up to a certain maximum with increasing chain length. A similar increase was also found for aldehydes and ketones while in the series of fatty acids the relation between stimulative effect and chain length was less regular. It was further found that the partial vapor pressures for alcohols of equal stimulating power increase approximately linearly with the saturated vapor pressures. In terms of thermodynamic activities the alcohols of intermediate chain length are equally stimulating while the lower alcohols are less effective. The relationship between the different molecular parameters and the olfactory stimulative power of the studied compounds is discussed and the similarity between the results obtained in the present investigation and those in studies of olfaction in insects is pointed out. (Contractor's abstract)

833

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

ON THE KERATIN FIBRILS OF THE SKIN. AN X-RAY SMALL ANGLE SCATTERING STUDY OF THE HORNY LAYER, by G. Swanbeck. [1959] [7]p. incl. illus. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)21 and National Institutes of Health) Unclassified

Published in Jour. Ultrastruct. Research, v. 3: 51-57, Oct. 1959.

The horny layer of the skin was investigated by means of x-ray diffraction. The fibrils of the horny layer were found to be independently scattering and were therefore assumed to be irregularly arranged. Slope- and peak-analysis of the oriented scatter gives a fibril diameter of 260A. The aggregation of 7 tonofibrils into the 260A fibril of the horny layer is considered to be the main step in the keratinization process of the epidermis.

834

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

THE RELATIONSHIP OF LATERAL GENICULATE
ACTIVITY TO THE ELECTROCORTICOGRAM IN THE
PRESENCE OR ABSENCE OF THE OPTIC TRACT IN-
PUT, by G. B. Arden and U. Söderberg. [1959] [7]p.
incl. diagrs. refs. (AFOSR-TN-59-637) (AF 61(514)-
1083) AD 225484   Unclassified

Also published in Experientia, v. 15: 163-169, Apr. 15,
1959.

The hypothesis that almost all the nerve fibers afferent
to the lateral geniculate body originate in the retina is
tested by recording the activity of the body before, dur-
ing, and after increasing the intra-ocular pressure to
the point where the eye becomes ischemic. It is shown
that another afferent pathway, at least as important as
the optic tract, exists to the lateral geniculate. There
is some evidence that the body contains interneuronal
paths.

835

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

THE RELATION BETWEEN THYROID CIRCULATION,
UPTAKE OF IODINE AND SECRETION OF THYROID
HORMONE IN CATS AND RABBITS, by U. Söderberg.
[1957] [2]p. (AFOSR-TN-59-838) (AF 61(514)1083)
AD 225483   Unclassified

Also published in Acta Physiol. Scand., v. 42, suppl.
145: 1957.

Arterial and venous blood passing to and from the thy-
roid gland was measured, sampled, and analyzed for
radio-iodine by a scintillation counter in lightly anaes-
thetized cats and rabbits. It was found that the uptake
of iodine is largely proportional to blood flow through
the gland. During severe vasoconstriction, which was
produced by electrical stimulation, hypothalamic heat-
ing, bleeding the animal, nociceptive stimuli, or admin-
istration of adrenaline, noradrenaline, vasopressin or
ACTH, the A-V difference falls and increases during
large dilations. The vasodilation was elicited by heavy
doses of thyrotropic hormone or electrical stimulation.
The secretion of thyroid hormone seems to follow the
secretion or administration of thyrotropic hormone, re-
gardless of the circulation through the gland.

836

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

FAST SUPRASPINAL CONTROL OF MAMMALIAN
MUSCLE SPINDLES. EXTRA- AND INTRAFUSAL

CO-ACTIVATION, by R. Granit, O. Pompeiano, and
B. Waltman. [1959] [26]p. incl. diagrs. tables, refs.
(AFOSR-TN-59-565) (AF 61(052)115) AD 221899
                                       Unclassified

Also published in Jour. Physiol. (London), v. 147: 385-
398, Sept. 2, 1959.

The effect of supraspinal stimulation upon the dis-
charge of hindlimb spindle afferents isolated from dor-
sal roots was investigated in decerebrate or anesthetized
cats. Study was also made to determine whether spindles
discharge early enough to be activated by α fibers.

837

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

THE EARLY DISCHARGE OF MAMMALIAN MUSCLE
SPINDLES AT ONSET OF CONTRACTION, by R.
Granit, O. Pompeiano, and B. Waltman. [1959] [37]p.
incl. diagrs. refs. (AFOSR-TN-59-566) (AF 61(052)-
115) AD 221898   Unclassified

Also published in Jour. Physiol. (London), v. 147: 399-
418, Sept. 2, 1959.

Muscle spindle afferents, coming from ankle flexors
or extensors (cat) and isolated in thin dorsal root fila-
ments, discharge early in contraction to a shock to the
muscle nerve or the severed ventral root. This early
discharge was found to consist of 2 components, one
appearing in advance of visible contraction, the other
one at the foot of the contraction. The properties of
the 2 components have been analyzed in 168 spindles
and 19 tendon organs.

838

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

STUDIES OF THE PHYSIOLOGY OF DISTURBANCES
OF MOTOR CONTROL, by O. Pompeiano. Final tech-
nical rept. Sept. 30, 1959, 8p. (AFOSR-TR-59-161)
(AF 61(052)115) AD 232389; PB 146097
                                       Unclassified

The problem of the fast control of mammalian muscle
spindles was examined. Consistent afferent driving
of the discharge of hindlimb spindle afferrents isolated
from dorsal roots was obtained by supraspinal stimula-
tion. The initiation of the spindle response in each case
was closely related in time to the onset of the evoked
contraction, which accompanied afferent driving. It was
considered unlikely that spindles were excited by γ
motoneurones, but rather mediated by α motoneurones.
An early discharge, too early to be caused by γ fibers,
was also elicitable from muscle spindle afferents when
stimulating muscle nerve or ventral root. This early
discharge was found to consist of 2 components, 1

appearing in advance of visible contraction, the other, at the foot of the contraction. Study of α types of release in tension-extension diagrams from cat's forelimb extensor muscle (triceps) was made. Post-brachial section of the spinal cord, deafferentation of the contralateral forelimb and cerebellectomy produced mainly a rise of the gain constant as derived from the slope of the curve in the tension-extension diagrams during slow stretch of the muscle. These effects were present in both normal and deafferented forelimbs. However deafferentation of the forelimb in animal released from cerebellar or spinal cord ascending inhibition actually produced a considerable loss of gain, demonstrating that the afferents had activated a subliminal fringe previously sensitized by the operations releasing α neurones. (Contractor's abstract)

839

Karolinska Inst. Nobel Inst. for Neurophysiology, Stockholm (Sweden).

CHANGES IN CEREBRAL BLOOD SUPPLY CAUSED BY CHANGES IN THE PRESSURE DROP ALONG TO THE BRAIN OF THE CAT, by U. Söderberg and N. Weckman. [1959] [13]p. incl. diagrs. (AFOSR-TN-59-560) (AF 61(052)119) AD 253121   Unclassified

Also published in Experientia, v. 15: 346-348, Sept. 15, 1959.

The pressure drop in the extra- and intra-cranial portions of the arteries to the cat's brain is sometimes large enough to significantly influence the cerebral blood flow. The fall in blood pressure in the arteries varies with arterial vasomotor activity as well as with changes in blood flow both inside and outside the skull. No evidence for special vasomotor activity in the carotid rete was found. Results show that a reduction in blood flow-through 1 or 2 of these arteries cannot always be satisfactorily compensated for by increased flow in the remaining vessels. As a consequence, signs of depressed cerebral activity appear when the carotid arteries are markedly constricted.

840

Kent State U. Dept. of Physics, Ohio.

WIDE RF LEVEL RF UNIT FOR AN NMR SPECTROMETER, by K. N. Kapur and J. W. McGrath. [1959] [3]p. incl. diagrs. (AFOSR-TN-59-261) (AF 49(638)168) AD 212326   Unclassified

Also published in Rev. Sci. Instr., v. 30: 272-274, Apr. 1959.

An improved rf unit for a nuclear magnetic resonance spectrometer is described. It uses a crystal oscillator for frequency stability and positive feedback from a cathode follower to increase the effective Q of the sample rf coil. This unit provides an rf level range

of 20 μv to 60 mv with little limitation on extending the range. This allows saturation studies. The circuit is well suited to direct relaxation time measurements. (Contractor's abstract)

841

Kent State U. Dept. of Physics, Ohio.

PROTON MAGNETIC RESONANCE STUDY OF THE STRUCTURE OF POTASSIUM PENTABORATE, by A. A. Silvidi and J. W. McGrath. Apr. 1959 [4]p. incl. diagrs. table, refs. (AFOSR-TN-59-262) (AF 49(638)-168) AD 212329   Unclassified

Also published in Jour. Chem. Phys., v. 30: 1028-1031, Apr. 1959.

The proton magnetic resonance absorption spectrum of monocrystalline potassium pentaborate has been obtained experimentally at room temperature using a Pound-Watkins spectrometer. The results indicate that there are two waters of hydration/molecule. The interproton distance is $1.60 \pm 0.02A$. The p-p axes lie in the b-c plane of the crystal and make an angle of $93° \pm 4°$ with each other. Using experimental data together with consideration of interatomic distances and hydrogen bonding the remaining hydrogens are tentatively located in the molecule. (Contractor's abstract)

842

Kent State U. Dept. of Physics, Ohio.

PROTON MAGNETIC RESONANCE STUDY OF LITHIUM SULFATE MONOHYDRATE, by J. W. McGrath, A. A. Silvidi, and J. C. Carroll. [1959] [6]p. incl. diagrs. tables, refs. (AFOSR-TN-59-397) (AF 49(638)168) AD 232979   Unclassified

Also published in Jour. Chem. Phys., v. 31: 1444-1449, Dec. 1959.

An extended proton magnetic resonance study of lithium sulfate monohydrate is presented. An oddity in the resulting Pake curves appears. Some of the curves show a shift so that they are described by equations of the form, $\Delta H = 2\alpha[3 \cos^2(\Phi + \Phi_0) \cos^2 \delta - 1] + $ constant shift. There are 2 orientations of the hydrated water molecule. For these the direction angles of the proton-proton axes with respect to the crystallographic a, b, and c axes are, respectively, $\alpha_0 = 97°$, $\beta_0 = 45°$, $\gamma_0 = 48°$, and $\alpha_0 = 74°$, $\beta_0 = 38°$, $\gamma_0 = 127°$. Apparently the hydrogens bond $O_5--H-O_5-H--O_1$, where O_5 are neighboring water oxygens and O_1 is a sulfate oxygen.

Several possible origins of the shifts in the Pake curves are discussed with limited success. An adequate theoretical explanation is lacking. (Contractor's abstract)

843

Kent State U. Dept. of Physics, Ohio.

PROTON MAGNETIC RESONANCE STUDY OF THE
STRUCTURE OF BARIUM CHLORIDE DIHYDRATE,
by A. A. Silvidi and J. W. McGrath. [1959] [3]p. incl.
diagrs. tables. (AFOSR-TN-59-886) (AF 49(638)168)
AD 236392   Unclassified

Also published in Jour. Chem. Phys., v. 32: 924-926,
Mar. 1960.

The proton magnetic resonance absorption spectrum
of barium chloride dihydrate has been obtained experi-
mentally at room temperature using a Pound-Watkins
spectrometer. The results indicate that there are 4
pairs of p-p directions in the crystal. The p-p distance
and direction angles of these 4 pairs are: 1.58A, $\alpha_0 =$
90°, $\beta_0 = 58°$, $\gamma_0 = 148°$; 1.58A, $\alpha_0 = 90°$, $\beta_0 = 58°$, $\gamma_0 =$
32°; 1.59A, $\alpha_0 = 148°$, $\beta_0 = 58°$, $\gamma_0 = 90°$; 1.57A, $\alpha_0 =$
32°, $\beta_0 = 58°$, $\gamma_0 = 90°$. The experimental error for the
p-p distance is ± 0.02A and for the direction angles it
is ± 4°. By using experimental data, x-ray analysis,
and the concept of hydrogen bonding the positions of
the hydrogen atoms were determined. (Contractor's
abstract)

844

Kent State U. [Dept. of Physics] Ohio.

PROTON MAGNETIC RESONANCE STUDY OF THE
MONOHYDRATES OF POTASSIUM MERCURIC
CHLORIDE AND POTASSIUM STANNOUS CHLORIDE
[Abstract], by A. A. Silvidi and J. W. McGrath. [1959]
[1]p. (AFOSR-TN-59-1019) [AF 49(638)168]
                          Unclassified

Presented at meeting of the Amer. Phys. Soc., Kent
State U., Ohio, Oct. 16-17, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
471, Dec. 28, 1959.

A proton magnetic resonance study has been made of
the monohydrates of potassium mercuric chloride and
potassium stannous chloride using a slightly modified
Pound-Watkins spectrometer. The results for the
mercuric salt are that there are 2 orientations of the
p-p axes lying in the crystallographic ab plane and
making angles of ± 20°33' with the a axis. The average
values of both of the p-p separations are 1.59 ± 0.01A.
The results for the tin salt are that there are 2 orienta-
tions of the p-p axes lying in the crystallographic ab
plane and making angles of ± 38°10' with the a axis.
The average values of both of the p-p separations are
1.59 ± 0.01A. The method of obtaining these values
will be briefly explained. The results will be compared
with the previously published information on these
compounds.

845

Kentucky U. [Dept. of Physics] Lexington.

FIELD INDUCED SWITCHING CYCLE IN STIBNITE
(Abstract), by D. M. Mattox and L. Gildart. [1959]
[1]p. [AF 49(638)90]   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
228, Apr. 30, 1959.

A stibnite crystal containing about 2% antimony can be
made to switch repeatedly between the values of
10^4 and 10^{10} ohms purely by electrical means. Break-
down requires a voltage pulse of about a μsec duration
at fields of the order of 10^3 v/cm as has been
scribed, the crystal then having a resistance of about
10^4 ohms. Restoration of the original resistance, 10^{10}
ohms, can be accomplished by means of (a) rf voltage
pulses and (b) low-frequency voltage pulses, at fields
of about 10^3 v/cm. The time required for restoration
is about a msec. Breakdown and restoration thus con-
stitute a complete, electrically induced switching cycle,
which is indefinitely repeatable. Other Group V-Group
VI compound semiconductors have been examined, but
only stibnite containing excess antimony has been found
to possess this behavior.

Laboratolre Mèditerranèen de Recherches Thermo-
dynamlques, Nice (France).
see Mèditerranèen de Recherches Thermodynamlques,
Nice (France).

846

Laval U. Dept. of Chemistry, Quebec (Canada).

STUDY OF CHEMICAL REACTIONS IN THE ELECTRI-
CAL DISCHARGE, by P. A. Giguère. Final rept. Nov.
10, 1959 [7]p. incl. refs. (Technical rept. no. 50)
(AFOSR-TR-59-183) (AF 18(600)492) AD 229717;
PB 144905   Unclassified

The mechanism by which hydrogen peroxide vapor de-
composes upon heating has been established definitely.
Above 400°C and at low pressure the reaction proceeds
mostly in the gas phase; no long chains are involved,
and the critical energy is about 50 kcal. The thermo-
dynamlc properties of hydrogen peroxide and its "heavy"
analogue D_2O_2 have been computed for temperatures up

to 1500°C. These data will be useful in evaluating the
performance of that high-energy chemical. A new
interesting effect was discovered incidentally: traces
of hydrogen peroxide are very efficient in suppressing
explosions at the 2nd limit in mixtures of hydrogen-
oxygen. Repeated attempts by various methods have
failed to reveal the spectrum of the elusive intermediate
HO_2. The claim by Russian lnvestlgators that a super-

oxide of hydrogen H_2O_4 can be produced in large con-

centrations by bombarding condensed ozone with atomic
hydrogen was proved to be unfounded. (Contractor's
abstract)

847

Laval U. Dept. of Chemistry, Quebec (Canada).

REACTION PRODUCTS OF ATOMIC HYDROGEN
WITH SOLID OZONE, by P. A. Giguère and D. Chin.
[1959] [2]p. incl. refs. (AF 18(600)492) Unclassified

Published in Jour. Chem. Phys., v. 31: 1685-1686, Dec.
1959.

An examination of the glassy substances produced by
bombarding liquid ozone with atomic hydrogen for 5 to
200 mln is made. The data gathered tends to disprove
the claims of a group of Russlan investigators (Zhur.
Flz. Kllm., v. 30: 2580-2581, Nov. 1956; v. 31: 1843-
1850, Aug. 1957) of successfully synthesizing a super-
oxide of hydrogen H_2O_4 in high concentrations.

848

Laval U. Dept. of Physics, Quebec (Canada).

RESEARCH ON THE AUGER ELECTRONS ASSOCIATED

WITH BETA-DISINTEGRATION, by C. Geoffrion.
Final rept. Jan. 1956-Aug. 1958. Aug. 21, 1959, 49p.
incl. diagr. tables, refs. (AFOSR-TR-59-145) (AF 18-
(600)1574) AD 227941; PB 144007   Unclasslfied

The work done under this contract has accomplished
the following results. The spectrum of L-Auger elec-
trons from Tl^{206} and Bi^{212} has been studied in the
region extending from 5 to 13 kev; the energy of 37 lines
has been determined with a precision varying from 10
to 20 v. This has been realized by uslng: (a) a carefully
calibrated high resolution beta-ray spectrometer; (b)
very thin source and source backing; (c) electron ac-
celeration at the Geiger counter, to obtain full trans-
mlsslon by the counter window. The identification of
the transition corresponding to each of the measured
lines has been done with the help of a new empirical
formula for secondary lonization potential. This rule
although still emplrical - represents a definite lmprove-
ment over other emplrical formulas. A new table of 60
theoretical values for the rates of varlous K-Auger
transltions has been calculated, to replace and complete
the incorrect table published 20 years ago by L.
Plncherle and used since by many workers. From this
new table and from radiative transition rates calculated
in the same approximation, K-fluorescence yield values
have been obtained that are in better agreement with
experimental results than most of the previously pub-
lished values.

849

Lehigh U. [Dept. of Mathematics] Bethlehem, Pa.

SOME UNIQUENESS THEOREMS ON RIEMANNIAN
MANIFOLDS WITH BOUNDARY, by C.-C. Hsiung.
[Final rept.] [1959] [15]p. incl. refs. (AFOSR-TR-59-
200) [AF 49(638)215]   Unclasslfied

Also published in Illinois Jour. Math., v. 4: 526-540,
Dec. 1960.

Theorem I. Let M_n and M_n^* be 2 star manifolds, with
boundaries B_{n-1} and B_{n-1}^* respectively, in an Euclidean
space E_{n+m} for any $m > 0$. Suppose that there exists
an orientation-preserving diffeomorphism f of the mani-
fold M_n onto the manifold M_n^* such that, at each pair of
corresponding points, the manifolds M_n and M_n^* have a
common fundamental normal frame $e_{n+1} \cdots e_{n+m}$ and
equal $P_{r, n-1}$ defined by the equation $\binom{n}{\alpha} P_{r\alpha} =$
$\Sigma 1/k_{r1} \cdots 1/k_{r\alpha}$ $(1 \leq \alpha \leq n)$ and associated with each
common unit normal vector e_r, $r = n + 1, \cdots, n + m$.
If the diffeomorphism f restricted to the boundary B_{n-1}
is a translation (strictly speaking, is induced by a
translation in the space E_{n+m}) carrying the boundary

B_{n-1} onto the boundary B^*_{n-1}, then the diffeomorphism f is a translation carrying the whole manifold M_n onto the whole manifold M^*_n. Theorem II. Let M_n be a star manifold with a spherical boundary B_{n-1} such that at every point $P^\mu_{r,\,n-2} P^\nu_{r,\,n-1}$ is constant for $\mu + \nu > 0$, $\mu \geq 0$, $\nu > 0$ and for each vector e_r of a fundamental normal frame of the manifold M_n. Then the manifold M_n is a compact subset of an n-sphere. Theorem III. Let M_n and M^*_n be 2 oriented convex hypercaps with boundaries B_{n-1} and B^*_{n-1} respectively. Suppose that there exists an orientation-preserving diffeomorphism f of the hypercap M_n onto the hypercap M^*_n such that at each pair of corresponding points the hypercaps M_n and M^*_n have the same outer normal vector and satisfy either $P_1 \leq P^*_1$, $P_2 \geq P^*_2$ or $P_1 \geq P^*_1$, $P_2 \leq P^*_2$ where P_α and P^*_α are defined by the equation in theorem I for the hypercaps M_n and M^*_n respectively. If the diffeomorphism f restricted to the boundary B_{n-1} is a translation carrying the boundary B_{n-1} onto the boundary B^*_{n-1}, then the diffeomorphism f is a translation carrying the whole hypercap M_n onto the whole hypercap M^*_n. The above theorems are proved and discussed.

850

Lehigh U. Dept. of Physics, Bethlehem, Pa.

MULTIPOLE SINGULARITIES OF CLASSICAL VECTOR AND PSEUDOVECTOR FIELDS, by P. Havas. May 25, 1959, 45p. incl. refs. (AFOSR-TN-59-479) (AF 18(600)1462) AD 215732   Unclassified

Also published in Phys. Rev., v. 116: 202-217, Oct. 1, 1959.

Forms are established for the multipole moments of arbitrary order compatible with the equations of motion and also of the moments compatible with the more restrictive interactions proposed by Harish-Chandra, which include those of electrodynamics as a special case. These forms are established under the assumption that the spin of the particle is of constant magnitude and has only spatial components in the rest system, and for pure 2^n-pole moments of constant magnitude (intrinsic moments) or of variable magnitude (induced moments, acceleration-dependent forces). The results are generalized on singularities of scalar and pseudoscalar fields, which establish the general form of the intrinsic moments, to show the possibility of induced moments of all orders.

851

Leyden U. Lorentz Inst. (Netherlands).

RELATIONS BETWEEN PATH INTEGRALS AND THE VARIATIONAL PRINCIPLES OF HAMILTON, by J. Vlieger, P. Mazur, and S. R. de Groot. July 16, 1959, 7p. (AFOSR-TN-59-959) (AF 61(052)16) AD 226407; PB 146019   Unclassified

Also published in Physica, v. 25. 55-56, Jan. 1959.

Groenewold's representation for the propagation of the Schrödinger equation is shown to lead to the so-called modified Hamilton principle. (Contractor's abstract)

852

Leyden U. Lorentz Inst. (Netherlands).

ENTROPY AND GAUSSIAN-MARKOFF PROCESSES, by P. Mazur and S. R. de Groot. July 16, 1959, 15p. (AFOSR-TN-59-960) (AF 61(052)16) AD 226408; PB 146020   Unclassified

The model of Gaussian-Markoff processes is used to discuss the time behavior of entropy. The statistical definitions of entropy of Boltzmann and Gibbs are considered. Under macroscopic conditions, the same behavior as expected from non-equilibrium thermodynamics is shown to be obtained in both cases. (Contractor's abstract)

853

Library of Congress. Science and Technology Div.. Washington, D. C.

AVIATION MEDICINE: AN ANNOTATED BIBLIOGRAPHY, VOLUME 2, 1953 LITERATURE, by A. J. Jacobius, M. J. Wilkins and others. St. Paul, Aero Medical Assoc., 1959, 354p. incl. refs. (Sponsored jointly by Air Force [Office of Scientific Research] under [MIPR-680-58-8], [Defence Research Board of Canada] and [Office of Naval Research] under NAonr-31-58) AD 207740   Unclassified

This bibliography contains abstracts of 1953 literature covering the following subject areas: (1) history and general aspects of aviation medicine; (2) aviation physiology; (3) pathology and pharmacology of aviation; (4) aviation psychology; (5) preventive medicine and sanitation; (6) special problems in high altitude and space flight; and (7) miscellaneous problems such as survival, rescue, accidents, human engineering, and personnel.

Libre U., Brussels (Belgium).
see Free U. of Brussels (Belgium).

854

Liège U. (Belgium).

PROBLEMS AND METHODS IN PARTIAL DIFFER-
ENTIAL EQUATIONS. PART III. DIFFERENTIATION
OF THE FINITE PART AND OF THE LOGARITHMIC
PART OF SOME DIVERGENT INTEGRALS WITH
APPLICATIONS TO THE CAUCHY PROBLEM, by F.
J. Bureau. Oct. 1959, 89p. incl. refs. (Technical
scientific note no. 1) (AFOSR-TN-59-963) (AF 61-
(052)86) AD 232055; PB 145744   Unclassified

The following topics are discussed: (1) Derivatives of
some improper integrals; (2) Finite part and logarithmic
part of some divergent integrals; (3) The Cauchy prob-
lem for the damped wave equation; and (4) The Cauchy
problem for the equation of Euler-Poisson-Darboux.

855

Liège U. (Belgium).

ASYMPTOTIC REPRESENTATION OF THE SPECTRAL
FUNCTION OF SELF-ADJOINT ELLIPTIC OPERATORS
OF THE SECOND ORDER WITH VARIABLE COEF-
FICIENTS, by F. J. Bureau. Nov. 1959, 77p. incl. refs.
(Technical scientific note no. 2) (AFOSR-TN-59-1182)
(AF 61(052)86) AD 232050; PB 146716   Unclassified

Also published in Jour. Math. Anal. and Appl., v. 1:
423-483, 1960.

Let $L_x = a^{ij}(x) \dfrac{\partial^2}{\partial x^i \partial x^j} + b^i(x) \dfrac{\partial}{\partial x} + c(x)$, $(i, j = 1, ..., n)$ be a self-adjoint elliptic operator with ana-
lytic coefficients and $u_{tt} - L_x u = 0$ the totally hyperbolic

equation associated with L_x. The connection between

the elementary solutions of L_x and the hyperbolic equa-

tion is described. The solution of the Cauchy problem
for the hyperbolic equation is written with classical
symbols only. Then the asymptotic behavior is con-
sidered of the spectral function $\mathcal{C}(x, y; \lambda)$ of $L_x v + \lambda v = 0$, $x \in D$, and $v = 0$ on D, where λ a parameter, D
a bounded simply connected domain of R^n with boundary
D. The asymptotic behavior of $\mathcal{C}(x, x; \lambda)$ is shown to
depend only on the values of the coefficients of L_x at

the point x and is independent of the boundary conditions.
The method applies to other problems in the theory of
vibrations when the solution of the corresponding
Cauchy problem is written in a suitable form. (Con-
tractor's abstract)

856

Liège U. (Belgium).

RESEARCH IN HYPERBOLIC DIFFERENTIAL EQUA-

TIONS, by F. J. Bureau. Annual summary rept. Mar.
14, 1958-Mar. 15, 1959, 5p. (AFOSR-TR-59-82)
(AF 61(052)86)   Unclassified

A review of the research to date is briefly described.
The objectives of the investigation is 2 fold: (1) Inves-
tigate the Cauchy problem for partial differential equa-
tions of the order n greater than 2 and p greater than 2
independent variables, (2) Investigate boundary value
problems for totally hyperbolic equations in several in-
dependent variables. The differentiation of the finite
part and of the logarithmic part of some divergent in-
tegrals were studied in order to perform the synthesis
of the representation formula obtained for the Cauchy
problem. A new method was found for finding explicit
solutions for the Cauchy problem. To study the boundary
problem a preliminary study to determine the asymp-
totic behavior of the spectral function was necessary.
These results have not been published to date.

857

Liège U. Inst. of Astrophysics, Cointe-Schlessin
(Belgium).

RESEARCH ON NUCLEAR QUADRUPOLE RESONANCE
IN SOLIDS, by J. Duchesne. Final technical rept. Jan.
1959 [68]p. incl. diagrs. tables, refs. (AFOSR-TN-59-
24) (AF 61(514)1212) AD 211608; PB 139563
                                Unclassified

The research on this contract is discussed in the follow-
ing topics: Detection of pure quadrupole spectra; Nature
of chemical bonds; Resonance intensity in mixed crys-
tals; Research in radiation chemistry; Tentative interpre-
tation of radiation resistance; Post effects and oxygen
effect; Neutron-irradiated sodium chlorate; and Study
of the broadening effect of resonance lines.

858

Liège U. Inst. of Astrophysics, Cointe-Sclessin
(Belgium).

NUCLEAR QUADRUPOLE RESONANCE IN IRRADIATED
ORGANIC CRYSTALS AND IN A SEMI-CONDUCTOR,
PART I. ELECTRON SPIN RESONANCE IN CARBONA-
CEOUS ROCKS, PART II, by J. Duchesne, M. Read, and
J. Depireux. Jan. 31, 1960, 32p. incl. diagrs. tables,
refs. (Technical scientific note no. 1) (AFOSR-TN-59-
1214) (AF 61(052)167) AD 236321; PB 147112
                                Unclassified

Part I. The intensity of quadrupole lines is used as a
method for the study of the damage induced by high
energy radiation in solid matter. Thermally treated
irradiated compounds, which are thereafter re-irradiated,
are especially considered. In this connection, the origin
of radioprotection phenomena, and the behavior of the
interactions between centers perturbed by irradiation,
are studied further. Not only gamma-rays are used,
but also x-rays and neutrons. The new method is

successfully applied to a semi-conductor. Parallel use of quadrupole spectroscopy and electron spin resonance is found highly valuable. Part II. The problem of the genesis of free radicals encountered in coals, brown coals, peats and petroleum is analysed. Two hypotheses concerned with the botanical origin and the effect of natural radioactivity are put forward. Whereas the former does seem to be able to give account of the facts for peats, the latter, combined with the geothermal hypothesis, allows a general solution for this problem. (Contractor's abstract)

859

Liège U. Inst. of Experimental Therapeutics, Brussels (Belgium).

[THE SPONTANEOUS ACTIVITY OF THE CELLS OF THE CENTRAL NERVOUS SYSTEM] L'activité spontanée des cellules du système nerveux central, by J. Schlag. Brussels, Arscia, 1959, 192p. incl. diagrs. refs. (AFOSR-TN-59-839) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)22 and National Center of Anesthesiology) Unclassified

A discussion is given of some of the peculiar features, relevant to the problems of the organization, origin and fuctions of the spontaneous activity of the central nervous system. An analysis of the patterns of neuronal firing is given. It is verified that mesencephalic units discharge either regularly, randomly or in long bursts. It is shown that the regularly firing neurons are generally unresponsive, whereas irregularly firing neurons are excitable by different stimuli. The reticular formation was noted for its complete absence of neuronal bursts. The electrical stimulation of the thalamic intralaminar nuclei was found to be effective. Justification is given of a severe criticism of the commonly used notions of excitation-inhibition systems.

860

Liège U. Inst. of Experimental Therapeutics, Brussels (Belgium).

[NOTE ON THE POSSIBILITY OF CHARACTERIZING MESENCEPHALIC RETICULAR UNITS BY THEIR SPONTANEOUS ACTIVITY] Note sur la possibilité de caractériser les unités réticulées mésencéphaliques par leur activité spontanée, by J. Schlag, J. Faidherbe, and M. Deliége. [1959] [13]p. incl. diagr. tables, refs. (AFOSR-TN-59-840) (AF 61(052)22) Unclassified

Also published in Arch Internat'l. Physiol, et Biochim., v. 67: 227-239, Apr. 1959.

The spontaneous activity of mesencephalic reticular neurons is recorded with microelectrodes in cats. It is found that units, of which spontaneous discharges succeed each other regularly, are in general not responsive to mechanical or electrical peripheral stimuli or visual and auditory stimuli. This relation is estab-

lished by measuring the spike intervals in recorded samples of spontaneous activity and comparing the statistical distributions of interval values. The significant correlation between the estimation of regularity of firing and the relative responsiveness is further supported by the actual possibility to predict responsiveness or unresponsiveness by the observation of the patterns of spontaneous activity. Two interpretations are proposed and discussed. On the 1 hand, the existence of at least 2 classes of functionally or anatomically differing neurons would explain the results. But, on the other hand, it is pointed out that normal quantitative variations of neuronal excitability in the reticular population would fully account for the described observations. (Contractor's abstract)

861

Little, Arthur D., Inc., Cambridge, Mass.

A TEMPERATURE-REGULATED IGNITION SOURCE, by J. Preston and L. E. Ashman. Jan. 1, 1959, 20p. incl. diagrs. (AFOSR-TN-59-30) (AF 18(603)109) AD 209202; PB 145622 Unclassified

Since the current to maintain a wire at a constant temperature depends largely upon the environment of the wire, the current and the temperature are a means of measuring the properties of that environment. The temperature controller described here is capable of heating a fine wire--of the order of a few mils in diam-- to some temperature between 700°C and the melting temperature, and holding the temperature constant to within a few degrees. The detector is a photomultiplier that monitors radiation from the center of the wire; changes in radiation result in compensating changes in the current. The controller responds within a msec to sudden changes in the environment of the wire. This rapid response is useful for detecting the onset of ignition in reactive gases and perhaps for measuring the thermal properties of nonreactive gases. (Contractor's abstract)

862

Little, Arthur D., Inc., Cambridge, Mass.

THE IGNITION OF GASES BY HOT WIRES, by L. E. Ashman. Nov. 15, 1959, 14p. incl. refs. (AFOSR-TR-59-173) (AF 18(603)109) AD 229497 Unclassified

Results are presented of 3 yr study of the ignition of gases by hot-wire sources. The techniques developed to carry out these studies were particularly useful in clarifying much of the confusion related to ignition by small sources. The hot-wire method is useful because within the boundary layer near a hot source, heat is transferred by pure conduction; thus, the theories of Frank-Kamenetsky and Semenov are valid. The theory predicts that the ignition temperature must increase as the size of the source decreases. Anomalies appear, however, when the wire size is reduced beyond a certain point, depending on the composition of the gas. These

anomalies are apparently caused by the depletion of reactants near the surface of very small sources. Both normal and anomalous effects were observed in the studies. (Contractor's abstract)

863

Litton Industries. Space Research Labs., Beverly Hills, Calif.

RESEARCH PROGRAM ON HIGH VACUUM FRICTION, by S. Hansen. Final rept. Mar. 30, 1959 [149]p. incl. illus. diagrs, tables, refs. (Pub. no. 1023) (AFOSR-TR-59-97) (AF 49(638)343) AD 227352; PB 161116
Unclassified

The program was directed towards the study of surface friction under conditions of high vacuum (10^{-5} to 10^{-6} mm Hg.). The 1st phase dealt primarily with preparations necessary to carry out the experimental effort. The 2nd phase was devoted to the methodical examination of the friction characteristics of a large group of materials. The principal test condition studied was that of the linear motion between 2 dry, clean, unlubricated, flat surfaces. In addition to the measurement program, effort was devoted to the study of the microscopic nature of the actual surface-to-surface contacts. Examination of the results of a single sliding contact between 2 clean, machined surfaces led to the conclusion that each individual contact area was largely point-to-plane. Subsequent point-to-plane studies produced some extremely interesting results. It was found that models could be loaded to yield pressures, and under certain conditions could be made to slide with abnormally low friction forces and without microscopic evidence of wear or surface distortion. This work indicated the existence of 2 modes of contact, 1 of pure sliding and a 2nd of areas undergoing shear. The low-friction, low-wear examples appear to be special cases wherein almost all contact areas are of the 1st type. A theory of friction has been postulated, based principally on the analysis of these tests.

864

Litton Industries. Space Research Labs., Beverly Hills, Calif.

RESEARCH STUDY ON PLASMA ACCELERATION, by G. Fonda-Bonardi. Final rept. Mar. 1, 1958-Sept. 30, 1959 [64]p. incl. illus. diagrs. table, refs. (AFOSR-TR-59-170) (AF 49(638)345) AD 229998; PB 144906
Unclassified

A summary is presented of the principles of operation, design criteria, construction details and instrumentation of a pulsed plasma accelerator. The purpose of the project was twofold: to provide verification of the theory previously developed, and to supply engineering information and design data for further applications of the principles involved. Preliminary experimental results are described which appear to substantiate the theoretical

predictions. A preliminary study of an application of the plasma accelerator to high specific impulse thrust production for propulsion purposes is described. It appears that a favorable efficiency can be obtained. A bibliography on pertinent magnetohydrodynamics research and related subjects is appended. (Contractor's abstract)

865

Litton Industries. [Space Research Labs.] Beverly Hills, Calif.

ELECTROMAGNETIC ACCELERATION OF PLASMA (Abstract), by G. Fonda-Bonardi. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) [AF 49(638)-345]
Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

A description is given of the instrumentation system developed for the evaluation of the performance of the plasma accelerator. Three separate methods are used to gather complementary information: (1) photoelectric transit detection, which provides an indication of the transit of the high velocity plasmoid at selected points in the accelerator tube, as well as a measure of the light output at these points; (2) microwave doppler system, which provides detailed velocity and acceleration information and a measure of the microwave reflectivity of the plasma; and (3) ballistic target, which measures the momentum of the plasmoid, and consequently its mass.

866

Lockheed Aircraft Corp. [Missile System Div., Palo Alto, Calif.]

ANALYSIS OF A SIMPLIFIED MODEL OF SOLID PROPELLANT RESONANT BURNING, by W. Nachbar and L. Green, Jr. [1959] [9]p. incl. diagr. table. (AF 18-(603)146)
Unclassified

Published in Jour. Aero/Space Sci., v. 26: 518-526, Aug. 1959.

A model which has been proposed to describe resonant burning of solid propellants assumes burning under conditions where the burning rate is determined by the rate of heat transfer from gas at flame temperature across a thin boundary film to the propellant surface. An idealized, film-type, heat-transfer mechanism is used. It is shown that it a certain "critical" frequency is present in the frequency spectrum of gas phase oscillations in the combustion chamber, this will cause oscillations in the heat input to the propellant surface which then couple with the decomposition mechanism to cause a change in the mean burning rate. The effect is what has been termed resonant or unstable burning of the

propellant. Results which are obtained in the present paper permit calculation of this critical frequency as a function of the propellant parameters and the steady-state burning conditions. The analysis makes possible predictions of the relative effect of these parameters on the probability of encountering resonant burning, and these predictions appear at present to be in accord with experience.

867

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.

LOW-PRESSURE DEFLAGRATION LIMITS IN THE STEADY DEFLAGRATION OF AMMONIUM PER-CHLORATE PELLETS, by W. Nachbar. Sept. 1959 [21]p. incl. diagrs. tables. (Rept. no. LMSD-288168) (AFOSR-TN-59-1092) (AF 49(638)412) AD 234700
Unclassified

Recent experimental results on the deflagration of pure and catalyzed pellets of ammonium perchlorate are reviewed, and a proposed model to explain the observed low-pressure deflagration limit on the basis of radiative heat loss to the surroundings is discussed. Based upon calculations of representative estimates for the radiant energy emission from the combustion product gases of deflagration ammonium perchlorate, the radiative heat transfers from the product gases both to the surroundings and to the solid surface are calculated for several values of pressure. It is found that, in comparison with the effect of the radiative heat loss from the surface, the effect of radiative energy emission from the product gases upon the deflagration rate is probably small at the lowest pressure reported for steady deflagration. However, because product-gas radiation increases sharply in importance where the deflagration rate decreases rapidly with slowly decreasing pressure at the deflagration limit, its effects in a model for the deflagration limit cannot be neglected with certainty. (Contractor's abstract)

868

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.

RADIANT ENERGY EMISSION FROM THE EQUILIB-RATED REACTION PRODUCTS OF A PURE AMMONI-UM PERCHLORATE PELLET, by D. Olfe and S. S. Penner. Sept. 1959 [49]p. incl. diagrs. tables. (Rept. no. LMSD-288169) (AFOSR-TN-59-1094) (AF 49(638)-412) AD 235161
Unclassified

Representative estimates are made for the radiant energy emission from the combustion products formed by a burning pure ammonium perchlorate pellet. Because emission and absorption of radiation by the gases in the reaction zone are negligible, the compilations may be used to estimate radiant energy loss from the combustion products, as well as radiant heat transfer

to the burning propellant surface. The rectangular geometry chosen for the calculations is itself of no particular importance, and the results may be translated readily to other geometric configurations. (Contractor's abstract)

869

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.

ON THE ASSUMPTIONS UNDERLYING DROPLET VA-PORIZATION AND COMBUSTION THEORIES, by F. A. Williams. Nov. 1959 [33]p. incl. diagrs. refs. (Rept. no. LMSD-288098) (AFOSR-TN-59-1148) (AF 49(638)-412) AD 232688; PB 145845
Unclassified

Also published in Jour. Chem. Phys., v. 33: 133-144, July 1960.

A study is undertaken to determine the range of validity of the assumptions that (a) the liquid temperature is constant and equal to the boiling temperature for a burning droplet, (b) the instantaneous vaporization rate of a droplet at a given size is the same as that of a constant-diam sphere of the same size, and (c) the duration of the initial unsteady period is much less than the total vaporization time of a droplet. It is shown that assumption (a) may lead to observable differences between the theoretical and experimental burning rates for low-energy fuels, that for practical purposes assumption (b) is probably always valid, and that approximation (c), which is most accurate for large values of the temperature at infinity, may lead to a 20% error in the computed value of the total vaporization time. The calculated duration of the initial unsteady period compares favorably with experiments on droplet ignition delay times. (Contractor's abstract)

870

London U. Imperial Coll [of Science and Tech.] (Gt. Brit.).

[THERMODYNAMICS OF MOLTEN ALLOYS], by L.-L. Cheng. Final rept. Jan. 1, 1957-Dec. 31, 1958. Apr. 1959 [71]p. incl. diagrs. tables, refs. (Rept. no. 8) (AFOSR-TR-59-69) (AF 61(514)1179) AD 217816
Unclassified

Dilute solution of S in liquid Sn and Pb: By the use of radio-sulphur, the H_2S gas/liquid equilibrium reactions of Sn-S and Pb-S systems were measured at a low temperature, and a radiochemical method of analysis was developed for determining the S content in metal beads which were equilibrated with H_2S/H_2 mixture of known S potential. Based on 1 at.-% S in liquid Sn or Pb as the standard state, the free energy change for the reaction $[S]_{Sn} = 1/2 S_2$, was $\Delta G° = 24, 940 - 5.11$ T cal (500° to 680°C); $\Delta G° = 23, 140 - 4.59$ T cal for reaction $[S]_{Pb} = 1/2$. The thermodynamic behavior of S in liquid Sn and Pb

at 600°C conformed with Henry's law below 0.44 and 0.38 at.-% S, respectively. Sn-Cu-S, Sn-Ag-S, Sn-Pb-S, and Cu-Ag-S systems: The effect of alloying elements on the activity coefficient of S in liquid metallic solution was studied. Ag additions to liquid Sn increased log D_S (distribution ratio) almost linearly up to about 40 at.-% Ag. At 66.5 at.-% Ag, the activity coefficient of S was increased to 40 times greater than it would be in pure liquid Sn. In the Sn-Cu-S system, Cu additions to liquid Sn decreased the activity coefficient of S instead of increasing it. The addition of Pb to liquid Sn did not decrease or increase the free electron/atom ratio. Three sets of measurements were made for Cu-Ag-S alloy studies at 1085°C. A small quantity of Cu-radio-sulphide was used as the S source to supply the equilibrium H_2S gas and the equilibrium S content of the condensed phases.

Lorentz Inst. Leyden (Netherlands).
see Leyden U. Lorentz Inst. (Netherlands).

871

Louvain U. Lab. for Inorganic [and Analytical] Chemistry, Brussels (Belgium).

KINETICAL PARAMETERS IN PREMIXED LAMINAR FLAMES, by A. Van Tiggelen, R. Corbeels, and H. Vandenabeele. Feb. 1960, 43p. incl. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-59-1149) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1245 and Fonds National de la Recherche Scientifique (Belgium)) AD 234580; PB 146640
Unclassified

Activation energy and reaction order in CH_4-O flames: Experimental burning velocities, obtained at different fuel-to-O ratios, dilutions with N, and initial temperatures of the fresh gases, are almost perfectly represented by a formula where the classical kinetic parameters of a chemical reaction are present (activation energy (38 kcal) and reaction order with respect to O (1.4), and to CH_4(-0.4)). The empirical formula corresponds exactly to the theory with a chain mechanism including the formation of a peroxide radical (CH_3O_2).

Reaction order in acetylene -O flames: The activation energy obtained was 31 kcal. The reaction order with respect to O varies between 2 and 0.8 and between -1 and 0.2 with respect to acetylene; the sum of both orders was always equal to unity and the negative value with respect to acetylene was valid at the rich side. A chain reaction with the formation of a peroxide must also occur in acetylene-O flames. Flame propagation velocity: CH_4-H-O mixtures: Burning velocities and flame temperatures in stoichiometric ternary CH_4-H-O mixtures at different dilutions with N were measured. These mixtures seem to correspond to a case of weak interaction between the 2 separate reactions. The ac-

tivation energy is about equal to the value given by a linear interpolation between the 2 extreme values (18 kcal for pure H and 38 for pure CH_4).

872

Louvain U. Lab. for Inorganic [and Analytical] Chemistry, Brussels (Belgium).

DETERMINATION OF ACTIVATION ENERGY AND REACTION ORDER IN PREMIXED LAMINAR FLAMES, by A. Van Tiggelen, P. J. Slootmaekers and others. Technical summary rept. Feb. 1959, 63p. incl. diagrs. tables, refs. (AFOSR-TR-59-36) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1245 and Fonds National de la Recherche Scientifique (Belgium)) AD 213039; PB 140778
Unclassified

Theoretical introduction: The theoretical basis, for the determination of the activation energy and of the reaction order with respect to fuel and oxidant from experimental data on burning velocities, is discussed. The theory is based on the branching condition in the flame front. Flame propagation in hydrazine mixtures: Measurements of flame propagation, temperature and flame front thickness in N_2H_4/O_2/A are reported. These data are compared with literature data on N_2H_4 decomposition flames. A general formula is given for the burning velocity in all kinds of N_2H_4 mixtures. Fluorine and chlorine flames: Flame propagation velocities are reported for fluorine mixtures with H_2, CO and CH_4. Flame temperatures are calculated and used for the determination of activation energies in these flames. A comparison is made with H_2/Cl_2 flames. Comparative study of flame propagation in nitrocompound mixtures: The properties of flames in CH_3NO_2/O_2, CH_3ONO/O_2 and $CH_4/NO_2/O_2$ mixtures in the presence of N_2 are compared. A different behavior is found between lean and rich mixtures. Influence on preheating on burning velocities: Some preliminary and fragmentary results are given concerning the influence of preheating on burning velocities.

873

Louvain U. Lab. for Inorganic [and Analytical] Chemistry, Brussels (Belgium).

COMPARATIVE STUDY OF FLAME PROPAGATION IN COMPOUNDS CONTAINING NITROGEN OXIDES, by S. De Jaegere and A. Van Tiggelen. [1959] [14]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1245 and Fonds National de la Recherche Scientifique (Belgium))
Unclassified

Published in Combustion and Flame, v. 3: 187-200, June 1959.

Flame propagation velocities and temperatures have been measured in methyl nitrite, nitromethane and methane-nitrogen dioxide mixtures with oxygen. Mixtures of methyl nitrite or methane plus nitrogen dioxide with sufficient oxygen behave like more classical fuel-oxidant mixtures. Activation energies and reaction orders with respect to fuel and oxidant have been derived. Very rich methyl nitrite-oxygen flames are to be compared with pure methyl nitrite decomposition flames: their burning velocities are abnormally low. Nitromethane-oxygen flames are characterized by a low activation, but are much slower than what might be expected from the theory.

874

Louvain U. Lab. for Inorganic and Analytical Chemistry, Brussels (Belgium).

FLAME PROPAGATION VELOCITY METHANE-HYDROGEN-OXYGEN MIXTURES, by R. Corbeels and A. Van Tiggelen. [1959] [7]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1245 and Fonds National de la Recherche Scientifique (Belgium))   Unclassified

Published in Bull. Soc. Chim. Belg., v. 68: 613-619, Nov.-Dec. 1959.

Flame propagation velocities and temperature in composite stoichiometric mixtures $H_2/CH_4/O_2$ at different compositions and dilution have been investigated. The experimental results show a weak interaction in the sense of a weak inhibition of hydrogen combustion by methane and a weak promotion of the methane combustion by hydrogen. The activation energy of the branching process in these composite mixtures lies between the values derived from experiments on the separate binary mixtures H_2/O_2 and CH_4/O_2. (Contractor's abstract)

875

Louvain U. [Lab. for Inorganic and Analytical Chemistry] Brussels (Belgium).

ACTIVATION ENERGY AND REACTION ORDER IN METHANE-OXYGEN FLAMES, by H. Vandenabeele, R. Corbeels, and A. Van Tiggelen. [1959] [8]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1245 and Fonds National de la Recherche Scientifique (Belgium))
                              Unclassified

Published in Combustion and Flame, v. 4: 253-260, Sept. 1960.

Flame propagation velocities and temperatures have

been measured in preheated and unpreheated methane-oxygen mixtures at different mixture strengths and varying dilutions with nitrogen. An activation energy of 38 kcal can be derived from these measurements. The order of the reaction with respect to oxygen is 1·4 and with respect to methane, -0·4. These parameters (orders and activation energy) are ascribed to the branching process. The reaction mechanism is discussed.

876

Louvain U. Lab. of Biophysics, Brussels (Belgium).

THE EXPERIMENTAL APPROACH TO PAIN, by A. E. McKenna. May 15, 1958 [37]p. incl. diagr. tables, refs. (Technical note no. 1) (AFOSR-TN-59-122) (AF 61(514)1101) AD 210427   Unclassified

Also published in Jour. Appl. Physiol., v. 13: 449-456, Nov. 1958.

A modification of the Hardy-Wolff-Goodell method of stimulation by thermal radiation was used in an experimental approach to pain. Thresholds of pain sensation were obtained in the usual manner, but response was measured, not only by the judgment of subjects, but by the reactions in a group of physiological variables as well; these included EEG, EKG, PGR and change in respiration. The threshold values obtained in terms of skin temperatures at stimulus site after irradiation were considerably higher (47.3-48.6°C) than those reported in previous investigations. Differences in threshold skin temperatures at different exposure times imply that the determinant for the sensation is not a critical temperature at skin surface, but is either a critical temperature at receptor level or a temperature difference between receptor level and deeper fibers. Questioning of the subjects revealed that the particular sensation experienced at the pain threshold was not painful for the large majority. Consequently, results obtained in threshold investigation can have no applicability to the human pain problem in real life. (Contractor's abstract)

877

Louvain U. Lab. of Biophysics, Brussels (Belgium).

PSYCHOGALVANIC RESPONSE AS A PAIN REACTION COMPONENT, by A. E. McKenna. [1959] [6]p. incl. diagrs. (AFOSR-TN-59-469) [AF 61(514)1101] AD 244808   Unclassified

Also published in Jour. Appl. Physiol., v. 14: 881-886, Nov. 1959.

Psychogalvanic responses (PGR) were measured in human subjects as responses to cutaneous stimulation by thermal radiation. There were 37 subjects of both sexes, aged 18-40 yr, and there were 2054 presentations. An apparatus for recording PGR on an EEG tracing is described. Based on physical intensity of stimulus

there is a complete overlap of pain-nonpain categories – from 35° to 55°C end temperature in irradiated skin. Plotting magnitude of PGR against physical intensity of stimulus for pain and nonpain categories reveals that the intensity of reaction in pain is not determined by physical intensity of stimulus. When the magnitude of reaction is compared as between pain and nonpain responses on the basis of the same stimulus intensities, it is found to be greater for pain to a highly significant extent; on the same basis, duration of response is longer for pain, but not at a high level of significance. The PGR is shown to be an accurate discriminator of the subjective pain sensation threshold. When electro-cortical reactions are compared to electrodermal reactions, both are found to be triggered in a consistent manner by the common stimulus, the consistency being reduced when the subject judges the stimulus painful. The effects of habituation are examined and shown not to be causal to results. Implications of the findings for the pain experience in the true life situation are discussed. (Contractor's abstract)

878

Louvain U. [Lab. of Chemical Physics] Brussels (Belgium).

STUDIES ON THE MECHANISM OI ELECTROLUMI-NESCENCE, by A. Luyckx, J. Vandewauwer and others. Final technical rept. Nov. 15, 1956–Nov. 14, 1958, 58p. incl. diagrs. tables. (AFOSR-TR-59-12) (AF 61(514)-1118) AD 210472; PB 139585   Unclassified

Electroluminescence of single crystals at variable frequency was studied. Zinc sulfide powder was activated by Cu, Cl, or Cu, Cl and Pb to form electroluminescent ZnS powders. The crystals were grown by sublimination of electroluminescent ZnS powder at a temperature between 1150° and 1220°C in an atmosphere containing a mixture of H_2S and H (50% of each) at a

pressure of 15 cm Hg measured at room temperature. Recrystallization occurs in a colder region of the quartz tube used as distillation apparatus. These crystals had to be activated by heating the crystal in an electroluminescent ZnS powder in which a drag of deliquescent $ZnCl_2$ was mixed. Distinctions were made between

ohmic and capacitive crystals at variable frequency. The 2 types of crystals behave differently in regard to light output, impedance and oscillograms of current and fields. These features were studied separately for each type of crystal. For all capacitive crystals, at each voltage, light output remained unvariable above a certain frequency, although current increased with frequency. For ohmic crystals, light increases with frequency. The evolution of crystals from ohmic type to capacitive type occurred when a dc field was imposed during a certain time.

879

Lund U. Dept. of Pharmacology (Sweden).

THE 'DESENSITIZING' EFFECT OF ACETYLCHOLINE ON THE MAMMALIAN MOTOR END-PLATE, by J. Axelsson and S. Thesleff. [1959] [12]p. incl. diagrs. tables. (Technical scientific note no. 1) (AFOSR-TN-59-299) (AF 61(052)103) AD 213083   Unclassified

Also published in Acta Physiol. Scand., v. 43: 15-26, 1958.

A micro-application technique was used to study the receptor desensitization which acetylcholine produces at the mammalian motor end-plate. In all the investigated muscles a steady release of acetylcholine produced a loss of sensitivity in the end-plate membrane. The results suggest that the concentrations of acetylcholine which produce desensitization are in certain mammalian muscles within the range of concentrations normally produced at the end-plate by a motor-nerve impulse and that consequently desensitization may develop during repetitive motor nerve stimulation. (Contractor's abstract)

880

Lund U. Dept. of Pharmacology (Sweden).

A STUDY OF THE INTERACTION BETWEEN NEURO-MUSCULAR BLOCKING AGENTS AND ACETYLCHO-LINE AT THE MAMMALIAN MOTOR END-PLATE, by S. Thesleff. [1959] [11]p. incl. diagrs. refs. (Technical scientific note no. 2) (AFOSR-TN-59-300) (AF 61-(052)106) AD 213084   Unclassified

Also published in Acta Anaesth. Scand., v. 2: 69-79, 1958.

Ionophoretic micro-application of drugs and intracellular electrodes were used to study the effects of neuro-muscular blocking drugs on the motor end-plate of single mammalian muscle fibers. The results obtained with d-tubocurarine and gallamine are compatible with the belief that these drugs block neuromuscular transmission by competing with acetylcholine for end-plate receptors. Decamethonium and succinylcholine on the other hand produce a neuromuscular block by end-plate depolarization as well as by non-competitive receptor desensitization. (Contractor's abstract)

881

Lund U. Dept. of Pharmacology (Sweden).

A STUDY OF SUPERSENSITIVITY IN DENERVATED MAMMALIAN SKELETAL MUSCLE, by S. Thesleff and J. Axelsson. Sept. 15, 1959 [19]p. incl. diagrs. refs. (Technical scientific note no. 3) (AFOSR-TN-59-1189) (AF 61(052)106) AD 234149   Unclassified

Also published in Jour. Physiol., v. 147: 178-193, June 23, 1959.

The sensitivity to acetylcholine of chronically denervated mammalian skeletal muscle was studied by ionophoretic micro-applicticn of the agent to single muscle fibers. In an innervated muscle acetylcholine produces membrane depolarization only when applied to the small and limited end-plate region of a fiber. In a denervated muscle, however, the entire muscle membrane becomes sensitive to acetylcholine. One to two wk after denervation the whole surface of the muscle is about as sensitive to acetylcholine as the end-plate region which has maintained its original responsiveness to the drug. The muscle is uniformly sensitive to acetylcholine which wherever applied to the membrane produces a depolarization of a similar magnitude and time course as when applied to the end-plate region of an innervated muscle. It is concluded that the increase in the size of the receptor area, following denervtion, accounts for the hypersensitivity of denervated muscles to acetylcholine and also explain the contracture produced in denervated mammalian muscles of depolarizing drugs. (Contractor's abstract)

882

Lund U. Dept. of Pharmacology (Sweden).

BRAIN CATECHOL AMINE CONTENT AFTER SEC-TIONING THE ADRENERGIC NERVES TO THE BRAIN VESSELS, by A. Bertler and E. Rosengren. [1959] [3]p. incl. table. (AFOSR-609) (AF 61(052)106) AD 255296   Unclassified

Also published in Acta Physiol. Scand., v. 47: 362-364, 1959.

The catechol amine content of rat brains after extirpation of the superiol cervical ganglia was investigated, and the values compared to those obtained from a sham-operated group of animals. There was no difference between the 2 groups, suggesting that sympatho-adrenergic nerves do not significantly contribute to the brain catechol amine content in rats. (Contractor's abstract)

883

Lund. U. Thermochemistry Lab. (Sweden).

EXPLORATORY STUDIES ON THE PHOTOLYSIS OF DISULFIDES IN AN ORGANIC MATRIX AT 77°K, by K. Rosengren, S. Sunner, and D. Timm. Aug. 1, 1959 [14]p. incl. diagrs. (Technical note no. 2) (AFOSR-TN-59-572) (AF 61(052)46) AD 230183; PB 145677
Unclassified

In an exploratory investigation aiming at the determination of "bond formation" energies by measuring the heat effect accompanying the recombination of radicals trapped in an organic matrix at 77°K, the photolysis of disulfides has been studied. It was found that disul-

fides were easily photolyzed, that the disappearance of the disulfide could be quantitatively followed by UV spectrophotometry, that during photolysis a new, unstable absorption band appeared at 232 mμ which preliminarily was assigned to the thiyl radical, that the primary reaction product did react with the hydrocarbons used for the formation of matrices and that the matrices investigated at 77°K are too close to (or already within) the premelting region. (Contractor's abstract)

884

Lund U. Thermochemistry Lab. (Sweden).

EQUILIBRIUM STUDIES ON THE DISPROPORTIONA-TION REACTION BETWEEN SOME DIALKYL DISUL-FIDES, by L. Haraldsson, C. J. Olander and others. May 1, 1960, 8p. incl. tables. (Technical note no. 3) (AFOSR-TN-59-573) (AF 61(052)46) AD 244327; PB 152478   Unclassified

The disproportionation equilibrium between 2 symmetric disulfides and the corresponding mixed 1 has been determined at 25° and at 60° by use of vapor phase chromatographic technique. For diethyl disulfide in mixture with dimethyl- and di-iso-propyl disulfide, respectively, the equilibrium constant is close to the statistically expected value, 4. For the pair diethyl- and di-tert-butyl disulfide, the constant is 24. Within the uncertainty of the experiments, the equilibrium constant is temperature independent and thus ΔH is equal to zero. The strongly restricted internal rotation in di-tert-butyl disulfide is responsible for the high value of the equilibrium constant. (Contractor's abstract)

885

Lund U. Thermochemistry Lab. (Sweden).

EQUILIBRIUM STUDIES ON DISULFIDES PHASE CHRO-MATOGRAPHY, by C. J. Olander and S. Sunner. June 1, 1959, 5p. incl. table. (Technical note no. 1) (AFOSR-TN-59-731) (AF 61(052)46) AD 219421; PB 145610
Unclassified

Some general aspects are given on the use of vapor phase chromatographic technique for the determination of equilibrium constants. The usefulness has been demonstrated for the disproportionation reaction between dimethyl and diethyl disulfide. (Contractor's abstract)

Lyman Lab. of Physics, Cambridge, Mass.
see Harvard U. Lyman Lab. of Physics, Cambridge, Mass.

886

Lyons U. Dept. of Physiology (France).

SUBCORTICAL PHOTICALLY AND SOMESTHETICALLY

EVOKED ELECTRIC ACTIVITY IN THE HUMAN
BRAIN DURING ATTENTION, by M. Jouvet and H.
Hermann. [1959] 10p. (AFOSR-TN-59-697) (AF 61-
(514)1206) AD 219392   Unclassified

Presented at Thirtieth annual meeting of the Aero Med.
Assoc., Los Angeles, Calif., Apr. 27-29, 1959.

Abstract published in Aerospace Med., v. 30: 190, Mar.
1959.

Stereotaxically oriented recording electrodes have been
introduced at the subcortical level of the visual system
or at the thalamic level of the somesthetic system in
conscious human subjects. Evoked responses to photic
stimuli or tactile stimuli are enhanced when the pa-
tient pays attention to them. These responses dir·t·.ih
greatly when the patient pays attention to another mo-
dality of stimuli. In patients with disturbances of con-
sciousness (confused or comatous state) responses do
not show any variation. These results are in agreement
with experiments on animals. It may be concluded that
some facilitatory mechanism acts during attention in
order to enhance afferent significant responses to the
cortex and block other nonsignificant stimuli. Cortex
and reticular formation of the brain stem may play a
foremost role in this system. (Contractor's abstract)

887

Lyons U. Dept. of Physiology (France).

NEUROPHYSIOLOGICAL MECHANISMS OF LEARNING,
by M. Jouvet. Final technical rept. Jan. 1, 1957-Dec.
31, 1958. June 1959, 35p. incl. diagrs. refs. (AF 61-
(514)1206) AD 218359; PB 142308   Unclassified

Results obtained from experiments on 50 chronic cats
show that habituation of the arousal reaction cannot be
explained by a functional deafferentation of the activating
reticular system. The main problem to investigate was
the process of falling asleep. Investigations were direc-
ted to calculate what inhibitory mechanisms would act
upon the activating ascending system. It was found that
during physiological sleep, slow waves are recorded
from cortex, diencephalon, and mesencephalon, in nor-
mal cats, subtotally decorticated cats, or cats with sub-
total section of the brain stem. However, there was no
slow wave evidence during sleep in the diencephalon or
the mesencephalon of totally decorticated cats and no
slow waves in the mesencephalon in mesencephalic cats.
These results show that a diffuse inhibitory system in
which the cortex plays a foremost role acts upon the
reticular formation during physiological sleep in nor-
mal cats.

888

McMaster U. Hamilton Coll., Ont. (Canada).

SOME NEW ATOMIC MASS DETERMINATIONS MADE
WITH A LARGE SINGLE-FOCUSING MASS SPEC-
TROMETER, by J. T. Kerr, G. R. Bainbridge and
others. Jan. 1, 1959, 9p. incl. diagrs. tables, refs.
(AFOSR-TN-59-618) (AF 49(638)247) AD 238215
Unclassified

Also published in Proc. Conf. on Advances in Mass
Spectrometry, London U. (Gt. Brit.) (Sept. 24-26, 1958),
New York, Pergamon Press, 1959, p. 1-9.

A large semi-circular magnetic analyzer with a re-
solving power (at the base of the peaks) of ~9000 has
been used to determine the atomic masses of
Kr^{84}, Kr^{86}, Xe^{129}, Xe^{132}, Hg^{200}, Hg^{201} and Hg^{204} to
a precision of ~1/2,000,000. In this work the necessa-
ry doublet spacings were determined by a beam modu-
lation technique. This technique and certain other de-
tails of the apparatus are described.

889

Madrid U. Dept. of Crystallography (Spain).

STUDIES OF THERMAL MOTION IN CRYSTALS, by
J. L. Amorós. Final technical rept. Dec. 15, 1956-
Dec. 14, 1958, 70p. incl. illus. diagrs. refs. (AFOSR-
TR-59-47) (AF 61(514)1146) AD 215061
Unclassified

A systematic survey of thermal continuous diffuse scat-
tering has been done in chain crystals and a scheme of
the dynamics of such molecular crystals have been ad-
vanced. The atomic vibrations in such crystals have
been studied by a direct way, and some relations be-
tween thermal expansion, polymorphism and thermal
diffuse scattering have been studied in crystals such as
oxalic acid dihydrate and α-succinic acid. The interpre-
tation of x-ray thermal (continuous) diffuse scattering
has been accomplished in terms of a new function: the
"difference Fourier transform" (DFT) of the molecules
and a full record of such thermal diffuse scattering has
been obtained for hexamine, naphthalene and anthracene.
DFT gives good agreement with experiment showing
that the main contribution to continuous diffuse scatter-
ing is that of the independent movement of the molecules
in the crystal. (Contractor's abstract)

890

[Madrid U. Instituto de Calculo (Spain)]

SEMI-ANALYTICAL FUNCTIONS IN CONVEX RE-
GIONS, by R. San Juan Llosá. [1959] 357p. incl. refs.
(AFOSR-TR-59-60) [AF 61(514)1254] AD 216625;
PB 145097
Unclassified

A study is presented of the relations between convex
plan sets and convex curves, i.e., the graphics of con-
vex continuous functions. The convex functions are
always upper bounded in every finite interval, which be-
comes equivalent to its continuity. Unbounded convex
sets, which are not as widely studied as bounded sets,
are mainly considered. The conclusions are established
for convex functions, but they are also valid for concave
functions. (Contractor's abstract)

Mallinckrodt Chemical Lab., Cambridge, Mass.
see Harvard U. Mallinckrodt Chemical Lab.,
Cambridge, Mass.

891

[Marey Inst., Paris (France).]

[DUALITY OF RESPONSES OF CELLS OF THE MEDI-
AN CENTER OF THE THALAMUS TO NATURAL OR
ELECTRICAL STIMULI] Dualité des réponses des
cellules du centre médian du thalamus á des stimula-
tions naturelles ou électriques, by D. Albe-Fessard
and M. L. Kruger. [1959] [3]p. incl. illus. (AFOSR-
TN-59-541) (AF 61(052)103) Unclassified

Also published in Compt. Rend. Séances Acad. Sci.,
v. 248: 299-301, Jan. 12, 1959.

Electrical stimuli or natural stimuli in the form of
abrupt pressure by means of a percussion instrument
or needle-point applied on the cornea, periosteum,
skin, and joint sheaths in almost all parts of the body
of the cat evoked responses of the cells of the median
center of the thalamus. 186 units in 8 cats were ex-
amined; 15 of them were active. 55 units showed
responses of short latency (19.5 and 24.3 msec for an-
terior and posterior limbs, respectively), correspond-
ing to a conduction rate of 50 msec. The responses of
58 other units showed long latency (av 625 msec), cor-
responding to a rate of 10 msec. It is concluded that
the fact of slow conduction may correspond to some
form of pain sensitivity connected with spino-thalamic
pathways.

892

[Marey Inst., Paris (France).]

[STUDY OF VISUAL AND AUDITORY "ASSOCIATION"
SYSTEMS IN THE CAT UNDER CHLORALOSE ANES-
THESIA] Etude des Systèmes "Associatifs" Visuel et
Auditifs chex le Chat Anesthésié au Chloralose, by P.
Buser, P. Borenstein, and J. Bruner. [1959] [20]p. incl.
illus. diagrs. table, refs. (AFOSR-TN-59-786) (AF 61-
(052)103) AD 227805 Unclassified

Published in Electroencephalog. and Clin. Neurophysiol.,
v. 11: 305-324, 1959.

In cats deeply anesthetized with chloralose, cortical

responses to visual or auditory stimulations can be observed in the suprasylvian and lateral anterior gyri. These cortical "association" responses as well as the subcortical pathways upon which they depend were the object of this study.. The significance of the results obtained, especially the fact that experimentation under deep chloralose anesthesia permits specific association systems to be identified, is discussed.

893

[Marey Inst., Paris (France)]

[DIFFERENTIAL CHARACTERISTICS OF RESPONSES TO SENSORY STIMULATION OF PARTS OF THE RED NUCLEUS] Caractéristiques différentielles des réponses aux stimulations sensorielles des deux parties du noyau rouge, by J. Massion and D. Albe-Fessard. [1959] [3]p. incl. illus. (AFOSR-TN-59-1010) [AF 61(052)103]
                                                          Unclassified

Also published in Compt. Rend. Séances Acad. Sci., v. 248: 3747-3749, June 29, 1959.

The area of the red nucleus of the anesthetized cat is shown to respond to various stimulations. With the aid of microelectrodes, the red nucleus was studied systematically and 3 modes of response were noted: (1) a short response with short latency, (2) the same response followed by an unexpected influx, (3) a short response sometimes repeated and followed then after a longer period by a rapid influx. These types of responding cells were located and their percentage tabulated.

894

[Marey Inst., Paris (France)]

[ROLE OF CEREBELLAR RELAYS IN THE ACTIVATION OF THE PACEMAKER OF LARGE NEURONS OF THE RED NUCLEUS] Role de relais du cervelet dans l'activation d'origine sensitive des neurones magnocellulaires du noyau rouge, by D. Albe-Fessard and J. Massion. [1959] [3]p. incl. illus. (AFOSR-TN-59-1011) [AF 61(052)103]   Unclassified

Also published in Compt. Rend. Séances Acad. Sci., v. 249: 315-317, July 15, 1959.

The 3 responses noted in the red nucleus are examined and several hypothesis are put forth to account for them. The one which is particularly treated here states that the influx afferents connect with the cells of the posterior red nucleus by indirect as well as direct pathways. This allows a relay to be established from other parts of the cerebral structures. Experiments are described on partial and complete decerebration and decerebellation. This helps establish the pathway involved. The inhibition mechanism is also discussed.

895

[Marey Inst., Paris (France)]

[DUALITY OF OBSERVED RESPONSES IN THE CENTRAL MEDIAN AT THE TIME OF SOMATIC STIMULATIONS. TYPES OF AFFERENCES AND SPINAL TRACTS] Dualité des réponses observées dans le centre médian lors de stimulations somatiques. Types d'afférences et voies spinales, by [M.] L. Kruger and D. Albe-Fessard. [1959] [1]p. (AFOSR-TN-59-1012) [AF 61(052)103]   Unclassified

Also published in Jour. Physiol. (Paris), v. 51: 501-502, June 1959.

The thalamic regions were examined from a histological point of view. The structures are identified where response corresponds to morphological regions, such as the reticular nucleus and the central and parafascicular nuclei. The last 2 are reported on here. The cells in these areas respond to both artificial stimulation (pressure) and natural stimulation (electrodes). There are reportedly 3 types of responses: (1) those which respond with a short latency only, (2) those which respond with a long latency, (3) those which respond with a short and then long latency.

896

[Marey Inst., Paris (France).]

[MACRO- AND MICRO-PHYSIOLOGICAL STUDY ON THE EVOKED RESPONSES OF THE RED NUCLEUS CAUSED BY SENSORY STIMULATION] Etude macro- et micro-physiologique des réponses évoquées dans le noyau rouge par des stimulations sensitivo-sensorielles, by D. Albe-Fessard and J. Massion. [1959] [2]p. (AFOSR-TN-59-1013) [AF 61(052)103]   Unclassified

Also published in Jour. Physiol. (Paris), v. 51: 385, June 1959.

The inhibition mechanism of the responses found in the cells of the red nucleus is discussed. By ablation and stimulation the area of inhibition is sought along with its pathway. Two distinct paths are found to have access to the red nucleus.

897

[Marey Inst., Paris (France)]

[POSSIBILITY OF A TRANSFER OF POST-TETANIC FACILITATION IN A DISYNAPTIC CHAIN] Possibilité d'un transfert de la facilitation post-tétanique dans une chaîne disynaptique, by [D.] Albe-Fessard and T. Szabo. [1959] [2]p. (AFOSR-TN-59-1135) (AF 61(052)103)
                                                          Unclassified

Also published in Jour. Physiol (Paris), v. 51: 465-466, June 1959.

The conditions for transfer of the post-tetanic facilitation which occurs in monosynaptic transmission caused by a repetitive stimulus of sufficient frequency are discussed. It is thought that the post-tetanic potentiation (P.T.P.) must play a vital role in the phenomenon. It had been established that 2 neurons, A and B, converging on a common neuron, C, was essential for occurrence. This allows for auto-activation to occur. It is thought that neuron C receives the potentiation from both B and A neurons which are capable of recruiting the larger D neurons. This results in prolonging the effect on C. This fits well with the disynaptic structure which is already known. Electrode investigations show that the amplitude of the action potential is important for recruitment. It is also shown that various explanations can be reached by application of this principle to other parts of the central nervous system.

898

Maryland U. Dept. of Physics, College Park.

GEOPHYSICAL EFFECTS OF SOLAR CORPUSCULAR RADIATION, by S. F. Singer. [1959] [5]p. incl. refs. (AFOSR-TN-59-163) (AF 18(600)1038) AD 211142
Unclassified

Also published in Ann. Geophys., v. 14: 433-437, Oct.-Dec. 1958.

Magnetic storms, aurorae and cosmic ray variations are explained from a unified theoretical point of view. The sudden commencement of magnetic storms seems to be due to ionospheric currents initiated by solar corpuscular radiation. The main phase of storms is explained in terms of an extra terrestrial ring current set up by the drifting motion of trapped solar particles. These trapped particles are also accelerated to high enough energies to cause aurora; the acceleration proceeds mainly by Fermi collisions with magnetohydrodynamic waves (which give rise to geomagnetic micropulsations). Decreases in cosmic ray intensity which accompany magnetic storms are produced by a diffusive deceleration process in interplanetary space. (Contractor's abstract)

899

Maryland U. Dept. of Physics, College Park.

SUMMARY OF RESULTS OF RESEARCH STUDY. [1959] [18]p. incl. refs. (AFOSR-TN-59-168) (AF 18-(600)1038) AD 211147; PB 139992   Unclassified

During the performance of this contract, a great deal of theoretical work was done on various aspects of cosmic rays and auroral particles. A number of papers are cited which came out under this contract relating to scientific problems of earth satellites. A major review article on research in interplanetary physics was written by the project director and is summarized in an appendix which is included. Regard-

ing the experimental work done under this contract, the objectives, the design of the experimentation, the design of the apparatus used, and the results are all outlined.

900

Maryland U. Dept. of Physics, College Park.

ROLE OF RINGCURRENT IN MAGNETIC STORMS (Abstract), by S. F. Singer. [1958] [1]p. (AFOSR-TN-59-239) [AF 18(600)1038]   Unclassified

Also published in Trans. Amer. Geophys. Union, v. 39: 532, June 1958.

E. N. Parker has thrown doubt on the existence of this ringcurrent. He concludes: (1) Even if it exists, the effects of the ringcurrent cannot be felt on Earth and therefore cannot give rise to magnetic storms because of the high conductivity of the Earth's outer atmosphere. (2) The main phase of magnetic storms can be explained in terms of an ionospheric current system. In the present analysis of the problem of the origin of magnetic storms conclusions were reached which are directly opposite to those of Parker's. The main difference seems to be that the effect of a magnetic field on the anisotropic conductivity is considered, a physical mechanism (trapped protons drifting in the Earth's field) which produces an equatorial ringcurrent at a distance of five to ten Earth-radii was investigated. (Contractor's abstract)

901

Maryland U. [Dept. of Physics] College Park.

TRAPPED ORBITS IN THE EARTH'S DIPOLE FIELD (Abstract), by S. F. Singer. [1959] [2]p. (AFOSR-TN-59-240) [AF 18(600)1038]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-28, 1956.

Also published in Bull. Amer. Phys. Soc., Series II, v. 1: 229, Apr. 26, 1956.

See item no. MDU.03:016, Vol. I for abstract.

902

Maryland U. Dept. of Physics, College Park.

SOME CONSEQUENCES OF A THEORY OF THE RADIATION BELT, by S. F. Singer. [1958] [7]p. incl. diagrs. (AFOSR-TN-59-241) [AF 18(600)1038] AD 212104   Unclassified

Presented at Ninth Internat'l. Astronaut. Cong., Amsterdam (Netherlands), Aug. 25-30, 1958.

Also published in Jour. Brit. Interplanetary Soc.,
v. 16: 558-564, Nov.-Dec. 1958.

A theory has been developed (MDU.03:042, Vol. II) to
account for the "radiation belt" reported by Explorer
and Sputnik satellites. This theory gives the origin of
the radiation, its nature and energy, and its distribution
around the Earth with latitude and with altitude. This
note summarizes the results of the theory and investi-
gates its consequences for studies of the outer atmos-
phere of the Earth, the planets and Moon; particular
attention is paid to space medical implications and
means of protection against the radiation. The most
promising counter-measure appears to be "sweeping-
out" of the radiation. Finally, more novel experiments
to test the trapping properties of the Earth's magnetic
field are suggested. (Contractor's abstract)

903

Maryland U. Dept. of Physics, College Park.

SCIENTIFIC PROBLEMS IN CISLUNAR SPACE AND
THEIR EXPLORATION WITH ROCKET VEHICLES, by
S. F. Singer. [1958] [10]p. incl. diagrs. refs.
[AF 18(600)1038]   Unclassified

Published in Proc. Ninth Internat'l. Astronaut. Con-
gress, Amsterdam (Netherlands) (Aug. 25-30, 1958),
Vienna, Springer-Verlag, v. 2: 904-913, 1959.

Also published in Astronaut. Acta, v. 5: 116-125, 1959.

The paper discusses scientific measurements which can
be carried out in the "cislunar" region between the
earth and the moon. Stress is placed on such problems
as the space distribution and intensity of cosmic rays,
auroral particles, and other corpuscular radiations
some of which might be responsible for the magnetic
storm producing ring current. The moon's magnetic
field is discussed, as well as measurements of the lu-
nar atmosphere and lunar tidal bulge.

904

Maryland U. Dept. of Physics, College Park.

ELECTRON SPIN RESONANCE OF ULTRAVIOLET
IRRADIATED COMPOUNDS. I. UNSATURATED HY-
DROCARBONS, by C. P. Poole, Jr. and R. S. Anderson.
[1959] [29]p. incl. diagrs. tables, refs. (Technical rept.
no. 120) (AFOSR-TN-59-407) (Also bound with its
AFOSR-217; AD 251449) (AF 18(600)1582) AD 214504;
PB 140505   Unclassified

Also published in Jour. Chem. Phys., v. 31: 346-354,
Aug. 1959.

Trapped radicals, formed by ultraviolet irradiation of
pure, unsaturated aliphatic hydrocarbons, maintained at
77°K, have been observed with a 3-cm electron spin
resonance spectrometer at g-factor of 2. Straight chain

radicals were characterized by well resolved hyperfine
structure of 4 or more components. Only those hydrogen
atoms attached to carbon atoms at or adjacent to the
location of the unpaired electron are found to contribute
appreciably to the observed hyperfine structure. Their
hyperfine coupling constants are approximately equal.
Radical formation and stabilization is attributed to the
separation from the parent molecule of highly mobile
hydrogen and methyl radicals which diffuse away from
the remaining radical fragments, and eventually react
with their environment or recombine. Stabilization of re-
maining fragments then occurs because of immobility
and structural resonance. The number of radical spins
detected was of the order 10^{16} to 10^{18} in 1 ml samples.
Most radicals were stable for weeks at 77°K. Consider-
ation is given to the existence of radicals resulting from
secondary hydrogen addition reactions. (Contractor's
abstract)

905

Maryland U. Dept. of Physics, College Park.

RADICALS TRAPPED IN VISCOUS MEDIA (Abstract), by
K. Hotta and R. S. Anderson. [1959] [1]p. (Bound with
its AFOSR-217; AD 251449) (AF 18(600)1582)
                                            Unclassified

Presented at Fourth Internat'l. Symposium on Free
Radical Stabilization. Washington, D. C., Sept. 1, 1959.

Electron spin resonance techniques were used to identify
radicals existing during non-steady state polymerization
reactions of methyl methacrylate, styrene, a-methyl
styrene, and vinyl acetate. In most cases the radicals
observed were created by the action of initiator radicals
induced by ultraviolet irradiation. Observation at 77°K
of benzoyl peroxide initiates monomer radicals in the
initial stage of polymerization of methyl methacrylate
and a-methyl styrene shows that the action of the initiator
is principally hydrogen abstraction from the monomer.
In styrene, where abstraction is energetically unfavor-
able, initiator addition occurs. Examination of a 1:1
styrene-methyl methacrylate comonomer shows that
radicals from both monomers initially exist in about
equal proportions. With methyl methacrylate the same
radical appears at all stages of the polymerization reac-
tion, except during photodegraduation, when an additional
radical is present. Viscosity measurements demonstrated
that detectable quantities of radical ($10^{15}/cm^3$) created
at room temperatures do not exist until the polymer
molecular weight exceeds 10^5. In general about 10^{17}
radicals/cm^3 were observed, corresponding to 1 radical
per 100 molecules.

906

Maryland U. Dept. of Physics, College Park.

THE V-A FOUR-FERMION INTERACTION AND THE
INTERMEDIATE CHARGED VECTOR MESON, by S.
Oneda and J. Pati. Dec. 1958, 11p. incl. diagrs. refs.
(Technical rept. no. 126) (AFOSR-TN-59-46) (AF 49-
(638)24) AD 209417   Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 125-127,
Feb. 1, 1959.

The consequences of this hypothesis are given for the
spectrum in K_{e3}, $K_{\mu 3}$ and muon decay, and for the
muon lifetime.

907

Maryland U. Dept. of Physics, College Park.

INTEGRAL EQUATION FOR PRODUCTION PROCESSES,
by J. Sucher and T. B. Day. Jan. 1959 [14]p. incl.
diagrs. (Technical rept. no. 130) (AFOSR-TN-59-153)
(AF 49(638)24) AD 211113; PB 142539   Unclassified

Also published in Nuovo Cimento, Series X, v. 13:
1111-1116, 1959. (Title varies)

An integral equation is derived which exhibits directly
the relation between an amplitude for production, in-
cluding all interactions, and the corresponding amplitude
for complete scattering between the initial particles
alone, and between the final particles alone. The only
non-measurable quantity involved in this relatively
simple relation is shown to be an amplitude for "pure
production" in which intermediate states with either the
initial particles or the final particles are excluded.
(Contractor's abstract)

908

Maryland U. Dept. of Physics, College Park.

K^-, $\bar{K}^\circ$ RELATIVE PARITY FROM THE K^--D CHARGE
EXCHANGE REACTION, by T. B. Day, G. A. Snow, and
J. Sucher. Apr. 1959 [26]p. incl. diagrs. table, refs.
(Technical rept. no. 132) (AFOSR-TN-59-435) (Spon-
sored jointly by Air Force Office of Scientific Research
under AF 49(638)24 and Atomic Energy Commission
under AT(40-1)2504) AD 214797
                                        Unclassified

Also published in Nuovo Cimento, Series X, v. 13: 614-
627, Aug. 1, 1959.

The reaction $K^- + D \to \bar{K}^\circ + 2n$ is studied in the hope
that limitations on the final states for the 2 neutrons
due to statistics will help differentiate between even
and odd relative parity of the K^- and $\bar{K}^\circ$ mesons. The
total cross-section for the reaction is calculated in the
impulse approximation, and expressed in terms of the

corresponding hydrogen cross-section for both even
and odd parity. The calculations are carried out (a) with
the use of antisymmetrized plane waves for the 2 neu-
trons, and (b) in the closure approximation. The ratio
of the odd to even parity cross-sections is about a factor
of 2 in either approximation. The total cross-section
for odd parity in the plane wave approximation is found
to be about 4 mb at a K^- laboratory momentum of 136
mev/c. (Contractor's abstract)

909

Maryland U. Dept. of Physics, College Park.

Λ° AND Σ° PRODUCTION FROM THE (Σ^-, D) SYS-
TEM, by T. B. Day, G. A. Snow and J. Sucher. May
1959 [9]p. incl. tables. (Technical rept. no. 136)
(AFOSR-TN-59-567) (Sponsored jointly by Air Force
Office of Scientific Research under AF 49(638)24 and
Atomic Energy Commission under AT(40-1)2504)
AD 216272   Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 469-470,
June 1, 1959.

The ratio of Λ° to Σ° production in the absorption of Σ°
particles in deuterium is calculated, using the experi-
mental value of the same ratio for absorption in hydro-
gen. It is assumed that the capture always takes place
in S orbits, that the relative parity of Σ^-, Σ° and Λ° are
even, and that the final state interaction can be neglected.
For a value of the Σ^-, Σ° mass difference of greater
than about 6 mev it is possible to obtain agreement with
experiment. Any enhancement of the Λ° production,
similar to that which exists for K^- absorption in deuteri-
um, would make agreement harder to obtain.

910

Maryland U. Dept. of Physics, College Park.

ON THE SUPPRESSION OF P-STATE CAPTURE IN
(K^-,p) ATOMS, by T. B. Day, G. A. Snow, and J. Sucher.
June 1959, 10p. incl. table, refs. (Technical rept. no.
137) (AFOSR-TN-59-606) (Sponsored jointly by Air
Force Office of Scientific Research under AF 49(638)24
and Atomic Energy Commission under AT(40-1)2504)
AD 217393   Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 61-64, July 1,
1959. (Title varies)

Reactions of K^- mesons at rest in liquid hydrogen or
deuterium are studied. It is pointed out that successive
Stark effect collisions of a highly excited (K^-,p) atom
with nearby protons in the liquid hydrogen will drastically
reduce the probability that the K^- meson ever reaches
the 2P orbit. Calculations indicated that of the K^- me-
sons captured by protons in liquid hydrogen in highly ex-
cited states $\leq 1\%$ will ever reach the 2P level. This re-
sult implies that when a K^- meson comes to rest in

liquid hydrogen, the nuclear capture reaction essentially always occurs with the relative orbital angular momentum of the (K^-, p) system equal to zero.

911

Maryland U. Dept. of Physics, College Park.

AN ATTEMPT AT UNIVERSAL FOUR-FERMION IN-TERACTION, by J. C. Pati and S. Oneda. June 1959, 45p. incl. diagrs. tables, refs. (Technical rept. no. 139) (AFOSR-TN-59-630) (AF 49(638)24) AD 218820; PB 144429   Unclassified

Also published in Nuovo Cimento, Series X, v. 16: 365-367, Apr. 1, 1960.

An attempt is made to explain the various decays of strange particles on the basis of vector and axial-vector 4-fermion interaction. The existence of $(V + A)$ currents as well as $(V - A)$ currents is considered as a possibility and the interaction is assumed to have the form $f(J_\alpha^{(+)} J_\alpha^{(+)*} + J_\alpha^{(-)} J_\alpha^{(-)*})$ + h.c., where f is the coupling constant, $J_\alpha^{(-)}$ is composed of all charged currents which have negative chirality, $\bar{A}\gamma_\alpha(1 + \gamma_5)B$, and $J_\alpha^{(+)}$ of those charged currents which have positive chirality, $\bar{C}\gamma_\alpha(1-\gamma_5)D$. The leptonic currents necessarily belong to the $J_\alpha^{(-)}$ group since the neutrino has a negative helicity. The appropriate assignment of chiralities to various possible charged baryonic currents has been studied in order to explain the characteristics of hyperon decays in the framework of global symmetry for the pion interactions. The virtual pionic or kaonic effects outside the loop are neglected. Results show that there are 3 solutions which can explain reasonably well the branching ratios and asymmetry parameters of hyperon decays. One of the solutions seems to be the best since it explains rather well the rates of hyperon decays and $\pi \to 1 + \gamma$ decay at the same time. Signs of asymmetry parameters of hyperon decays are important to distinguish these solutions. (Contractor's abstract)

912

Maryland U. Dept. of Physics, College Park.

COLLISIONAL AUGER PROCESS FOR MU-MESIC ATOMS, by T. B. Day and J. Sucher. July 1959, 7p. (Technical rept. no. 143) (AFOSR-TN-59-771) (AF 49(638)24) AD 270578; PB 143157   Unclassified

An attempt is made to evaluate the cross section for the collisional de-excitation of a μ-mesic Li atom in Li which was estimated by Day and Morrison (Phys. Rev., v. 107: 912, 1957) as $\sim \pi a_0^2$, where a_0 is the Bohr ra-

dius. Bernstein and Wu (Phys. Rev. Ltrs., v. 2: 404, 1959) criticized the suggestion by Day and Morrison that de-excitation of a μ-mesic atom might occur by a collision with another atom, wherein an electron of the other atom takes off the released energy. The criticism was based on the observation that the cross section for this process could not be very different from the corresponding one for de-excitation of an excited atom by inelastic scattering of a free electron. Results show that the estimation of Day and Morrison is too large by almost an order of magnitude. The conclusion of Bernstein and Wu appears valid that the formula for the cross section for the collisional de-excitation does correspond to the formula for the cross section for the inelastic scattering of a free electron by a μ-mesic atom. (ASTIA abstract)

913

Maryland U. Dept. of Physics, College Park.

K^--NUCLEON SCATTERING LENGTHS AND THE K^--d SCATTERING REACTIONS, by T. B. Day, G. A. Snow and J. Sucher. July 1959 [18]p. incl. diagr. tables, refs. (Technical rept. no. 142) (AFOSR-TN-59-772) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)24 and Atomic Energy Commission under AT(40-1)2504) AD 220579; PB 144038
Unclassified

Also published in Nuovo Cimento, Series X, v. 14: 637-648, Nov. 1, 1959.

The K^--d elastic and total cross sections are calculated, using a model which includes multiple scattering effects. The scattering lengths which Dalitz and Tuan (Phys. Rev. Ltrs., v. 2: 425 (1959)) find as fits to the K^--p data are used in an attempt to distinguish between the 4 possible solutions. The impulse approximation fails to give sensible results in this problem. (Contractor's abstract)

914

Maryland U. Dept. of Physics, College Park.

AN ASYMPTOTIC CAUSALITY REQUIREMENT FOR SYSTEMS WITH CONSTRAINED INPUTS, by J. Sucher. July 1959, 12p. (Technical rept. no. 141) (AFOSR-TN-59-773) (AF 49(638)24) AD 220577; PB 143156
Unclassified

Also published in Nuclear Phys., v. 14: 263-269, Dec. 1959.

The usual formulation of causality for simple linear systems: "no output before input", may fail to imply that the system kernel, $K(\tau)$, is a causal function of the time delay τ, because the class of physically admissible input functions may not contain a complete set of causal signals. An attempt is made to formulate a causality requirement, asymptotic in nature, which overcomes this difficulty. It is found, rather generally, that systems

which satisfy this requirement cannot have a finitely acausal kernel. If it could be shown that the kernel cannot be infinitely acausal, the validity of the usual dispersion relations for such systems would be ensured. (Contractor's abstract)

915

Maryland U. Dept. of Physics, College Park.

K$^-$-NUCLEON SCATTERING LENGTHS AND THE K$^-$-d INELASTIC CROSS SECTION, by T. B. Day and J. Sucher. July 1959, 7p. incl. table, refs. (Technical rept. no. 146) (AFOSR-TN-59-819) (AF 49(638)24) AD 225919; PB 143640   Unclassified

The K$^-$-d inelastic cross sections are calculated in order to verify the heuristic estimation arrived at from results of a former paper. The measurement of the total elastic scattering cross section for K$^-$ meson on deuterons has been hindered by the difficulty in separating out the inelastic, "break-up" events. The results are presented in table form, and show that the calculated and estimated values are consistent.

916

Maryland U. Dept. of Physics, College Park.

ON THE LEPTONIC DECAY MODES OF K-MESON, by K. Chadan and S. Oneda. Aug. 1959, 10p. incl. diagrs. refs. (Technical rept. no. 151) (AFOSR-TN-59-877) (AF 49(638)24) AD 226348; PB 143639   Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 292-295, Sept. 15, 1959. (Title varies)

An investigation is undertaken regarding how far the so-called V-A Fermi interaction can account for the strangeness non-conserving weak reactions. It has been noticed that the observed rates of the decays

$K^\circ \to \pi^\pm + e^\mp + \nu$ and $K^+ \to \pi^\circ + e^+ + \nu$ seem to be anomalously small compared with the universal rates. Using a dispersion technique, it is conjectured that the rate of $K \to \mu + \nu$ decay is not in contradiction with the experimentally indicated slow rates of hyperon decays into leptons.

917

Maryland U. Dept. of Physics, College Park.

HYPERFRAGMENT FORMATION FOR THE K$^-$-DEU-TERON INTERACTION IN FLIGHT, by T. B. Day, G. A. Snow, and J. Sucher. [1959] 8p. incl. diagr. table. (Technical rept. no. 154) (AFOSR-TN-59-1072) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)24 and Atomic Energy Commission under AT(40-1)2504) AD 228578; PB 144343
                                                        Unclassified

This note estimates the percentage of the K$^-$-d reactions of the type $K^- + d \to \Sigma^- + n + \pi^+$ which results in a bound (Σ^-, n) system, presumably bound in an S state. The results, presented in table form, show that the hope of observing hyperfragment formation in deuterium bubble chambers is not bright. The results imply that the (Σ^-, n) hyperfragment production cross section at the momenta calculated will be ≤ 0.1 mb.

918

Maryland U. Dept. of Physics, College Park.

HIGH ORBITAL S-STATE CAPTURE OF π^--MESONS BY PROTONS, by T. B. Day, G. A. Snow, and J. Sucher. [1959] 8p. incl. refs. (Technical rept. no. 159) (AFOSR-TN-59-1295) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)24 and Atomic Energy Commission under AT(40-1)2504) AD 230914; PB 145643   Unclassified

Also published in Phys. Rev., v. 118: 864-866, May 1, 1960.

The consequences of the very short capture time for π^- mesons in liquid hydrogen, recently measured by Fields, Yodh, Derrick, and Fetkovich, are discussed. It is pointed out that collisional de-excitation mechanisms, even including the Stark effect enhancement of capture, seem inadequate to explain the experiment. Alternative possibilities are discussed.

919

Maryland U. Dept. of Physics, College Park.

VARIATIONAL APPROACH TO THE MANY-BODY PROBLEM USING DENSITY MATRICES (II), by R. U. Ayres. Dec. 1958, 18p. (Technical rept. no. 127) (AFOSR-TN-59-94) (AF 49(638)399) AD 210184
                                                        Unclassified

The variational approach to the quantum many-body problem is considered further, with particular emphasis upon the hierarchy of distribution functions which are derivable from the "reduced density matrices" of Löwdin (Phys. Rev., v. 97: 1474, 1955) and Mayer (Phys. Rev., v. 100: 1574, 1955). Corrections to the Hartree-Fock energy are obtained for a system of particles interacting with a screened Coulomb interaction. The results are left in terms of one unknown parameter, which is determined by a very complicated integral condition. The problem has not yet been evaluated in practice, due to the analytic difficulty.

920

Maryland U. [Dept. of Physics] College Park.

THE EFFECT ON SUPERCONDUCTIVITY OF AN INTERACTION BETWEEN CONDUCTION AND 4f

ELECTRONS, by J. Peretti and A. A. Maradudin. Mar. 1959 [64]p. incl. diagrs. refs. (Technical note no. BN-166) (AFOSR-TN-59-383) (AF 19(600)1315 and AF 49-(638)399) AD 214010; PB 140524   Unclassified

Presented at meeting of the Amer. Phys. Soc., Massachusetts Inst. of Tech., Cambridge, Mar. 30-Apr. 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 149, Mar. 30, 1959. (Title varies)

Alloying lanthonum with the paramagnetic rare earth metals decreases the superconductive transition temperature by an amount ΔT_c which depends on the concentration and the total spin of the solute atom. An attempt is made to explain this behavior by considering the Coulomb interaction of conduction electrons with the 4f inner electrons of the solute atoms. Various effects of this interaction are taken into account. The result is that ΔT_c is nearly proportional to the solute concentration and depends on the total spin in a rather complicated way. The 2nd and all higher order terms in the perturbation expansion for the thermodynamic functions do not affect the value of the transition temperature. The T_c decrease arises solely from the coulomb exchange interaction of the zero order. The solution of the complete integral equation for the variation of the energy gap with temperature and Δ was carried out and results plotted. The energy gap at any temperature below $T_c^{(0)}$ is lowered by the exchange interaction. (ASTIA abstract)

921

Maryland U. Dept. of Physics, College Park.

A REMARK ON THE MEISSNER EFFECT AND THE THEORY OF PERFECTLY FREE ELECTRONS, by J. Peretti. June 1959, 3p. (Technical rept. no. 140) (AFOSR-TN-59-554) (AF 49(638)399) AD 216719; PB 142604   Unclassified

It is shown that by considering a causality requirement, the Meissner effect can be deduced from the assumption that the superconducting electrons behave as if they are free. The equation for the Meissner effect is arrived at by assuming the current to be linearly dependent on the electric field and to be "caused" by the field.

922

Maryland U. Dept. of Physics, College Park.

SUGGESTED PAIR DISTRIBUTION FUNCTION FOR STRONGLY INTERACTING PARTICLES, by R. [U.]

Ayres. May 1959, 23p. incl. diagrs. (Technical rept. no. 134) (AFOSR-TN-59-624) (AF 49(638)399) AD 217688   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 14, Jan. 28, 1959. (Title varies)

A simple treatment of the many-body problem is given using standard methods, but especially emphasizing the connection between the 2-body distribution functions in momentum space and configuration space. With the results obtained 1st order energies are reproduced of the hard-sphere, "soft-sphere", square-well and Lennard-Jones gases that obey Fermi or Bose statistics.

923

Maryland U. Dept. of Physics, College Park.

VIBRATIONAL THERMODYNAMIC PROPERTIES OF LATTICES WITH DEFECTS, by J. Mahanty, Aug. 1959, 95p. incl. diagrs. refs. (Technical rept. no. 145) (AFOSR-TN-59-758) (AF 49(638)399) PB 143680
        Unclassified

Some techniques are developed for evaluating the changes in the vibrational properties of a lattice due to the presence of defects, and they have been applied to the study of the effect of defects on some lattice models. The techniques are based on the work of Montroll who has given a method for obtaining integral expressions for the change due to defects in an additive function of the normal mode frequencies of a lattice. The integral expressions for the changes in vibrational thermodynamic properties are contour integrals of functions whose poles are distributed in such a way that integration becomes inconvenient. It is shown that if the evaluation of the change in thermodynamic properties at low and high temperature is restricted, the need for integrating over such singular functions can be avoided by using some special devices. These devices lead to some useful formulas which are employed in the study of the effect of isotope and substitutional impurities in 1, 2, and 3 dimensional lattices with nearest neighbor central and noncentral force interactions. Results are given for the low and high temperature values of the change in Helmholtz free energy due to defects in these cases. Methods for extending the applicability of these techniques to the case of more complicated lattices are indicated, and the discrete frequencies that arise due to an isotope defect in lattices with coupled displacement components are computed. (Contractor's abstract)

924

Maryland U. Dept. of Physics, College Park.

QUASI-PARTICLE APPROACH TO INTERACTION IN

AN IDEALIZED METAL, by J. J. Quinn and R. A. Ferrell. Sept. 1959, 24p. incl. diagrs. refs. (Technical rept. no. 156) (AFOSR-TN-59-1246) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)399 and Office of Naval Research under Nonr-179700) AD 229342; PB 148890   Unclassified

Presented at the Internat'l. Plasma Physics Inst., Seattle Wash., Sept. 1959.

Also published in Jour. Nuclear Energy, Pt. C, v. 2: 18, 1961.

The properties of a degenerate electron gas with a background of positive charge capable of propagating phonons are studied by means of a quasi-particle approach. The ground state of the system is pictured as a vacuum state, and any additional particles or holes together with their polarization clouds are thought of as quasi-particles. The Coulomb repulsion and the effective electron-electron attraction due to phonon exchange are treated separately. The specific heat, spin susceptibility, and compressibility are determined in terms of the effective energy of interaction $V_{pp'}$ of 2 quasi-particles. Considering only the lowest order process contributing to $V_{pp'}$, reproduces known results for the high density limit Coulomb correction to the specific heat and spin susceptibility, but gives a new result for the phonon correction. To lowest order, the electron-phonon interaction produces no change in the spin susceptibility, in contrast to general expectation. For real metallic densities higher order graphs must be included; however for this case it may be possible to choose $V_{pp'}$ empirically. (Contractor's abstract)

925

Maryland U. [Dept. of Physics] College Park.

CORRELATION ENERGY AND PAIR DISTRIBUTION FUNCTION FOR A DEGENERATE ELECTRON GAS (Abstract), by A. J. Glick and R. A. Ferrell. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)399), Atomic Energy Commission, and Office of Naval Research)
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 14, Jan. 28, 1959.

The interaction energy of an electron gas can be expressed in terms of the Fourier transform $P(k)$ of the pair distribution function $g(r)$. Using first-order perturbation theory to calculate $P(k)$ leads to the well-known logarithmic divergence in the correlation energy. The calculation can be improved by expressing $P(k)$ in terms of the dynamic dielectric constant for the electron gas. Going to the limit of high density leads

to the Gell-Mann-Brueckner result. The advantage of working explicitly with the pair distribution function is that there exist general criteria for checking the validity of approximate calculations for the case of arbitrary density. $P(k)$ and $g(r)$ must both satisfy positive definiteness criteria since $P(k)$ is related to the cross section for scattering fast charge particles and $g(r)$ is a probability density. $g(r)$ is further restricted in that the value of $\int g(r) \, d^3 r$ is assigned a priori.

926

Maryland U. Dept. of Physics, College Park.

[A REMARK ON PAULI PARAMAGNETISM FOR AN ELECTRON SYSTEM] Remarque sur le paramagnetisme de Pauli d'un gaz d'electrons, by J. Peretti. [1959] [2]p. [AF 49(638)399]   Unclassified

Published in Compt. Rend. Séances Acad. Sci., v. 248: 1303-1304, Mar. 2, 1959.

It is shown that the Pauli paramagnetism of an electron gas is not entirely determined when purely electrostatic interactions is taken into account. (Contractor's abstract)

927

Maryland U. Dept. of Physics, College Park.

[EVALUATION OF THE PAIR DISTRIBUTION FUNCTION FOR AN IMPERFECT QUANTUM GAS. GENERAL METHOD] Évaluation de la fonction de distribution binaire d'un gaz quantique imparfait. Methóde générale, by L. Colin and J. Peretti. [1959] [4]p. [AF 49(638)399]   Unclassified

Published in Compt. Rend. Seances Acad. Sci., v. 248: 1625-1628, Mar. 16, 1959.

A general method is indicated permitting the evaluation of the pair distribution function $p(\vec{r}_1, \vec{r}_2)$ as a function of the temperature T and fugacity z. This method requires the calculation of the generalized distribution integral $A^{(2)}(\vec{r}_1, \vec{r}_2)$. (Contractor's abstract)

928

Maryland U. [Dept. of Physics] College Park.

VIBRATION FREQUENCIES OF DEFECT MODES FOR LATTICES WITH COUPLED DISPLACEMENT COMPONENTS (Abstract), by J. Mahanty and A. A. Maradudin. [1959] [1]p. [AF 49(638)399]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

All calculations up to the present time of the frequencies of localized modes of vibration associated with defects in a crystal have been carried out either for the longitudinal vibrations of linear chains or for physically unrealistic models of 2- and 3-dimensional lattices where the x, y, and z-components of displacement are uncoupled. The usual methods for calculating these frequencies cannot be used in the case of lattices with coupled displacement components. The frequencies of the localized modes due to a light isotope defect in a monatomic linear chain in which the particles have coupled longitudinal and transverse displacement components have been calculated by a study of the analytic properties of the secular determinant in the complex frequency plane. A single frequency emerges from the top of each of the 2 bands of the frequency spectrum, and each varies quadratically with the strength of the defect. Applications of this method to 2- and 3-dimensional lattices will be discussed.

929

Maryland U. [Dept. of Physics] College Park.

VIBRATIONAL FREQUENCY SPECTRA OF TWO-DIMENSIONAL LATTICES WITH COULOMB LATTICES (Abstract), by J. A. Davies and A. A. Maradudin. [1959] [1]p. [AF 49(638)399] Unclassified

The frequency spectra of a 2-D monatomic lattice with Coulomb interactions plus nearest neighbor repulsive forces have been calculated for the cases of 1 and 2 degrees of freedom per lattice point. In the former case the vibrations are taken to be normal to the plane of the lattice. The frequency spectrum contains 2 logarithmic infinities and a discontinuity in slope not found in short-range force models. The latter singularity is associated with a critical point at which grad $\omega^2 \neq 0$. The 2nd model differs from that studied by Smollett only in the range of the non-Coulomb forces. The constant frequency curves are qualitatively the same as obtained by Smollett, but the frequency spectrum contains a logarithmic infinity, 2 jump discontinuities not located at the end points, and a discontinuity in slope in addition to the singularities found by Smollett.

930

Maryland U. [Dept. of Physics] College Park.

ROTATIONAL ENERGY LEVELS IN DIATOMIC MOLECULAR CRYSTALS (Abstract), by B. J. Castle. [1959] [1]p. [AF 49(638)399] Unclassified

Crystals of CO and N_2 exhibit transitions from one solid form to another at 61.6°K and 35.6°K, respectively. The prediction of these transition temperatures on the basis of classical self-consistent calculations employing the intermolecular potential has been discussed by Jansen and de Wette whose results are in good agreement with experiment. The Schrödinger equation for the rotational eigenstates of the molecules in the low-temperature structures, with the inclusion of a potential which is believed to be a good representation of the crystal field, has as eigenfunctions oblate spheroidal wave functions. The separation of the lowest lying rotational energy levels is not small enough to justify the assumption of a Boltzmann distribution for the diatomic rotors below the transition point. The partition function for the rotational states has therefore been calculated quantum mechanically for the region in which the classical approximation is deemed invalid, taking two shells of neighbors about a central molecule into account, and including the effect of nuclear spin in the case of N_2. The results for the transition temperatures will be discussed.

931

Maryland U. [Dept. of Physics] College Park.

ELASTIC CONSTANTS OF SOLID ARGON AT 0°K (Abstract), by R. M. Winter and A. A. Maradudin. [1959] [1]p. [AF 49(638)399] Unclassified

The vibrational Helmholtz free energy of a crystal at low temperatures separates into the zero-point energy and a temperature-dependent part. If the lattice is strained both of these depend on the strain parameters and hence contribute to the elastic constants. Calculations were made on the zero-point energy contributions to the elastic constants of solid argon using a Lennard-Jones 6-12 potential with nearest neighbor interactions only. In the quasi-harmonic approximation, the potential energy of the strained lattice is expanded to quadratic terms in the displacements of the atoms from their equilibrium positions, but the force constants now depend on the strain parameters. Using the moment-trace method, calculations were made on the even moments of the frequency spectrum (up to μ_{10}) for a strained lattice as functions of the strain parameters, and used inverse Lagrange interpolation to obtain μ_1, which is proportional to the zero-point energy. The corrections to

the elastic constants for the static lattice are of the order of 10% in each case, and the Cauchy relation $c_{12} = c_{44}$ is not satisfied at $0°K$.

932

Maryland U. [Dept. of Physics] College Park.

EVALUATION OF THE PAIR DISTRIBUTION FUNCTION FOR A HARD SPHERE BOSE GAS (Abstract), by L. C. Scherer and J. Peretti. [1959] [1]p. [AF 49(638)-399]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 244, Apr. 30, 1959.

The pair distribution function for a quantum system is expressed as a power series of the fugacity, the coefficients of which are temperature dependent. For the hard sphere case these coefficients have been calculated to the first order in a/λ (where a is the scattering length of the interacting potential and λ the thermal wavelength) using torons with two fixed points or alternatively U functions.

933

Maryland U. Dept. of Physics, College Park.

[CHANGE OF THE TRANSITION TEMPERATURE OF SUPERCONDUCTING ALLOYS OF LANTHANUM AND OTHER RARE EARTH METALS WITH THE SPIN OF THE SOLUTE ATOM] Variation de la température de transition des alliages supraconducteurs du lanthane et des autres terres rares avec le spin du soluté, by A. [A.] Maradudin and J. Peretti. [1959] [3]p. incl. diagr. [AF 49(638)399]   Unclassified

Published in Compt. Rend. Séances Acad. Sci., v. 248: 2856-2858, May 20, 1959.

Recent experiments have shown that the transition temperature of superconducting lanthanum is lowered when a determined fraction of lanthanum atoms is replaced by 2 rare earth impurities, by a quantity depending on the spin of the atom and on the exchange between the conduction and the 4f electrons. This report explains this effect.

934

Maryland U. Dept. of Physics, College Park.

DIELECTRIC CONSTANT AND PAIR DISTRIBUTION FUNCTION OF THE DEGENERATE ELECTRON GAS (Abstract), by A. J. Glick. [1959] [1]p. (Bound with its AFOSR-1856) (AF 49(638)399)   Unclassified

The degenerate electron gas is studied by means of its dielectric constant and pair distribution function. Kramers-Kronig relations and sum rules for the dielectric constant are derived from the principle of causality. With these relations it is possible to determine the entire dielectric constant once its imaginary part is known. A dielectric constant, valid in the random phase approximation, is found in a way that complements Lindhard's determination of the same quantity. In the dielectric formulation, the properties of this mode are shown to be completely determined by the spectrum of single particle excited states. A study of the scattering of fast particles by the electron gas suggests that continuum excitations might be experimentally observable in the related case of electrons passing through thin metal films. The effective screening of the long range Coulomb interaction by the electrons in the system is exhibited by a study of the pair distribution function. An analysis of the ferromagnetic state of the electron gas leads to a strong integral restriction on the pair distribution function. The random phase approximation is found to violate this restriction. Adding an exchange correction gives a satisfactory distribution function, and leads to the same correlation energy. In an attempt to go beyond the random phase approximation the dielectric constant is re-defined in terms of a scattering cross section. With the new definition a theory is constructed which presents a means of calculating the dielectric constant more accurately.

935

Maryland U. Dept. of Physics, College Park.

PROPERTIES OF THE UPPER ATMOSPHERE DEDUCED FROM THE RADIATION BELT, by S. F. Singer. [1959] [22]p. incl. diagrs. refs. (AFOSR-TN-59-158) (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)5575 and Air Force Office of Scientific Research under AF 49(638)530) AD 211117; PB 142708   Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., May 4-7, 1959.

Abstract published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-7: 283, July 1959.

Also published in Planetary and Space Sci., v. 2: 165-173, Apr. 1960.

A new theory was developed which gives the distribution of density with altitude for a planetary exosphere in the absence of the thermodynamic equilibrium. A level of altitude is reached at which the density of the atmosphere is so low that the mean free path becomes of the order of the scale height. The theory is applied to the exosphere by fixing the temperature of the base at 530 km and by using satellite drag data between 500 and 1000 km. The upper limit is set at about 10^6 H atoms per cm^3 at an altitude of 1000 km from the cosmic

ray neutron albedo theory of the inner radiation belt. The existence of a minimum (slot) between the 2 observed radiation belts is accounted for in terms of the breakdown of the adiabaticity of the magnetic moment of trapped particles. The initial injection of solar corpuscular radiation consists mainly of protons and electrons with velocities of 2×10^8 cm/sec. These 20 kev protons form a third and rather transient radiation belt at 4-8 earth radii and account for most of the effects observed during magnetic storms.

936

Maryland U. Dept. of Physics, College Park.

FARADAY ROTATION OF RADIO WAVES WITHIN THE CRAB NEBULA, by H. Laster and A. M. Lenchek. Feb. 1959 [4]p. incl. refs. (AFOSR-TN-59-164) (AF 49(638)530) AD 211142; PB 144029 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 66, Jan. 28, 1959. (Title varies)

Mayer has observed a polarization of about 7% for microwaves of 9500 mc emitted from Crab Nebula. This compares with mean polarizations of about 17% and more for continuous light observed by Oort and Walraven. If polarization of the continuous emission is caused by synchrotron radiation as has been suggested, many factors tend to lower the polarization for lower frequencies. One important factor is Faraday rotation. The existence of polarization at 9500 mc sets upper limits on the average of the product of magnetic field times ionization within the Crab Nebula. The ionization can be estimated and upper limits therefore places on the total magnetic energy in the Crab. Since the limits depend upon certain assumptions about the structure of the field, validity of these assumptions is discussed.

937

Maryland U. Dept. of Physics, College Park.

RADIOWAVE PROPAGATION IN INTERPLANETARY MAGNETIC FIELDS, by A. M. Lenchek. Jan. 1959 [25]p. incl. diagrs. table, refs. (Technical note no. 113) (AFOSR-TN-59-165) (AF 49(638)530) AD 211144 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 66, Jan. 28, 1959. (Title varies)

The measurement of intensities of molecular band systems is often complicated by the partial overlapping of adjacent bands, making the direct measurement of integrated total band intensities extremely difficult, if not impossible. Several attempts have been made by various authors to overcome the problem, none being generally applicable. Two general methods are suggested here. In the 1st a known fraction of the band is employed, and in the 2nd the rotational intensity distribution within a band is interpreted in terms of the total band intensity. The methods have been tested experimentally and found to be in good agreement for the NO β and O_2^+ second negative systems where the integrated intensities were independently measured. (Contractor's abstract)

938

Maryland U. [Dept. of Physics] College Park.

THEORY OF THE COSMIC-RAY RADIATION BELT: ALTITUDE, LATITUDE, AND ENERGY DISTRIBUTION (Abstract), by S. F. Singer, H. Griem, and R. C. Wentworth. [1959] [1]p. (AFOSR-TN-59-166) [AF 49-(638)530] AD 211145 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 7, Jan. 28, 1959.

The intensity of the radiation follows from a balance of the rates of injection into trapped orbits with the rate of removal from such orbits. A discussion of the lifetime of electrons and protons in the exosphere and of the possible injection mechanisms indicates that cosmic ray albedo neutrons should be the dominant source at low and intermediate latitudes; they provide decay protons with energy up to a few hundred mev. The lifetime of these protons is mainly determined by collision loss. Angle scattering is negligible and the intensity can therefore be obtained from the production rate by integration over the orbits. In this report directional and omnidirectional differential and integral intensities are calculated for latitudes up to 45° and altitudes to two earth radii. The proposed mechanism may be adequate to explain the observed intensities except for the fringe regions where probably injection from solar corpuscular beams is the dominant production mechanism and adds an auroral (soft) radiation belt.

939

Maryland U. Dept. of Physics, College Park.

LIFETIMES OF TRAPPED AURORAL RADIATION BELT PARTICLES. PART 1. EFFECT OF SCATTERING BY THE IONIZED COMPONENT OF THE OUTER ATMOSPHERE, by R. C. Wentworth, W. M. MacDonald, and S. F. Singer. Mar. 1959 [35]p. incl. diagrs. tables, refs. (AFOSR-TN-59-167) (Sponsored jointly by

AFCRC Geophysical Research Directorate under
AF 19(604)3861 and Air Force Office of Scientific Research under AF 49(638)530) AD 211146
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II,
v. 4: 7, Jan. 28, 1959.

Also published in Phys. Fluids, v. 2: 499-509, Sept.-Oct.
1959. (Title varies)

The existence of trapped protons and electrons in the
earth's magnetic field was discussed in connection with
a theory of magnetic storms, and was demonstrated in
rocket flights to altitudes of several earth radii. Once
introduced into captive orbits, these particles should be
strictly trapped in the earth's dipole magnetic field.
However, various mechanisms exist which limit their
lifetimes, such as collisions with atoms and ions in the
earth's outer atmosphere, charge exchange, and scattering by hydromagnetic waves. The effect of the scattering
of these particles by the ionized hydrogen and electron
components of the outer atmosphere is considered. The
Fokker-Planck equation was used to derive an expression for the change in the distribution function due to
small-angle, single particle Coulomb collisions. Upper
lifetime limits, as determined by this mechanism, of
both protons and electrons are derived as functions of
their initial nonrelativistic energies. (Contractor's
abstract)

940

Maryland U. Dept. of Physics, College Park.

SOME ASPECTS OF A THREE-BODY PROBLEM, by
G. K. Oertel and S. F. Singer. Mar. 1959, 21p. incl.
diagrs. (AFOSR-TN-59-405) (AF 49(638)530)
AD 214502; PB 140501   Unclassified

Also published in Astronaut. Acta, v. 5: 356-366, 1959.

A special case of the restricted three-body problem of
celestial mechanics, namely the motion of a particle in
the field of two non-rotating mass centers whose separation remains fixed is considered. Applying a formalism developed by Charlier, limits for the motion of
this small mass and give, in particular, the equations
for the ellipses in terms of the constants of motion are
derived. Especially simple expressions have been derived for a particular choice of initial conditions. Interestingly, the equations of the two limiting ellipses
do not depend on how the total mass is distributed between the two centers of attraction; they depend only on
the separation of the two centers. However, the rate at
which the actual orbit traverses between the limiting
ellipses does depend on the division of mass. For the
case in which the two limiting ellipses coincide, the periodic case, the energy and also the equation of the orbit are independent of the distribution of the total mass

between the two centers, the energy being the Kepler
energy for the particular orbit. The theory may be applied to discuss the motion of a satellite near a planet
which has a large bulge or "bump".

941

Maryland U. [Dept. of Physics] College Park.

DISTRIBUTION OF NEUTRAL HYDROGEN IN THE
EARTH'S EXOSPHERE (Abstract), by S. F. Singer.
[1959] [1]p. (AFOSR-TN-59-468) [AF 49(638)530]
AD 215227; AD 261668   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
222, Apr. 30, 1959.

The exosphere is defined as the outermost region of a
planetary atmosphere where collisions can be neglected and neutral atoms move in essentially free ballistic
orbits. We derive their concentration as a function of
altitude; it differs considerably from densities obtained
by considerations of thermodynamic equilibrium. The
new theory gives the correct value for the escape flux
and for the density at infinity. We can now obtain numerical values for the lower exosphere of the earth by
applying a theory of the cosmic ray radiation belt to
counting rates observed in satellites by Van Allen
et al. Combining with drag data from satellite orbits,
we obtain a temperature of $1500°K$ at 530 km, the deduced base of the exosphere. The transition altitude
(beyond which hydrogen takes over from oxygen as the
most important constituent of the exosphere) turns out
to be 1000 km. At this level the H-concentration is 3 x
10^6 per cm^3 and the total density 9 x 10^{-18} g/cm. Numerical results will be presented on neutral hydrogen
densities out to several earth radii.

942

Maryland U. Dept. of Physics, College Park.

TRAPPED RADIATION IN THE EARTH'S MAGNETIC
FIELD, by S. F. Singer. Aug. 1959, 7p. incl. refs.
(AFOSR-TN-59-1028) (Sponsored jointly by Air Force
Cambridge Research Center as AFCRC-TN-59-763;
scientific rept. no. 2 under AF 19(604)5575 and Air Force
Office of Scientific Research as technical rept. no. 153
under AF 49(638)530) AD 227259; PB 144416
Unclassified

Also published in Proc. Fourth Internat'l. Conf. on Ionization Phenomena in Gases, Uppsala (Sweden) (Aug. 17-
21, 1959), Amsterdam, North-Holland Publishing Co.,
1960, p. 1187-1190.

Problems of injection, lifetime, and possible heating of
plasmas in the earth's magnetic field are discussed.

Injection can take place by (1) solar corpuscular streams which perturb the magnetic field, (2) means of neutrons which decay within the field, or (3) the direct release of charged particles within the earth's magnetic field. The behavior of the trapped particles shows many interesting features which are important for laboratory plasmas confined in a mirror geometry. Phenomena occur in naturally trapped plasmas such as (1) instabilities set up by trapped particles, their bunching and the emission of electromagnetic waves of low frequency; and (2) interaction between charged particles and hydromagnetic waves leading to particle acceleration which eventually manifests itself in the form of aurora. (Contractor's abstract)

943

Maryland U. Dept. of Physics, College Park.

PRESENT STATUS OF THE EARTH'S RADIATION BELT, by S. F. Singer. Sept. 1959, 6p. incl. table. (Technical rept. no. 155; Scientific rept. no. 3) (AFOSR-TN-59-1029; AFCRC-TN-59-766) (Sponsored jointly by AFCRC Electronics Research Directorate under AF 19(604)5575 and Air Force Office of Scientific Research under AF 49(638)530) AD 227260; PB 146274   Unclassified

Also published in Proc. Tenth Internat'l. Astronaut. Congress, London (Gt. Brit.) (Aug. 30-Sept. 5, 1959). Vienna, Springer-Verlag, v. 1: 390-393, 1960.

The present available observations on the geomagnetically trapped radiation are reviewed. The inner belt contains a large flux of high energy penetrating protons while the outer belt consists mainly of low energy electrons. The inner belt, therefore, is of considerable importance from a spacemedical point of view since shielding presents a real problem. The possible use of "sweeper satellites" to depress the intensity of the inner belt is discussed. The creation of artificial radiation belts by means of electrons injected from a rocket or satellite-borne accelerator is discussed in greater detail. Such artificial belts can be of great value for geophysical studies.

944

Maryland U. [Dept. of Physics] College Park.

CHARGE ON A BODY MOVING IN AN IONIZ.   T-MOSPHERE WITH PERVADING MAGNETIC ..   ) (Abstract), by S. F. Singer and K. P. Chopra. [1959] [1]p. [AF 49(638)530]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 360, Aug. 27, 1959.

A body moving in an ionized atmosphere with a pervad-

ing magnetic field may acquire charge through collisions with ions and electrons, photoejection of electrons, and induced electric currents due to the motion across the magnetic lines of force. The phenomena have different behaviors at slow and fast speeds of the body. In the intermediate case, the calculations would be quite involved. A knowledge of the nature and amount of charge on a body is of interest in the problems concerning the dynamics of dust particles, meteors and meteorites, whistling atmospherics, and indeed the motion of artificial earth satellites. The relative importance of the various processes of charging under specified conditions is discussed. Some insight can be gained by performing simple experiments in a low-density wind tunnel. The principle of design of a method of estimating satellite charge is briefly discussed.

945

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

AXISYMMETRIC FREE-CONVECTION TEMPERATURE FIELD ALONG A VERTICAL THIN CYLINDER (Abstract), by F. R. Hama, J. V. Recesso, and J. Christiaens. [1959] [1]p. [AF 18(600)1014]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 196, Mar. 30, 1959.

Also published in Jour. Aero/Space Sci., v. 26: 335-342, June 1959.

With a view to studying the effect of strong transverse curvature on boundary-layer problems, the axisymmetric free-convection problem along a vertical thin cylinder is investigated theoretically as well as experimentally. A theory is developed as an extension of the Pohlhausen solution of a thick axisymmetric laminar boundary layer by Mark and by Glauert and Lighthill. Experiments consist of a thermocouple survey of the temperature field over an electrically heated brass cylinder of 1/4 in. diam and 10-ft height and an interferometric study of the density field over a bare tungsten wire of 0.02-in. diam and 5-ft height. The thermal-layer thicknesses are about five and fifty times the radii of the cylinders, respectively. Experimental results of the local heat-transfer coefficient are in excellent agreement with the theory. This, in turn, justifies the theories of laminar boundary layer along a thin cylinder.

946

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SOME TRANSITION PATTERNS IN AXISYMMETRIC

BOUNDARY LAYERS, by F. R. Hama. [1959] [4]p.
incl. illus. [AF 18(600)1014]   Unclassified

Published in Phys. Fluids. v. 2: 664-667, Nov.-Dec.
1959.

Direct observation of the vortex pattern caused by a
ring-shaped trip is made on 1-in. and 1/?-in. circular
cylinders and on a 30° cone in a water tank. Over the
cylinders the boundary-layer thickness is approximate-
ly equal to the radius of the cylinders. Ring-shaped
vortices are shed and deformed into vortex loops in the
same manner as on a flat plate. On the cone the ring-
shaped vortices are stretched and then inevitably de-
formed into vortex loops, indicating that a mere stretch-
ing is not a sufficient mechanism for the creation of a
turbulence spot. A mechanism of the final breakdown
from the vortex loop is tentatively proposed.

947

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

THE USE OF FOURIER TRANSFORMS FOR THE
STUDY OF SINGULAR POINTS IN THE FREQUENCY
SPECTRUM OF A CRYSTAL, by J. Peretti and A. [A.]
Maradudin. Nov. 1958 [9]p. (Technical note no. BN-
155) (AFOSR-TN-59-21) (AF 18(600)1315 and AF 49-
(638)399) AD 208751; PB 138783   Unclassified

Also published in Compt. Rend. Séances Acad. Sci.,
v. 247: 2310-2311, Dec. 22, 1958.

A new method based on theorems relating to the
asymptotic behavior of Fourier transforms is pre-
sented for determining the shape of vibrational fre-
quency spectra in the immediate vicinity of their criti-
cal points. The method is illustrated by applying it to
the determination of the shape of spectra due to ana-
lytic critical points for one-, two- and three-dimen-
sional lattices. (Contractor's abstract)

948

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

AUXILIARY INTEGRALS FOR LATTICE SUMS, by
A. A. Maradudin and G. H. Weiss. Dec. 1958, 11p.
incl. tables. (Technical note no. BN-156) (AFOSR-
TN-59-55) (AF 18(600)1315) AD 209420
          Unclassified

Also published in Jour. Chem. Phys., v. 31: 1433,
Nov. 1959.

The integrals

$$\phi_m(x) = \int_1^\infty t^m e^{-xt}\, dt$$

are tabulated for the following values of x and m: x =
0.2(0.2)20 and m = 0.5(1)12.5. (Contractor's abstract)

949

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

QUANTUM STATISTICS OF INTERACTING PARTI-
CLES. II. CLUSTER INTEGRAL DEVELOPMENT OF
TRANSPORT COEFFICIENTS, by E. W. Montroll and
J. C. Ward. [1959] [21]p. incl. diagrs. refs. (AFOSR-
TN-59-258) [AF 18(600)1315] AD 262052
          Unclassified

Also published in Physica, v. 25: 423-443, June 1959.

A systematic cluster integral expansion has been de-
veloped for time relaxed pair distribution functions.
Each cluster integral can be represented by a Feynman
type diagram in $(r, \beta + it)^{-1})$ space. By employing a for-
malism due to Kubo (Jour. Phys. Soc. Japan, v. 12: 570,
1957) such distribution functions are used to obtain clus-
ter integral developments of transport coefficients.
The transport coefficients are time integrals over time
relaxed momentum correlation functions. Since the
time integral of each cluster integral diverges, one must
sum various sets of cluster integrals before integration.
It is shown that in the classical limit, summation over 1
particular set of integrals is equivalent to solving the
Boltzmann equation. Irreversibility enters naturally in-
to the formalism through the introduction of grand ca-
nonical ensemble averages and passage to the limit as
the number of particles and volume become infinite in
such a way the N/V preserves the proper value for the
density. (Contractor's abstract)

950

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

ON THE CLUSTER INTEGRAL DEVELOPMENT OF
PAIR DISTRIBUTION FUNCTIONS, by S. Fujita, A.
Ishihara, and E. Montroll. Jan. 1959, 25p. incl. diagrs.
(Technical note no. BN-163) (AFOSR-TN-59-260)
(AF 18(600)1315) AD 264129   Unclassified

A general cluster integral formalism is developed for
the calculation of the molecular pair distribution func-
tion. A hybrid between a Mayer graph and a Feynman
diagram is associated with the cluster integrals. The
formalism is used to derive the London-Placzek formu-
la for the pair distribution function of perfect Bose-
Einstein and Fermi-Dirac gases and the Debye-Hückel
distribution function for a low density, electron gas.
(Contractor's abstract)

951

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

ON AN ASYMPTOTIC EXPANSION OCCURRING IN

THE EVALUATION OF A LATTICE SUM, by G. H. Weiss and A. A. Maradudin. Apr. 1959, 3p. (Technical note BN-167) (AFOSR-TN-59-529) (AF 18(600)-1315) AD 216536   Unclassified

Also published in Canad. Jour. Phys., v. 37: 965-968, Aug. 1959.

A simple derivation of an asymptotic expansion which occurs in the evaluation of certain lattice sums is presented. An alternative to the Poisson summation formula is used which is the Euler summation formula.

952

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

INTEGRATION IN FUNCTIONAL SPACES AND ITS APPLICATIONS IN QUANTUM PHYSICS, by I. M. Gel'fand and A. M. Yaglom, tr. by A. A. Maradudin. May 1959, 51p. incl. refs. (Technical note no. BN-171) (AFOSR-TN-59-552) (AF 18(600)1315) AD 216692   Unclassified

Also published in Jour. Math. Phys., v. 1: 48-69, Jan.-Feb. 1960 (trans. from Uspekhi Matem. Nauk, v. 11: 77-114, Jan. 1956).

In a translation from Gel'fand and Yaglom's article (Uspekhi Matematicheskikh Nauk, v. 11: 77-114, Jan. 1956) an attempt is made to throw light on the question of the utilization of methods of measure theory and integration in functional spaces into quantum physics. Certain mathematical questions connected with this application are examined.

953

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE PAIR DISTRIBUTION FUNCTION OF A BOSE HARD SPHERE SYSTEM, CALCULATED TO THE FIRST ORDER OF THE SCATTERING LENGTH, by L. [S.] Colin and J. Peretti. July 1959 [46]p. incl. diagrs. (Technical note no. BN-179) (AFOSR-TN-59-739) (AF 18(600)1315) AD 220036; PB 142990   Unclassified

Also published in Nuovo Cimento, Series X, v. 14: 233-234, Oct. 1, 1959.

Using the binary collision expansion method, the expression is derived of the pair distribution function of a system of Bose particles interacting via a hard sphere potential of radius a, up to the 1st order in a/λ. A general formula is used relating the pair distribution function in the grand canonical ensemble to certain generalized cluster integrals. The evaluation of these cluster integrals up to the 1st order in a/λ is achieved by using the diagrammatical analysis of the cluster func-

tions of the binary collision expansion method, which is equivalent to this order with the method of t rous. (Contractor's abstract)

954

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

[VARIATION OF THE TRANSITION TEMPERATURE OF SUPERCONDUCTING ALLOYS OF LANTHANUM AND OTHER RARE EARTH METALS WITH THE SPIN OF THE SOLUTE] Variation de la température de transition des alliages supraconducteurs du lanthane et des autres terres rares avec le spin du soluté, by A. [A.] Maradudin and J. Peretti. [1959] [3]p. incl. diagr. (AFOSR-TN-59-804) (AF 18(600)1315)   Unclassified

Also published in Compt. Rend. Séances Acad. Sci., v. 248: 2856-2858, May 1959.

Recent experiments of B. T. Matthias et al. (Phys. Rev. Ltrs., v. 1: 98; 449, 1958.) have shown that the transition of superconducting lanthanum is lowered by the addition of rare earth impurities by a quantity depending on the spin of the atom and on the exchange between the conduction and the 4f electrons.

955

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

COMPARISON OF THE PAIR THEORY AND THE QUASI-PARTICLE METHOD FOR THE EVALUATION OF THE PROPERTIES OF AN INTERACTING BOSE SYSTEM, by J. Peretti. Aug. 1959 [12]p. incl. diagrs. (Technical note no. BN-182) (AFOSR-TN-59-850) (AF 18(600)1315) AD 225194; PB 143153   Unclassified

The connection is investigated existing between the theories of Lee, Huang and Yang (Phys. Rev., v. 106: 1135-1145, June 15, 1957) and those of Boboliubov for the interacting Bose systems. The comparison is performed so that any physical quantity calculated in 1 of the 2 formalisms can be transcribed very easily in the other. Any physical quantity can be evaluated with the formalism which seems the more appropriate for this purpose. (Contractor's abstract)

956

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE PAIR DISTRIBUTION FUNCTION OF A HARD SPHERE BOSE SYSTEM CALCULATED BY THE PSEUDO-POTENTIAL METHOD, by L. S. Colin. Sept. 1959 [38]p. incl. diagrs. tables. (Technical note no. BN-185) (AFOSR-TN-59-928) (AF 18(600)1315) AD 226857   Unclassified

Also published in Jour. Math. Phys., v. 1: 87-96, Mar.-Apr. 1960.

The pair distribution function for a system of hard sphere bosons was performed replacing the hard sphere potential by the pseudo-potential. The problem was continued using the quasi-particle formalism of Bogoliubov. In this calculation, a system of bosons interact via the pseudo-potential, and is regarded as a weak interaction when the system is very dilute. The Hamiltonian of the system is diagonalized by canonical transformation; this has the effect of separating the energy into 2 parts, (a) the ground state energy and (b) that which corresponds to an ideal Bose gas composed of "elementary excitations" or quasi-particles. This formalism was applied to the calculation of the pair distribution function of the system. The quantity was calculated by averaging over a grand canonical ensemble constructed with the total number of quasi-particles. The obtained result is valid both for the condensed and gaseous phases of the system and also for any distance r between the particles. A discussion of this result and the one obtained by the binary collision expansion method is presented, and a comparison between these 2 results and experimental results at $4.2°K$ is given. (Contractor's abstract, modified)

957

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

NATURE OF THE SINGULARITIES IN THE SPECTRUM OF A ONE-DIMENSIONAL IONIC LATTICE, by J. Gillis and G. [H.] Weiss. Sept. 1959, 4p. (Technical note no. BN-184) (AFOSR-TN-59-931) (AF 18(600)-1315) AD 226854; PB 144312   Unclassified

Also published in Phys. Rev., v. 115: 1520-1521, Sept. 15, 1959.

It is known, by a theorem of van Hove, that regular lattices will have singularities in their frequency spectra, the type of singularity depending on the dimension. Although several studies of the 1-dimensional lattice with Coulomb interactions have appeared, no one yet has succeeded in identifying the type of singularity that appears in addition to the inverse square root-singularity, in the frequency spectrum. In this note it is established that for a 1-dimensional crystal the singularity is of the form $g(\omega) \sim A[(\omega - \omega_1) \ln 1/(\omega - \omega_1)]^{-\frac{1}{2}}$ where A is a constant and ω_1 is the position of the singularity.

(Contractor's abstract)

958

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

DISPERSION RELATIONS AND VIBRATIONAL FRE-

QUENCY SPECTRA, by A. A. Maradudin and G. H. Weiss. Oct. 1959, 9p. (Technical note no. BN-187) (AFOSR-TN-59-110-) (AF 18(600)1315) AD 228739; PB 144782   Unclassified

Also published in Nuovo Cimento, Series X, v. 15: 408-415, Feb. 1, 1960.

Many relations have been given connecting the dispersion relation and frequency spectrum for a vibrating lattice. It is the purpose of this paper to show that these relations can all be derived from a single integral representation by using different representations of the delta function. (Contractor's abstract)

959

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE ELECTRONIC GROUND STATE OF AN APERIODIC ONE-DIMENSIONAL DELTA-FUNCTION LATTICE, by A. A. Maradudin and B. S. Gourary. Nov. 1959, 4p. incl. diagr. (Technical note no. BN-189) (AFOSR-TN-59-1191) (In cooperation with Johns Hopkins U., Silver Spring, Md.) (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(600)1315 and Bureau of Ordnance under NOrd-7386) AD 229963; PB 145314   Unclassified

The study of impurity band conductivity leads to the problem of the electrical conductivity of 1-dimensional disordered lattices. The nature of solutions is considered of the following Schroedinger equation:

$$\left[-\frac{1}{2}\frac{d^2}{dx^2} + V(x)\right]\psi(x) = E\psi(x), \text{ where } V(x) \text{ is an}$$

aperiodic potential energy, and the equation is written in Hartree atomic units. (Contractor's abstract)

960

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

WEAK AND ELECTROMAGNETIC INTERACTIONS, by A. Salam and J. C. Ward. [1959] [10]p. [AF 18(600)-1315]   Unclassified

Published in Nuovo Cimento, Series X, v. 11: 568-577, Feb. 16, 1959.

The postulate of a local connection in a charge space leads to the introduction of 3 spin fields. One of these can be identified with the electromagnetic, and the other 2 can be shown to mediate all known weak interactions, thus unifying these interactions with electromagnetism. The theory takes account of the fact that weak interactions violate parity and strangeness conservation while electromagnetic interactions do not do so. (Contractor's abstract)

961

Maryland U. [Inst. for Fluid Dynamics and Applied
Mathematics] College Park.

ANHARMONIC LATTICE VIBRATION ABSORPTION
IN A ONE-DIMENSIONAL DIATOMIC LATTICE (Ab-
stract), by A. A. Maradudin and R. F. Wallis. [1959]
[1]p. [AF 18(t00)1315]   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
143, Mar. 30, 1959.

Using the Born-Huang theory of optical absorption in
anharmonic lattices, calculations have been made of
the optical absorption coefficient of a 1-dimensional
diatomic lattice with nearest neighbor interactions for
which the potential energy has been expanded up to cu-
bic terms in the atomic displacements. For this mod-
el it is possible to obtain exact expressions in closed
form for the absorption coefficient in both the low- and
high-temperature limits. The frequency dependent
damping constants in this theory vary as the cube of
the absolute temperature at high temperatures in con-
trast with the linear dependence obtained from the
classical treatments of Blackman and Neuberger.

962

Maryland U. [Inst. for Fluid Dynamics and Applied
Mathematics] College Park.

QUANTUM STATISTICAL PAIR DISTRIBUTION FUNC-
TION (Abstract), by S. Fujita, A. Isihara, and E. W.
Montroli. [1959] [1]p. [AF 18(600)1315]
                                     Unclassified

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
14, Jan. 28, 1959.

Using the idea of "torons" introduced by Montroll and
Ward, it is shown that the pair distribution function in
the grand canonical ensemble is expressed in terms of
propagators corresponding to the normal and exchange
scattering of 2 "torons" in position-temperature space.
The "toron" is a mathematical entity which circulates
around the positron-temperature torus and in terms
of which the quantum-statistical effect is conveniently
expressed. Since the momentum representation of the
propagators of torons is found to take the same expres-
sion for the classical and quantum statistical cases,
there exists a simple transformation which enables us
to write down the quantum statistical counterpart from
the Boltzmann statistical propagators. Assuming
small coupling constants, the diagrams representative
of "toron" scattering are analyzed by using the same

methods in quantum field theory. Explicit calculations
are made for the pair distribution function of an elec-
tron gas at low and high temperatures.

963

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

ABSORPTION AND EMISSION SPECTRA OF AN ELEC-
TRON IN A ONE-DIMENSIONAL DEEP TRAP, by B. S.
Gourary and A. A. Maradudin. [1959] [17]p. incl. diagrs.
(In cooperation with Johns Hopkins U., Silver Spring,
Md.) (Sponsored jointly by Air Force Office of Scien-
tific Research under [AF 18(600)1315] and Bureau of
Ordnance under NOrd-7386)   Unclassified

Abstract published in Proc. 1959 Internat'l. Symposium
on Color Centers in Alkali Halides, Oregon State Coll.,
Corvallis (Sept. 8-11, 1959) [Salem] Oregon State Board
of Higher Education, 1959, p. 20.

Also published in Jour. Phys. Chem. Solids, v. 13: 88-
104, May 1960.

The wave functions and the energies of the bound states
of an electron in a special 1-dimensional deep trap are
calculated. Only 2 essential approximations are made
in the course of the treatment, namely the Born-
Oppenheimer approximation for the separation of the
electronic and the nuclear motions, and the harmonic
approximation for the lattice energy. Further approxi-
mations are also made, but these are not essential to
the calculation and they can be avoided, if necessary.
Green's function techniques are employed in the solu-
tion of the electronic and the lattice-vibration problems,
and they make possible the treatment of both the local-
ized and the extended lattice-vibration modes and their
influence on the electronic absorption (emission) spec-
trum. The first 2 moments of the absorption and emis-
sion spectra are then calculated. The principal utility
of this work lies in providing a test case for more ap-
proximate theories, although a generalization of the
method to 3 dimensions and to more realistic potentials
should also be possible. (Contractor's abstract)

964

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

VIBRATION FREQUENCY SPECTRA OF DISORDERED
LATTICES. II. SPECTRA OF DISORDERED ONE-DI-
MENSIONAL LATTICES, by C. Domb, A. A. Maradudin
and others. [1959] [13]p. incl. diagrs. refs. [AF 18-
(600)1315]   Unclassified

Published in Phys. Rev., v. 115: 24-36, July 1, 1959.

By using a combination of the moment-trace method
and a new method, the "delta-function" method, the vi-
brational frequency spectrum of a randomly disordered,

2-component, isotopic, linear chain has been computed for a wide range of the concentrations of the 2 kinds of particles and of their mass ratios. In addition the particular case of a chain in which the mass of 1 of the isotopic constituents becomes infinite can be treated exactly, and the results of this analysis shed light on the form of the spectra for lattices with large but finite mass ratios for the 2 constituents. The spectra are characterized by the disappearance of the square-root singularity at the maximum frequency which is found in ordered 1-dimensional lattices, and by the appearance of impurity bands, the nature of which is discussed. Finally, the zero-point energy of a randomly disordered lattice is calculated and compared with the zero-point energy of an ordered lattice and of the separated phases. (Contractor's abstract)

965

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE TRANSMISSION OF ELECTROMAGNETIC WAVES IN THE PRESENCE OF A CONDUCTING LAYER OF GAS, by G. S. S. Ludford. Feb. 1959, 22p. (Technical note no. BN-160) (AFOSR-TN-59-159) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)154 and Office of Ordnance Research under DA 36-034-ORD-1486) AD 211118; PB 139852
Unclassified

Two related questions concerning the transmission of electromagnetic waves are considered: (1) The reflection and transmission of plane waves at a perfectly conducting layer of gas in an otherwise non-conducting atmosphere, when there is a uniform external magnetic field perpendicular to the layer present. The result is that a layer of finite depth h is an almost perfect filter, being transparent to waves of frequency $(n \pi A_0)/h$ $(A_0 =$ Alfvén velocity, n an integer). (2) The existence of plane surface waves for such a finite layer. There is always one such wave and, for certain ranges of frequency, two. The first becomes choked at the filter frequencies; its velocity first tending to zero and then jumping to a finite value. The second chokes at the frequencies $(n \pi A_0 a_0)/h \sqrt{a_0^2 + A_0^2}$ $(a_0 =$ acoustic velocity. (Contractor's abstract)

966

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON THE FLOW OF A CONDUCTING FLUID PAST A MAGNETIZED SPHERE, by G. S. S. Ludford and J. D. Murray. Apr. 1959 [20]p. incl. diagr. (Technical note no. BN-169) (AFOSR-TN-59-424) (In cooperation with Harvard U., Cambridge, Mass.) (Sponsored jointly by

Air Force Office of Scientific Research under AF 49-(638)154 and Office of Ordnance Research under DA 36-034-ORD-1486) AD 214774; PB 140802   Unclassified

Also published in Jour. Fluid Mech., v. 7: 516-528, Apr. 1960.

In the steady flow of an incompressible, inviscid, conducting fluid past a magnetized sphere, the 1st-order effects of the magnetic field and conductivity are studied. Paraboloidal wakes of vorticity and magnetic intensity are formed, the former being half the size of the latter. The vorticity, generated by the non-conservative electromagnetic force, is logarithmically infinite on the sphere. For the case of a dipole at the center of the sphere, the drag coefficient is $C_D = \dfrac{144\mu'^2}{5(2\mu + \mu')^2} \beta R_M$, where μ and μ' are the permeabilities of the fluid and sphere, respectively, β is the ratio of the smallest magnetic pressure at the sphere to the free-stream dynamic pressure, and R_M is the magnetic Reynolds number.

(Contractor's abstract)

967

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

FURTHER RESULTS ON THE FLOW OF A CONDUCTING FLUID PAST A MAGNETIZED SPHERE, by G. S. S. Ludford and J. D. Murray. June 1959, 9p. (Technical note no. BN-174) (AFOSR-TN-59-648) (In cooperation with Harvard U., Cambridge, Mass.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-(638)154 and Office of Ordnance Research under DA 36-034-ORD-1486) AD 218328; PB 142274
Unclassified

Also published in Proc. Sixth Midwestern Conf. on Fluid Mech., Texas U., Austin (Sept. 1959), Austin, Texas U. Press [1959] p. 457-465.

In this paper the general axially symmetric magnetic distribution is considered in more detail than in the previous report (item no. 966). In particular, the drag for an off-center dipole is determined. (Contractor's abstract)

968

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

THE PROPAGATION OF SMALL DISTURBANCES IN HYDROMAGNETICS, by G. S. S. Ludford. [1959] [14]p. incl. diagr. (AF 49(638)154)   Unclassified

Published in Jour. Fluid Mech., v. 5: 387-400, Apr. 1959.

This paper is concerned with the propagation of small initial disturbances in a conducting gas under the influence of a uniform external magnetic field. For a perfect conductor, there are 3 types of plane waves, each of which depends strongly on the angle at which the magnetic field is crossed. The modifying effects of finite conductivity are determined and, in the case of these waves, this is done uniformly for all angles. A general disturbance may be resolved into 2 parts, 1 of which satisfies a 4th-order equation and the other a 5th; for a perfect conductor these reduce to 2nd- and 4th-order equations, respectively. The free oscillations of the gas are examined when it is contained in a rectangular box, and, in particular, when the external field is very weak or very strong. For vanishingly weak fields the idealization of infinite conductivity proves to be inadequate. Finally, the initial-value problem is discussed. (Contractor's abstract)

969

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

THE PROPAGATION OF WAVES ALONG AND THROUGH A CONDUCTING LAYER OF GAS, by G. S. S. Ludford. [1959] [14]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-154 and Office of Ordnance Research under DA-36-034-ORD-1486) AD 261590   Unclassified

Published in Jour. Fluid Mech., v. 9: 119-132, Sept. 1960.

Two related questions concerning the transmission of electromagnetic waves are considered. (1) The reflection and transmission of plane waves at a perfectly conducting layer of gas in an otherwise nonconducting atmosphere, when there is a uniform external magnetic field perpendicular to the layer is discussed. Here the main result is that a layer of finite depth h is an almost perfect filter, being transparent to waves of frequency $n\pi A_0/h$ (A_0 = Alfvén velocity, n an integer). (2) The existence of plane surface waves for such a finite layer is also examined. There is always 1 such wave and, for certain ranges of frequency, 2. The 1st becomes 'choked' at the filter frequencies, its velocity 1st tending to zero and then jumping to a finite value. The 2nd chokes at the frequencies $n\pi A_0 a_0/h$ ($a_0^2 A_0^2$) (a_0 = acoustic velocity). (Contractor's abstract)

970

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON A MEAN VALUE THEOREM, AND ITS CONVERSE, FOR THE DISPLACEMENTS IN THE THEORY OF

ELASTICITY, by J. B. Diaz and L. E. Payne. Jan. 1959, 7p. (Technical note no. BN-161) (AFOSR-TN-59-212) (AF 49(638)228) AD 211666   Unclassified

The displacement components in the theory of elasticity obey a certain mean value theorem which is the analogue of Gauss' mean value theorem in potential theory. This mean value theorem, and its converse, are proved directly, using only the corresponding theorem of Gauss, and its converse, in potential theory. (Contractor's abstract)

971

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

EXACT BOUNDS FOR SOLUTIONS OF HYPERBOLIC EQUATIONS BY FINITE DIFFERENCE METHODS, by H. F. Weinberger. Mar. 1959, 13p. (Technical note no. BN-165) (AFOSR-TN-59-372) (AF 49(638)228) AD 213858; PB 142533   Unclassified

The mean square deviation of the finite difference approximation from the solution of the wave equation vanishing on the surface of an N-cube and satisfying given Cauchy data is bound in terms of the Cauchy data. The bound is proportional to the mesh parameter h. (Contractor's abstract)

972

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

HYPERBOLIC AND PARABOLIC EQUATIONS WITH SUBHARMONIC DATA, by A. Weinstein. Mar. 1959, 14p. incl. refs. (Technical note no. BN-164) (AFOSR-TN-59-426) (AF 49(638)228) AD 214776
        Unclassified

Published in Proc. Symposium on Numerical Treatment of Partial Differential Equations with Real Characteristics, Rome (Italy) (Jan. 28-30, 1959) Rome, Libreria Eredi Virgilio Veschi, 1959, p. 74-86.

Monotonicity and convexity properties are studied for a class of hyperbolic and parabolic equations with subharmonic data. Previous results on the case of non-subharmonic data are extended. (Contractor's abstract)

973

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

UNIQUENESS THEOREMS FOR THE DIFFERENTIAL EQUATION $u_{xy} = f(x,y,u,u_x,u_y)$, by W. [L.] Walter. Feb. 1959, 26p. incl. refs. (Technical note no. BN-159) (AFOSR-TN-59-577) (AF 49(638)228) AD 217024; PB 142680   Unclassified

The question of uniqueness of the characteristic bounaary value problem is discussed for the hyperbolic differential equation $u_{xy} = f(x,y,u,u_x,u_y)$. A number of well known uniqueness theorems for the ordinary differential equation $y' = f(x,y)$ (among them the theorems of Nagumo and Osgood) are shown to be valid for the hyperbolic equation. (Contractor's abstract)

974

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON THE EXISTENCE THEOREM OF CARATHEDORY FOR ORDINARY AND HYPERBOLIC EQUATIONS, by W. [L.] Walter. June 1959, 38p. incl. refs. (Technical note no. BN-172) (AFOSR-TN-59-614) (AF 49(638)228) AD 217401　Unclassified

The existence theorem of Peano for the ordinary differential equation $y' - f(x,y)$ w is generalized by Caratheodory to functions $f(x,y)$ with singularities of a certain type. It is shown that a generalization of the same kind can be performed with the hyperbolic differential equation $u_{xy} = f(x,y,u,u_x,u_y)$. An existence and uniqueness theory for the characteristic and for the non-characteristic initial value problem of the equation in the sense of Caratheodory is given. (Contractor's abstract)

975

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

EXACT INFORMATION BY FINITE DIFFERENCE APPROXIMATION, by H. F. Weinberger. June 1959, 12p. incl. refs. (Technical note no. BN-173) (AFOSR-TN-59-644) (AF 49(638)228) AD 218327; PB 142689　Unclassified

Presented at Sixth annual High-Speed Computer Conf., Louisiana State U., Baton Rouge, 195f.

Exact bounds are obtained for the stresses and the torsional rigidity in the classical torsion problem from the solution of a corresponding finite difference problem. (Contractor's abstract)

976

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

BOUNDS IN THE CAUCHY PROBLEM FOR THE LAPLACE EQUATION, by L. E. Payne. [1959] [11]p. incl. refs. (AFOSR-TN-59-645) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49-(638)228] and National Science Foundation)
Unclassified

Also published in Arch. Rational Mech. and Anal., v. 5: 35-45, 1960.

Let u be a solution of Laplace equation $\Delta u = 0$ in a bounded n-dimensional domain D and let Σ be a portion of D. If $|u| \leq M$ in D, then for any $P \in D$, $|u(P)|^2 \leq K_0 M^{2(1-\delta)}[K_1 \int_\Sigma u^2 d\sigma + K_2 \int_\Sigma |\operatorname{grad} u|^2 d\sigma]^\delta$, where the K_i are constants depending only on Σ, D, and δ is a function of Σ, D, P, $0 < \delta < 1$. The significance of this inequality is that it establishes the continuous dependence, in the uniform sense, of solutions of $\Delta u = 0$, on the Cauchy data of u on Σ, these data being considered in the $L^2(\Sigma)$ norm. Inequalities of a similar nature, but with $\int_\Sigma u^2 d\sigma$, $\int |\operatorname{grad} u|^2 d\sigma$ replaced by $\sup_\Sigma u^2$, $\sup_\Sigma |\operatorname{grad} u|^2$, have been derived by M. M. Laurentiev (Izves. Akad. Nauk SSSR. Ser. Mat., v. 20: 819-342, 1956: Dokl. Akad. Nauk SSSR, v. 112: 195-197, 1957. (Math Rev. Abstract)

977

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON SOME GENERALIZED CAUCHY PROBLEMS AND THE CONVEXITY OF THEIR SOLUTIONS, by R. W. Carroll. Apr. 1959, 101p. incl. diagrs. (Technical note no. BN-168) (AFOSR-TN-59-649) (AF 49(638)-228) AD 218561　Unclassified

A class of generalized Cauchy problems are treated for equations of the type of the Euler-Poisson-Darboux (EPD) equation. In the case of the EPD equation Weinstein's results about the convexity and growth of the solution are extended to the most general multiply subharmonic initial data and some of his criteria are sharpened. The conditions under which there will be a convexity theorem for equations of this type are examined. For the EPD equation of index n-1 a study is made when the generalized solution is a solution in the usual sense. (Contractor's abstract)

978

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON A SINGULAR DIFFERENTIAL OPERATOR, by A. Weinstein. July 1959, 11p. incl. refs. (Technical note no. BN-175) (AFOSR-TN-59-651) (AF 49(638)228) AD 218326; PB 142272　Unclassified

Some applications are given of a singular differential operator to some problems in differential equations. The operator is of the form: $D_k (u) - \dfrac{d^2 u}{dt^2} + \dfrac{k}{t} \dfrac{du}{dt}$.

(Contractor's abstract)

979

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

UPPER AND LOWER BOUNDS FOR QUADRATIC IN-
TEGRALS, AND AT A POINT, FOR SOLUTIONS OF
LINEAR BOUNDARY VALUE PROBLEMS, by J. B.
Diaz. June 1959, 47p. incl. refs. (Technical note nc.
BN-178) (AFOSR-TN-59-720) (AF 49(638)228)
AD 219685; PB 149729   Unclassified

An introduction is presented to several methods for
obtai ing reliable, precise, numerically computable up-
per and lower bounds for a large class of problems of
the general nature of those mentioned in the title. For
definiteness, only certain specific boundary value prob-
lems are considered in detail, although the same pro-
cedures can be easily seen to be applicable in more gen-
eral situations. (Contractor's abstract)

980

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

ЛN UNIQUENESS THEOREMS FOR ORDINARY DIF-
FERENTIAL EQUATIONS AND FOR PARTIAL DIF-
FERENTIAL EQUATIONS OF HYPERBOLIC TYPE,
by J. B. Diaz and W. L. Walter. July 1959, 16p. (Tech-
nical note no. BN-177) (AFOSR-TN-59-740) (AF 49-
(638)228) AD 219684; PB 142989   Unclassified

Also published in Trans. Amer. Math. Soc., v. 96: 90-
100, July 1960.

Uniqueness theorems for the ordinary differential
equation $y' = f(x,y)$ and for the hyperbolic partial dif-
ferential equation $u_{xy} = f(x,y,u,u_x,u_y)$ are proved by
means of an elementary method, which is also applica-
ble in more general situations, and involves only the
ordinary Lagrange mean value theorem of the differen-
tial calculus and simple properties of continuous real
valued functions. (Contractor's abstract)

981

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

A THEORY OF LOWER BOUNDS FOR EIGENVALUES,
by H. F. Weinberger. Aug. 1959, 97p. incl. refs.
(Technical note no. BN-183) (AFOSR-TN-59-974)
(AF 49(638)228) AD 226855; PB 144306   Unclassified

A polynomial equation is derived whose roots are lower
bounds for the eigenvalues of a differential operator.
The coefficients of the equation depend upon some arbi-
trary functions and upon the minimal information nec-
essary to determine any lower bounds. Conditions are
given under which the lower bounds obtained converge

to th. correct eigenvalues as more arbitrary functions
are used. The method serves to unify and improve many
of the known methods of finding lower bounds. (Con-
tractor's abstract)

982

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

NEW INEQUALITIES FOR MEMBRANE AND PLATE
EIGENVALUES, by L. E. Payne. Sept. 1959 [14]p.
(Technical note no. BN-186) (AFOSR-TN-59-1040)
(AF 49(638)228) AD 226856; PB 144292   Unclassified

Part I also published in Jour. Math. and Phys., v. 39:
155-159, July 1960. (Title varies)

Two notes are presented on isoperimetric inequalities
for membrane and plate eigenvalues. Part I - A Note
On Isoperimetric Inequalities for Plate Eigenvalues
gives the upper and lower bounds for clamped plate
eigenvalues in terms of fixed membrane eigenvalues
for the same region. Part II - Some Applications of
Krahn's Inequality, gives a natural extension of the iso-
perimetric inequality of Faber and Krahn. (Contrac-
tor's abstract)

983

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

[ON THE DIFFERENTIAL EQUATION $u_{xy} = f(x,y,u,u_x,u_y)$
I. SINGLE VALUE THEOREMS FOR THE CHARACTERIS-
TIC INITIAL VALUE PROBLEMS] Über die Differential-
gleichung $u_{xy} = f(x,y,u,u_x,u_y)$. I. Eindeutigkeitssätze für
die charakteristiche Anfangswertaufgabe, by W. [L.]
Walter. [1959] [17]p. incl. refs. (AF 49(638)228)
                                          Unclassified

Published in Math. Zeitschr., v. 71: 308-324, 1959

This is the 1st of 3 parts that propose the study of an
equation of the type $u_{xy} = f(x,y,u,u_x,u_y)$ with initial
Cauchy conditions. Some already known theorems
(Osgood, Nagumo, Kamke) are reviewed. Thus, the dis-
cussion on uniqueness theorem for the solution of $u_{xy} =$
$f(x,y,u,u_x,u_y)$ independent of u_x is expanded. A generali-
zation is given of a uniqueness criterion for differential
systems of this type.

984

Maryland U. Inst. for Fluid Dynamics and Applied
Mathematics, College Park.

[ON THE DIFFERENTIAL EQUATION $u_{xy} = f(x,y,u,u_x,u_y)$.

II. EXISTENCE PROPOSITIONS FOR THE INITIAL VALUE PROBLEMS] Über die Differentialglelchung $u_{xy} = f(x,y,u,u_x,u_y)$. II. Existenzsätze für das charakteristische Anfangswertproblem, by W. [L.] Walter. [1959] [18]p. (AF 49(638)228)   Unclassified

Published in Math. Zeitschr., v 71: 436-453, 1959.

The problem in the title is continued to be treated by generalizing methods which apply to ordinary differential equations. Part I deals with uniqueness. Part II is largely concerned with existence. It is shown that a solution exists if f is continuous and bounded and satisfies the inequality $|f(x,y,u,v,w) - f(x,y,u,\bar{v},\bar{w})| \leq g_1(y,|v -$

$\bar{v}|) + g_2(x,|w - \bar{w}|)$, provided the continuous functions

$g_i(x,z)$ are nondecreasing in z with $g_i(x,o) = 0$ and the

ordinary differential equations $z'(x) = g_i(x,z)$ have cer-

tain regularity properties. A direct relation of the equation $u_{xy} = h(x,y,u_y)$ with ordinary differential equation $w'(x) = h(x,y,w(x))$ is established. Namely, if the solution of the initial-value problem for the ordinary differential equation is not unique, the Goursat problem for the partial differential equations does not have a solution for arbitrary initial data. Finally, it is shown that under any of the conditions of uniqueness given in Part I, the Picard iteration converges to the solution of the Goursat problem if a solution exists.

985

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE ELECTRIC SPARK METHOD FOR QUANTITATIVE MEASUREMENTS IN FLOWING GASES, by H. F. Bomelburg, J. Herzog, and J. R. Weske. Jan. 1959 [28]p. incl. illus. diagrs. table, refs. (Technical note no. BN-157) (AFOSR-TN-59-273) (AF 49(638)385) AD 212707; PB 140222   Unclassified

The operating principle of the technique and the required instrumentation are described. Characteristics of spark discharges are analyzed theoretically and experimentally. A calibration is established for quantitative evaluation of spark photographs. Examples of application are given for subsonic, transonic, and supersonic flow and for investigations of turbomachines. (Contractor's abstract)

986

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE ELECTRIC SPARK METHOD FOR QUANTITATIVE MEASUREMENTS IN FLOWING GASES, by H. J. Bomelburg, J. Herzog, and J. R. Weske. [1959]

[8]p. incl. illus. diagrs. table, refs. (Technical note no. BN-157a) (AFOSR-TN-59-273a) (AF 49(638)385) AD 230363   Unclassified

Published in Zeitschr. Flugwissensch., v. 7: 322-329, 1959.

This report is an addendum to item no. 985 and enlarges somewhat on the data presented therein.

987

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

PLASMADYNAMICS--FROM THE GASDYNAMIC POINT OF VIEW, by S.-I. Pai. Dec. 1958, 21p. incl. refs. (Technical note no. BN-154) (AFOSR-TN-59-34) (AF 18-(600)993 and AF 49(638)401) AD 209206
                    Unclassified

Also published in Proc. First Internat'l. Symposium on Rarefied Gas Dynamics, Nice (France) [July 2-5, 1958] New York, Pergamon Press, 1960, p. 394-405.

The fundamental concepts of plasma dynamics, the dynamics of ionized media, and its relations with ordinary gas dynamics are discussed. First the plasma dynamics were considered from a microscopic point of view. The application of kinetic theory to plasma is briefly reviewed; particularly the extension of Maxwell-Boltzmann equations to the plasma flow and its limitations. Secondly, the plasma dynamics were considered from a macroscopic point of view. The conservation equations for plasma and its relations with the kinetic theory are given and discussed. Finally, the conservation equations were applied to a special case of fully ionized plasma to obtain all the important parameters which characterize the flow of plasma. A special case in which the general plasma equations may be reduced to ordinary magneto-gasdynamics equations is indicated. (Contractor's abstract)

988

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

RAYLEIGH'S PROBLEM IN A TRANSVERSE MAGNETIC FIELD, by H.-T. Yang. Dec. 1958 [12]p. incl. diagrs refs. (Technical note no. BN-158) (AFOSR-TN-59-47) (AF 49(638)401) AD 209418; PB 145567
                    Unclassified

Rayleigh's problem of an infinite flat plate set impulsively into uniform motion in its own plane, in the presence of a transverse uniform magnetic field, is studied in the present note. The fluid is assumed to be an incompressible continuum, and the plate electrically non-conducting. Two limiting cases are discussed somewhat in detail. (1) The magnetic field is very weak. In this case it is found that the flow field is only

slightly perturbed from the classical Rayleigh's result. (2) The magnetic field is very strong. Here the flow field is greatly influenced by the magnetic field. An Alfvén wave, propagating at high speed in the direction of the magnetic field, gives rise to a small discontinuity in the flow velocity at the wave front. (Contractor's abstract)

989

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE ELECTRIC CONDUCTIVITY OF A PARTIALLY IONIZED GAS, by A. C. Pipkin. Apr. 1959, 30p. incl. table. (Technical note no. BN-170) (AFOSR-TN-59-489) (AF 49(638)401) AD 215842; PB 142180
Unclassified

Also published in Phys. Fluids, v. 4: 154-158, Jan. 1961. (Title varies)

The electrical conductivity of a gas in a magnetic field may be calculated from transfer equations. The present calculation makes use of an approximation based on the smallness of the electron-ion mass ratio. A further approximation based on the smallness of neutral atom collision cross sections in comparison to Coulomb cross sections is possible when the temperature is not too high, but this approximation is used only after the general expression for the conductivity has been obtained. (Contractor's abstract)

990

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SELECTED TOPICS FROM THE THEORY OF GAS FLOW AT HIGH TEMPERATURES. VI. SOME ASPECTS OF PARTICLE INTERACTION IN GASES, by J. M. Burgers. June 1959, 40p. incl. refs. (Technical note no. BN-176) (AFOSR-TN-59-631) (AF 49(638)-401) AD 218782; PB 143012   Unclassified

Three examples are considered of particle interaction in gases, referring to (a) reactions taking place at close binary encounters; (b) collisions between charged particles treated with the aid of a 2-particle distribution function; and (c) electric fields which appear when there are differences in positive and negative charge density, as are found in the case of plasma oscillations. (Contractor's abstract)

991

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE WAVE MOTIONS OF SMALL AMPLITUDE IN RADIATION-ELECTRO-MAGNETO-GAS DYNAMICS,

by S. I. Pai and A. I. Speth. July 1959 [21]p. incl. diagrs. (Technical note no. BN-180) (AFOSR-TN-59-879) (AF 49(638)401) AD 225691; PB 143387
Unclassified

Also published in Proc. Sixth Midwestern Conf. on Fluid Mech., Texas U., Austin (Sept. 1959), Austin, Texas U. Press [1959] p. 446-456.

The fundamental equations of radiation-electro-magneto-gas dynamics are discussed. These equations are linearized under the condition that there exists an externally applied uniform magnetic field. Wave motions of infinitesimal amplitude which may be divided into a transverse wave and a longitudinal wave are analyzed. Radiation phenomena exert influence only on the longitudinal wave while the transverse wave is independent of the radiation field. The radiation effect is characterized by introducing a radiation parameter which is the ratio of radiation pressure to the gasdynamic pressure. For ideal plasma, it may be expressed in terms of an effective radiation sound speed. Various simple cases of this wave motion of small amplitude in radiation electro-magneto-gas dynamics are discussed. The condition where the radiation effect becomes important is also discussed. (Contractor's abstract)

992

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE WAVE MOTIONS OF SMALL AMPLITUDE IN A FULLY IONIZED PLASMA. PART I. WITHOUT EXTERNAL MAGNETIC FIELD, by S. I. Pai. Nov. 1959 [24]p. incl. diagrs. refs. (Technical note no. BN-191) (AFOSR-TN-59-1271) (AF 49(638)401) AD 229705; PB 144778   Unclassified

Also published in Rev. Modern Phys., v. 32: 882-887, Oct. 1960.

Wave motions of infinitesimal amplitude in a fully ionized plasma, consisting of singly charged ions and electrons, were investigated. A 2-fluid theory was used. There are no externally applied electromagnetic fields. First the linearized fundamental equations for both the ions and electrons in the plasma as well as those for the electromagnetic field were constructed. They were then applied to the case of a plane harmonic wave. It was found that the wave motion can be separated into 3 groups, characterizing 2 transverse waves (which are not distinguishable among themselves) and one longitudinal wave. Undamped transverse waves occur only when the frequency ω of the wave is higher than the plasma frequency of the electrons ω_e, and there are no such waves if $\omega < \omega_e$. For longitudinal waves, there is one undamped mode when (ω/ω_e) is smaller than unity. At low frequencies the speed of propagation of this mode is the sound speed of the plasma as a whole. The speed of propagation decreases as the frequency ω of the wave in-

creases and tends to a limiting value equal to the sound speed of the ions of the plasma. This latter speed is $1/\sqrt{2}$ times the sound speed for the plasma as a whole. When (ω/ω_e) is greater than unity, a second undamped wave can occur. The speed of propagation of this wave is infinite when $\omega/\omega_e = 1$ and decreases toward the limiting value of the sound speed of the electrons as the frequency of the wave increases toward infinity. (Contractor's abstract)

993

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics. College Park.

SECOND APPROXIMATIONS FOR THE STRESS TENSOR AND THE HEAT FLUX IN A GAS, by H.-T. Yang. [1959] [2]p. [AF 49(638)401]   Unclassified

Published in Phys. Fluids, v. 2: 237-238, Mar.-Apr. 1959.

Support is given to the simplified Bhatnagar-Gross-Krook transfer equation as a satisfactory approximation of the Boltzmann collision as far as the 2nd approximation. This support verifies the use of the simplified approach in the acquisition of qualitative information.

994

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

ON THE LINEARIZATION OF BOLTZMANN'S EQUATION IN RELATION TO ADIABATIC AND ISOTHERMAL BEHAVIOR (Abstract), by J. M. Burgers. [1958] [1]p. [AF 49(638)401]   Unclassified

Presented at meeting of the Amer. Phys. Soc., San Diego, Calif., Nov. 24-26, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 198, Mar. 30, 1959.

To linearize Boltzmann's equation the collision terms on the right-hand side are replaced by a simplified expression, and the distribution function for the velocities is split into an undisturbed part F_0 and a small disturbance (for convenience a single type of monatomic molecule is taken). As restoring term on the right-hand side a Maxwellian distribution is used, not $-F_0$, but with a number density, mean flow velocity, and mean temperature to be found from the condition that the conservation equations must be satisfied. Such linearized equations are applied to the behavior of a gas subjected to a periodic impressed force field. When the conservation conditions are worked out, a result is obtained which can be adapted to adiabatic or to isothermal behavior, depending on ratios formed out of the collision frequency

and wave number of the impressed force, and mean molecular speed. For an impressed electric field the relative change in number density is not always given by $\pm e\,\varphi/kT$ (φ: potential).

995

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

LAMINAR JET MIXING OF ELECTRICALLY CONDUCTING FLUID IN A TRANSVERSE MAGNETIC FIELD, by S. I. Pai. [1959] [2]p. (AF 49(638)401)   Unclassified

Published in Jour. Aero/Space Sci., v. 26: 254-255, Apr. 1959.

The effect on laminar jet mixing of an electrically conducting, incompressible, and viscous fluid under an applied transverse magnetic field is discussed. Only the case of small electrical conductivity σ or small magnetic Reynolds Number is considered so that the induced magnetic field may be neglected. The fundamental equation of the problem is given as $u(\partial u/\partial x) + v(\partial u/\partial y) = -(Q/9)x^{-2n}u + v(\partial^2 u/\partial y^2)$ $(\partial u/\partial x) + (\partial v/\partial y) = 0$ where the external magnetic field is taken as $H_0(x) = H_1 x^{-n}$ and $Q = 9(\sigma/\rho)\mu_e^2 H_1^2$; H_1 is a constant. The boundary conditions are also listed. It is shown that for the 1st approximations, if $f = f_0 + Q^{-m}f_1$, the increment of the axial velocity component u over the corresponding value in the ordinary fluid dynamics increases with Q. A similar solution is also made for $n = 2/3$, $m = 0$. Such a solution is called a similar solution because the shapes of velocity distribution u at various x-stations is similar.

996

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

ON THE MECHANISM OF THERMAL IONIZATION (Abstract), by H. D. Weymann. [1959] [1]p. [AF 49(638)-401]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 284, Apr. 30, 1959.

A theory is given for the thermal ionization behind strong shock waves. It is shown that the process which essentially determines the time to reach a definite degree of ionization consists of a 2-step mechanism in which an atom is 1st excited to the resonance level by a collision with another atom and it becomes completely ionized in a successive collision with an atom assuming in both cases that sufficient translational energy is available. The theoretical results concerning the

dependence of the ionization rate on time and tempera-
ture are in good agreement with the experimental re-
sults. A comparison of the theoretical and the experi-
mental results further allows a determination of the
excitation cross sections for atom-atom collisions.
The diffusion of electrons out of an initially neutral
plasma is considered and expressions are given for
the stationary electron density and the resulting po-
tential. Experimentally measured diffusion potentials
agree well with the calculations.

997

Maryland U. [Inst. for Fluid Dynamics and Applied
Mathematics] College Park.

MAGNETOGASDYNAMIC PROBLEMS FROM THE
POINT OF VIEW OF PARTICLE DYNAMICS, by J. M.
Burgers. [1959] [17]p. (AF 49(638)401)
Unclassified

Also published in Proc. Durand Centennial Conf. on
Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-
8, 1959), New York, Pergamon Press, 1960, p. 288-
304. (AFOSR-TR-59-108)

Attention is directed, with the use of 2 examples, to
the determination of the motion of a single particle, in
order to indicate some of the problems that turn up
when attempts are made to solve the equations of mo-
tion. It is pointed out that when the mean free path of
the particles becomes long in comparison to other di-
mensions, the motion of the individual particle takes
on added importance. Collisions between particles can
be neglected, and the various particle motions become
independent of each other. The role of "external elec-
tric fields" is investigated and its influence on parti-
cles carrying an electric charge discussed.

998

Maryland U. Inst. for Molecular Physics, College Park.

ELASTIC SCATTERING OF SLOW IONS IN GASES,
by E. A. Mason and J. T. Vanderslice. Feb. 24, 1959
[29]p. incl. diagrs. tables, refs. (Rept. no. IMP-OSR-
12) (AFOSR-TN-59-185) (AF 18(600)1562) AD 211325;
PB 139853 Unclassified

Also published in Jour. Chem. Phys., v. 31: 594-600,
Sept. 1959.

Differential cross sections for the elastic scattering
of slow ions by neutral atoms or molecules have been
calculated by numerical integration of the classical
equations of motion. The model used for the ion-neu-
tral potential energy function consists of 3 terms:
an r^{-4} attraction, an r^{-6} attraction, and an r^{-12} re-
pulsion. The attractive terms are theoretically sound,
but the repulsive term is empirical. Quantum effects
have been ignored, but an approximate formula indi-

cates at what point the classical calculations begin to
fail in any low energy region where experimentation
is difficult. (Contractor's abstract)

999

Maryland U. Inst. of Molecular Physics, College Park.

THE KIRKENDALL EFFECT IN GASEOUS DIFFUSION,
by K. P. McCarty and E. A. Mason. Sept. 11, 1959
[86]p. incl. diagrs. tables, refs. (Rept. no. IMP-OSR-
13) (AFOSR-TN-59-966) (AF 18(600)1562) AD 226853;
PB 143917 Unclassi.

Also published in Phys. Fluids, v. 3: 908-922, Nov.-
Dec. 1960.

The different rates of transfer by random motion of the
2 gases in binary diffusion tends to build up a hydrostat-
ic pressure in 1 region of the mixture. This pressure
will cause a back flow of the 2 gases together. The
analogous effect in solids, the Kirkendall effect, was
demonstrated experimentally for gases, and the results
are explained theoretically. The apparatus used to ob-
serve the Kirkendall effect in gases was essentially 2
bulbs connected by a capillary tube and a larger diame-
ter tube. A drop of silicone oil blocked the larger tube.
Diffusion of gases through the capillary tube built up
a pressure difference that caused the drop to move.
The motion of the drop was predicted from the results
of kinetic theory. The motion of the drop was used to
determine the diffusion coefficients for several gas sys-
tems after the system He-Ar was used to calibrate the
apparatus. The accuracy of these diffusion coefficients
is comparable with the accuracy of those obtained by
other methods.

1000

Maryland U. Inst. of Molecular Physics, College Park.

INVESTIGATIONS OF INTERMOLECULAR FORCES, by
E. A. Mason. Final rept. Sept 15, 1955 - Sept. 15, 1959.
Oct. 15, 1959, 32p. incl. diagr. table, refs. (AFOSR-
TR-59-147) (AF 18(600)1562) AD 228141; PB 144347
Unclassified

A new phenomenon in gaseous diffusion was investigated
which is the analogue of the Kirkendall effect in solids.
The results were shown to be explainable on the basis
of the rigorous kinetic theory of gases. The experi-
mental method appears to be a novel and useful way of
measuring gaseous diffusion coefficients. Investiga-
tions of molecule-molecule and ion-molecule forces
were also carried out theoretically through studies of
scattering and mobility. Applications of the results in-
cluded determination of gaseous ion mobilities and of
high-temperature gas properties. (Contractor's
abstract)

1001

[Massachusetts General Hospital. Neurophysiological Lab., Boston]

STUDIES OF EVOKED RESPONSES BY FLASH IN MAN AND CAT, by M. A. B. Brazier. [1958] [26]p. incl. illus. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)98, National Institute of Neurological Diseases and Blindness, and Office of Naval Research)   Unclassified

Published in Proc. Henry Ford Hospital Internat'l. Symposium on Reticular Formation of the Brain, Detroit, Mich. (Mar. 14-16, 1957), Boston, 1958, p. 151-176.

Studies of the secondary discharge evoked by a brief supramaximal light flash under control conditions and under a variety of anesthetics, e.g., avertia, chloralose, chloroform and nembutal, indicate that the secondary discharge does not have a diffuse representation at the cortex and has no counterpart in the lateral geniculate. Amplitude of response at the collicular and more rostral dorsal levels of the brain stem is not as drastically affected by barbiturate or avertin anesthesia as those in the medial brain stem. The presence of double responses in the center median and subthalamus suggests that impulses from a single flash reach these centers by more than 1 route although the possibility of corticofugal return as well as optic nerve input is recognized. The double response at the cortex under anesthesia has the appearance of blocking a normally active inhibitory mechanism.

1002

Massachusetts General Hospital. [Neurophysiological Lab.] Boston.

EFFECT OF DI-ETHYL ETHER ANESTHESIA ON THYROID FUNCTION OF RATS: PITUITARY, ADRENAL AND THYROID RELATIONSHIP, by T. Oyama, M. S. Potsaid, and D. W. Slingerland. [1959] [6]p. incl. diagrs. tables, refs. (AF 49(638)98)   Unclassified

Published in Endocrinol., v. 65: 459-464, Sept. 1959.

The possible role of the pituitary and adrenal hormones in the depressive effect of ether anesthesia on thyroid function in rats was studied. Di-ethyl ether anesthesia for 2 hr significantly depressed release of radioiodine (I^{131}) from the thiouracil blocked thyroid gland in both bilateral adrenalectomized rats maintained with cortisone and in the bilateral adrenal-medullectomized rats. Administration of ether anesthesia depressed thyroidal uptake of radioiodine in the hypophysectomized rats treated with small doses of exogenous TSH, although no significant effect was noted in the absence of thyrotropin. Ether anesthesia inhibited the TSH-stimulated release of thyroidal I^{131} in the hypophysectomized rats. Recovery from this inhibition by

ether was rapid and more marked when larger amounts of TSH were used. These findings indicate that the effect of di-ethyl ether anesthesia in rat thyroid was not mediated through the adrenal cortex or medulla. It is suggested that the ether anesthesia might influence thyroid function in rats by inhibiting the action of TSH or by a direct action on the thyroid.

1003

[Massachusetts Inst. of Tech., Cambridge]

ON THE INEQUALITY OF CASTELNUOVO-SEVERI, by A. Mattuck and J. Tate. [1958] [5]p. (AFOSR-3571) [AF 18(603)91]   Unclassified

Also published in Abhandlungen Math. Seminar Hamburg U., v. 22: 295-299, 1958.

The Castelnuovo-Severi inequality (1) $1/2[D \cdot D] < dd'$ is related to the divisors D of a surface of the form $V = C \times C'$, the product of two complete, singularity-free curves C and C', where $d = [D \cdot (P \times C')]$ and $d' = [D \cdot (C \times P')]$ this straight line from Dupon Cresp. C'. The authors show that the inequality can be derived from the Riemann-Roch theorem for V. The equation can be written, as a consequence of the particular structure of V_0 as the product of two curves, in the form (2) $x(D) - 1/2[D \cdot D] - dd' + (d + 1 - g')(d' + 1 - g)$; g,g' are the forms of C resp. C', and x(D) signifies the Euler characteristic of D, therefore one has the alternating non-negative sum $x(D) = \dim D - \sup D + \dim$ (K-D) (K a canonical divisor on V). If $\varphi_1, \varphi_2: C' \rightarrow C$ are two rational mappings, and D_1, D_2 the associated graphs, one has from (1), used on the divisors of the form $n_1 D_1 + n_2 D_2$, the formula (3) $|\text{Grad } \varphi_1 + \text{Grad } \varphi_2 - N| \leq 2g(\text{Grad } \varphi_1 \cdot \text{Grad } \varphi_2)^{\frac{1}{2}}$, where $N = [D_1 \cdot D_2]$ signifies the number of solutions P^1 from $\varphi_1(P') = \varphi_2(P')$, counted with the multiplicities of algebraic geometry. Formula (3) contains as a special case the Riemann conjecture for a curve C upon a finite body k with q elements: one selects $C' = C$, φ_1 as the identity mapping, φ_2 as that mapping which gives all coordinates the power of q.

1004

Massachusetts Inst. of Tech., Cambridge.

AN INTERPRETATION OF G. WHITEHEAD'S GENERALIZATION OF H. HOPF'S INVARIANT, by M. A. Kervaire. [1959] [21]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)91 and National Science Foundation)   Unclassified

Published in Ann. Math., v. 59: 345-365, Mar. 1959.

In the present paper, the generalized H. Hopf's invariant H: $\pi_{d+n+1}(S_{n+1}) \to \pi_{d+n+i}(S_{2n+1})$, due to G. Whitehead, is given a new definition which has some similarity with the original H. Hopf's definition. The invariant $H(f)$ appears as depending in particular on the position in S_{d+i+1} of the inverse images M_d, M'_d by f: $S_{d+n+1} \to S_{n+1}$ of 2 regular values q,q' in S_{n+1}. As an application of the new definition of H, it is proved that any regular imbedding (without self-intersection) of the d-sphere into euclidean (d + n)-space induces over S_d the trivial normal bundle provided that $2n > d + 1$.

1005

Massachusetts Inst. of Tech., Cambridge.

THE IRREDUCIBILITY OF THE REGULAR SERIES ON AN ALGEBRAIC VARIETY, by A. Mattuck. [1959] [5]p. [AF 18(603)91]   Unclassified

Published in Illinois Jour. Math., v. 3: 145-149, Mar. 1959.

Let V be a projective algebraic variety over an algebraically closed field k, A the Albanese variety of V, and f: $V \to A$ the canonical map of V into A, which (replacing, if necessary, V by the birationally equivalent graph of f on V x A) may be supposed single-valued. Let V(n) be the n-fold symmetric product of V with itself, and F:$V(n) \to A$ the map defined by $F(x_1 + x_2 + ... + x_n) =$ $\Sigma f(x_i)$, the addition on the right referring to the group law on A. The inverse images $F^{-1}(a)$ of points on A represent regular series in the sense of Albanese (Ann. Scuola Norm. Sup. Pisa, v. 3: 1-26, 1934). Proof is presented of the following theorem. Let dim $V - r > 1$, let $q = $ dim A, and let $g(\geq q)$ be the genus of a generic curve on a normal model of V. Then: (1) when $n \geq g$ the generic $F^{-1}(a)$ is absolutely irreducible and F is surjective; and (2) if n_0 is the smallest integer for which (1) holds then, if $n \geq n_0 + q$, every $F^{-1}(a)$ is absolutely irreducible and of dimension nr-q. (Math. Rev. abstract)

1006

Massachusetts Inst. of Tech., Cambridge.

A THEOREM ON AFFINE CONNEXIONS, by N. Hicks. [1959] [13]p. [AF 18(603)91]   Unclassified

Published in Illinois Jour. Math., v. 3: 242-254, June 1959.

The object of this study is to generalize a theorem of W. Ambrose to the non-Riemannian case. The outline of proof is the same as that of the theorem of Ambrose, except for modifications. The theorem characterizes a simply connected C^∞ manifold, on which is defined a complete affine connection, by the behavior of the curvature and torsion forms under parallel translation along finitely broken geodesics emanating from some fixed point. In the analytic case, one need only consider unbroken geodesics. As an immediate consequence of the result, the (known) theorem is obtained which states that a simply connected manifold, on which is defined a complete connection having zero curvature and torsion invariant under parallel translation, is a Lie group. Relaxing the simply connected hypothesis to just connected, and adding an assumption that the holonomy group be the identity, proof can be presented to show that the manifold is a homogeneous space. An example shows that there is no hope of proving that M is a Lie group under these hypotheses.

1007

[Massachusetts Inst. of Tech., Cambridge]

THE GEOMETRIC INTERPRETATION OF A SPECIAL CONNECTION, by I. M. Singer. [1959] [6]p. (AF 18-(603)91)   Unclassified

Published in Pacific Jour. Math., v. 9: 585-590, 1959.

An esthetic problem remaining in the foundations of Riemannian geometry is discussed. To each Riemannian metric on a manifold one associates a connection on its bundle of bases. This connection is uniquely characterized by its having zero torsion and its parallel translation preserving the metric. By the very definition, at each tangent space of the bundle the connection assigns a complement to the vertical. Yet the various existence proofs of the Riemannian connection are computational and do not exhibit this complementary space (the horizontal space) directly. The problem is how can one do so directly from the metric, given by the reduction of the bundle to the bundle of frames. Under rather special circumstances, a geometric and coordinate free construction of a connection is exhibited. This includes the class of complex analytic bundles and gives a geometric construction of a connection of type (1,0) with curvature of type (1,1), useful in algebraic geometry. For the case of complex vector bundles Nakano computes this connection in terms of coordinates. For Kähler manifolds it turns out that this connection is the Riemannian connection restricted to the unitary subbundle. Hence a solution is obtained to the aforementioned problem for Kähler manifolds.

1008

Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge.

INELASTIC DIFFUSION IN PANELS, by M. M. Chen.

Nov. 1958, 9p. incl. diagrs. (ASRL-TR-76-1)
(AFOSR-TN-59-33) (AF 49(638)160) AD 209205;
PB 140041   Unclassified

The problem of inelastic diffusion in stiffened panels
has been studied. The governing ordinary differential
equation has been solved numerically for the case where
the Ramberg-Osgood exponent, n, is equal to 20. For
the case of n = 2 the solution is in a closed form. Nu-
merical results have been carried out for several load-
ing levels and for several geometrical parameters.
(Contractor's abstract)

1009

Massachusetts Inst. of Tech. Aeroelastic and Structures
Research Lab., Cambridge.

ON LARGE DEFLECTION OF CURVED STRIPS UN-
DER COMBINED THERMAL AND PRESSURE LOAD-
INGS, by M. M. Chen. May 1959, 52p. incl. diagrs.
tables, refs. (ASRL-TR-76-2) (AFOSR-TN-59-676)
(AF 49(638)160) AD 219871   Unclassified

The governing equations in various forms for large de-
flections of initially curved strips, including thermal
force and thermal moment effects, are derived based
on Reissner's variational principle. Exact solutions
are obtained for the cases corresponding to net ten-
sile, compressive, and zero in-plane forces with ar-
bitrary distributed, thermal loads, and small initial
curvature. Numerical examples are given for a
clamped-clamped strip with a particular initial shape,
temperature distribution, and uniform pressure. For
the purpose of comparison, approximate solutions
based on Reissner's variational principle and mini-
mum potential energy are obtained. In both methods,
the vibrational modes and assumed modes are used.
Good agreement is shown in the numerical examples.
These approximate methods of solution will be used
for the case of finite plates. (Contractor's abstract)

1010

Massachusetts Inst. of Tech. Aeroelastic and Structures
Research Lab., Cambridge.

STRESS FUNCTIONS FOR PLATES BOUNDED BY
PIECEWISE ANALYTIC CURVES, by M. M. Chen and
P. T. Hsu. [1959] 4p. [AF 49(638)160]
                                  Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 240,
Mar. 1960.

In a recent note Balmer (Jour. Aero/Space Sci., v. 26:
675-676, Oct. 1959) has shown that the stress function
for a plate of polygonal shape fulfilling the stress free
boundary conditions can be derived from the generaliza-
tion of the standard expression for the Airy stress func-

tion for rectangular plates. The application of this gen-
eralization to include planforms bounded by piecewise
analytic curves is examined.

1011

Massachusetts Inst. of Tech. Aeroelastic and Structures
Research Lab., Cambridge.

ON SOME SOLUTIONS FOR LARGE DEFLECTIONS
OF HEATED STRIPS AND PLATES, by M. M. Chen
and K. A. Foss. [1959] [30]p. incl. diagrs. table, refs.
(Sponsored jointly by Air Force Office of Scienti   Re-
search under AF 49(638)160 and Wright Air Develop-
ment Center under AF 33(616)5504)   Unclassified

Also published in Proc. Fourth Midwestern Conf. on
Solid Mech., Texas U., Austin (Sept. 9-11, 1959), Austin,
Texas U. Press, 1959, p. 207- 32.

The governing equations for large deflections of initially
curved plates and strips, including thermal force and
thermal moment effects, are derived. Exact solutions
are obtained for uniform curved strips under arbitrary
lateral loads and thermal loads. Numerical examples
are given for a strip under uniform pressure with a
given temperature distribution. For comparison, ap-
prox solutions based on Reissner's variational principle
and on the min potential energy principle have been
computed. In both methods, thermal buckling modes,
vibrational modes, and other assumed modes were used.
Good agreement is shown in the numerical examples for
heated strips. Analogous approx solutions for finite
plates are formulated and discussed. (Contractor's ab-
stract)

1012

Massachusetts Inst. of Tech. Aeroelastic and Structures
Research Lab., Cambridge.

VIBRATION AND FLUTTER OF CYLINDRICAL AND
CONICAL SHELLS, by Y. Shulman. June 1959, 174p.
incl. diagrs. tables, refs. (ASRL-TR-74-2) (AFOSR-
TN-59-776) (AF 49(638)219) AD 226444; PB 144307
                                  Unclassified

The theory of thin shells is examined, and some simpli-
fied general expressions are presented. An appropriate
variational principle is formulated, and the similarity
to shallow-shell theory is shown. These results and
those of the more exact Flügge shell theory are applied
to the problem of free vibration of conical shells. The
general problem of panel and shell flutter is reviewed,
and a physical explanation of the phenomenon is offered,
based on conclusions drawn from piston theory results.
A general formulation is given, followed by a method of
solution which is named here after Movchan and Houbolt,
who apparently developed it independently. The Galerkin
method is examined, and its characteristics for this

problem are discussed. This method is then applied to the solution of the flutter problem of cylindrical and conical shells. (Contractor's abstract in part)

1013

Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge.

ON THE AEROELASTIC CHARACTERISTICS OF LOW ASPECT RATIO WINGS WITH CHORDWISE DEFORMATION, by J. Dugundji and J. D. C. Crisp. July 1959, 1v. incl. diagrs. tables, refs. (ASRL-TN-74-3) (AFOSR-TN-59-787) (AF 49(638)219) AD 227221; PB 143960
Unclassified

An investigation was made into the nature of chordwise flutter and divergence characteristics of low aspect ratio wings. Two simple low aspect ratio configurations were examined in detail. The 1st was a cantilever rectangular wing possessing a bending, a torsion, and a 1st chordwise bending mode. The 2nd was a free-free delta wing of sufficiently low aspect ratio so that spanwise deformations can be neglected. Some effects of aerodynamic heating and longitudinal accelerations on these planforms were also examined. Simple closed form solutions were developed for the flutter and divergence characteristics wherever appropriate. The general trends revealed may prove to be of interest to persons involved in the interpretation of aeroelastic analys.s of such surfaces. Among the trends indicated was the role played by mass density ratio for the delta wings. At the lower mass density ratios, more chordwise modes had to be included in the modal type analyses. For high mass density ratios, the flutter characteristics became dependent on dynamic pressure q and independent of the mass density ratio.

1014

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

CORRECTION OF EPOCH ERROR IN CIRCULAR ORBITS. PART I. CORRECTION BY TANGENTIAL TRANSFER, by L. J. Berman. Feb. 5, 1959, 10p. incl. diagrs. table. (AFOSR-TN-59-62, pt. 1) (AF 49(638)-363) AD 209494; PB 140450   Unclassified

The correction is considered of the epoch parameter which locates a body in space at any given time. The size, shape, and orientation of the orbit are assumed to be correct; the original orbit is assumed to be circular; and the error is assumed to be variable from zero to a complete circuit, or period, in magnitude. The epoch correction is made by putting the vehicle into a transfer orbit with a period differing from that of the circle and then going back to the original orbit at some subsequent point of intersection. The orbit changes are effected by impulses of thrust. The case of the transfer orbit being tangential to the circle is discussed, i.e., when the thrust impulses are parallel

to the line of flight. The equations are all written in non-dimensional terms, each quantity being ratioed to the corresponding quantity for some standard orbit. (ASTIA abstract)

1015

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

CORRECTION OF EPOCH ERROR IN CIRCULAR ORBITS. PART II. CORRECTION BY NON-TANGENTIAL TRANSFER, by L. J. Berman. Apr. 30, 1959, 36p. incl. diagrs. (AFOSR-TN-59-62, pt. 2) (AF 49(638)363) AD 214637; PB 142191   Unclassified

A vehicle in a circular orbit is transferred into a second orbit by impulsive thrust. At some subsequent intersection of the 2 orbits, a second impulse is applied to transfer it back to the original orbit. In general, the average angular velocity in the transfer orbit will differ from that in the circular orbit, and the epoch of the body will be changed by such a maneuver. This maneuver is studied with a goal of determining what conditions affect the choice of the transfer orbit. In particular the time taken for completion of the epoch change and the characteristic velocity required are studied. Finally it is shown that the imposition of a restriction on the minimum perigee radius considerably modifies the choice and even makes some conditions impossible to satisfy. (Contractor's abstract)

1016

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

OPTIMUM EXHAUST VELOCITY FOR LOW-THRUST ESCAPE, by L. J. Berman. Sept. 1, 1959, 13p. incl. diagrs. (AFOSR-TN-59-929) (AF 49(638)363) AD 228262   Unclassified

A study was made to find the optimum value of exhaust velocity for escape orbits of vehicles with power-scaled propulsion systems. Since any interplanetary flight will be composed of segments of escape orbits and segments of Keplerian orbits, the results are generally applicable. The effect was shown of low accelerations on the optimum choice of exhaust velocity for power-scaled propulsion systems, and the effect on the actual performance of the vehicle was demonstrated. It is indicated that for the case of earth escape for moderate accelerations, accuracy in the determination of the exhaust velocity is not a critical factor. (Contractor's abstract)

1017

Massachusetts Inst. of Tech. Dept. of Mathematics, Cambridge.

LORENTZ STRUCTURES ON THE PLANE, by J. W. Smith. [1959] 26p. (AFOSR-TN-59-652) (AF 49(638)-42) AD 228329; PB 144059   Unclassified

Also published in Trans. Amer. Math. Soc., v. 95: 226-237. May 1960.

Lorentz structures on the plane are investigated After noting the most basic global properties of these spaces, a normal space is defined, and shown to be geodesically connected. The question arises then what can prevent a space from being normal, and the answer is found in certain structures which will be referred to as barriers. After introducing a notion of completeness, a connection is established between barriers and curvature for a complete space. Some examples are considered. (Contractor's abstract)

1018

Massachusetts Inst. of Tech. [Dept. of Mathematics] Cambridge.

BEST POSSIBLE TRIANGLE INEQUALITIES FOR STATISTICAL METRIC SPACES, by E. Thorp. [1959] 12p. (AFOSR-TN-59-1159) (AF 49(638)42) AD 234730   Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 734-740, Oct. 1960.

The following problem is solved: Given a t-function, there exists a corresponding statistical metric space that can be made into a Menger space for which the t-function is strongest. The solution is had by constructing, for the given t-function, a space such that it is strongest. The space constructed has an uncountable number of points. For some t-functions, spaces may be constructed with a finite number of points. This is illustrated by an example, and an alternate construction is introduced. The construction for the general case is effected by associating a constraining triangle with each point in the domain of the real-valued function T. The alternate construction uses a single triangle to constrain T along a curve or throughout a region. An example of Menger space for which there is no strongest t-function is also given.

1019

[Massachusetts Inst. of Tech. Dept. of Mathematics, Cambridge.]

AN OPERATOR THEORETIC APPROACH TO GENERALIZED FOURIER TRANSFORMS, by R. A. Kunze. [1959] [14]p. (AFOSR-65-0084) (AF 49(638)42)   Unclassified

Published in Ann. Math., v. 69: 1-14, Jan. 1959.

Let G be a locally compact abelian group and let f be a measurable function on G. The operator L f' on $L_2(G)$ is defined as the operator whose domain consists of all g in $L_2(G)$ such that $\int |f(x-y)g(y)| dy$ is locally integrable and $\int f(x-y)g(y)dy$ is in $L_2(G)$ as functions of x, and whose value at g is the latter function. If L f' is densely defined and has a closure Lf, then Lf is unitarily equivalent via the Plancherel transform to multiplication by a measurable function F on the character group of G. The author calls F the generalized Fourier transform of f, and proceeds to explore this notion. In some ways this notion is well behaved; for example, anything in Lp(G) for $1 \le p \le 2$ has the appropriate generalized Fourier transform, and so does the Heaviside function on the line. On the other hand, this notion is strange in some ways; for example it is not one-to-one (the generalized Fourier transform of any polynomial on the line is 0), and the author does not believe that the set of functions having a generalized Fourier transform is linear. (Math. Rev. abstract)

1020

Massachusetts Inst. of Tech. Dept. of Mathematics, Cambridge.

LOCALIZATION AND SUMMABILITY OF MULTIPLE FOURIER SERIES, by E. M. Stein. [1958] [55]p. incl. refs. (AFOSR-65-0085) (AF 49(638)42)   Unclassified

Published in Acta Math., v. 100: 93-147, 1958.

The theory of "spherical" summability of multiple Fourier series is dealt with by forming the Fourier series of f(x) so that f(x) =

$$\sum a_n e^{i n \cdot n} = \sum a_{n_1, n_2 \ldots n_x} e^{i(n_1 x_1 \ldots + n_k x_k)} \text{ where } n =$$

$(n_1, \ldots, n_k)$ is a vector with integral components. The general problem of the theory concerns itself with the validity (and meaning) of $\lim_{R \to \infty} S_R^\delta (x, f) = f(x)$ for some appropriate δ. Results are presented for $L^p(Q_k)$, $1 < p \le 2$ and for "near" $L^1(Q_k)$. For the former, assuming that $f(x) \in L^p(Q_k)$, $1 < p \le 2$, then (1) if f(x) vanishes in a neighborhood of x_0, then $\lim_{R \to \infty} S_R^\delta (x_0, f) = 0$ ($\alpha \ge 1/2(k-1)$). (2) If $S_*^\delta (x, f) = \sup_{R > 0} |S_R^\delta(x, f)|$, then $S_*^\delta (x, f)_p \le A_{p, \delta} f(x)_p$, if $\delta > \alpha(2/p-1)$. (3) If $\delta > \alpha(2/p-1)$, then $\lim_{R \to \infty} S_R^\delta (x, f) = f(x)$ for almost every x. (4) If $\delta > \alpha(2/p-1)$, then $\lim S_R^\delta (x, f)(x)_p = 0$. (5) If $\delta > \alpha$

$(2/p-1)-1/p'$, then $\lim_{R \to \infty} \frac{1}{R} \int_0^R |S_u^\delta(x,f)-f(x)|^2 du = 0$ for almost every x. For results "near" $L^1(Q_K)$, as always $\alpha = 1/2(k-1)$ (1) if $f(x)$ vanishes in a neighborhood of x_0, and $\int_Q |f(x)| \log^+ |f(x)| dx$ is finite, then $\lim_{R \to \infty} S_R^\alpha(x_0,f) = 0$. (2) $\int_{QK} S_R^\alpha(x,f)dx < A \int_{QK} |f(x)|(\log^+ f(x)|)^2 dx + B$. (3) If $\int_{G_K} |f(x)|(\log^+ f(x)|)^2 dx$ is finite, then $\lim_{R \to \infty} S_R^\alpha(x,f) = f(x)$ for almost every x. (4) If $\int_{Q_K} |f(x)| \log^+ f)x_i| dx < \infty$, then $\lim_{R \to \infty} \int_{Q_K R} |S_u^\alpha(x,f)-f(x)| dx = 0$. (5) If $f(x) \in L^1(Q_K)$, then $\lim_{R \to \infty} \frac{1}{R} \int_0^R |S_u^\alpha(x,f)-f(x)|^2 du = 0$.

1021

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

ELASTIC-PLASTIC TORSION OF A CIRCUMFEREN-TIALLY NOTCHED BAR, by J. B. Walsh and A. C. Mackenzie. [1959] [23]p. incl. diagrs. refs. (AFOSR-TN-59-710) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)957 and Office of Naval Research under N5ori-60) AD 225303; PB 143677   Unclassified

Also published in Jour. Mech. and Phys. Solids, v. 7: 247-257, Oct. 1959.

In this investigation of the torsion of the circumferentially notched bar of elastic-plastic material, methods have been outlined for obtaining: (a) a theoretical torque-twist curve, (b) plastic strains in the plane of the notch. Results of applying these methods are presented for a bar of particular geometry and extended to bars of other geometry. The discrepancy between the theoretical results and those obtained in an experimental study is a reflection of the difference between the ideal, non work-hardening material assumed in the theory and the work-hardening material available for experiment. (Contractor's abstract, modified)

1022

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

CONTRIBUTION OF INTERFACE COUPLES TO THE ENERGY OF A DISLOCATION, by F. A. McClintock. [1959] 3p. (AFOSR-TN-59-711) (AF 18(600)957) AD 225302   Unclassified

Also published in Acta Metall., v. 8: 127, Feb. 1960.

An estimate of the n.   itude of the effects of interface couples on dislocations may be obtained from the energy contributed by them if the displacements are those usually found around a screw dislocation. Taking the x_1 and x_2 axes normal and the x_3 axis parallel to the screw dislocation having a Burgers vector b, the only displacement is that in the x_3 direction, u_3, where $u_3 - (b/2\pi) \tan^{-1}(x_1/x_2)$. From this assumed displacement, the components of lattice rotation and then lattice curvature can be found. Equations were studied to determine a strain energy density in terms of the radius from the center of the dislocation.

1023

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

ON NOTCH SENSITIVITY, by F. A. McClintock. May 9, 1959 [32]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-712) (AF 18(600)957) AD 225304; PB 143676   Unclassified

Also published in Welding Jour., v. 40: 202s-209s, May 1961.

A discussion of the need for considering the ductility of structures leads to the definition of both load and deformation factors relating the actual behavior of notched sections to that predicted by plasticity theory for fully ductile materials. Experiments on pure aluminum are in agreement with the fully plastic theory. Experiments on 7075 aluminum alloy and 4140 steel show a notch sensitivity, with a crack behavior and size effect similar to that predicted from elastic-plastic analysis. (Contractor's abstract)

1024

Massachusetts inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

THE SINGLY-GROOVED, PLANE STRAIN TENSILE TEST, by F. A. McClintock. [1959] [25]p. incl. illus. diagrs. table, refs. (AFOSR-TN-59-713) (AF 18(600)-957) AD 225301; PB 143675   Unclassified

The distributions of stress and strain around a single groove in a plane strain specimen subject to fully plastic tension are found theoretically. The distinguishing features of this configuration are the lack of triaxiality and the constant strain pattern as the specimen separates. Experiments show a similar deformation, but quantitative agreement seems to require consideration of strain hardening and possibly anisotropy. The transition temperature is lower than in the Charpy test, and a shear lip is absent. (Contractor's abstract)

1025

Massachusetts Inst. of Tech. Dept. of Mechanical
Engineering, Cambridge.

HEAT TRANSFER IN DISSOCIATED COMBUSTION
GASES, by J. C. Cutting, J. A. Fay and others. July
1959 [45]p. incl. illus. diagrs. tables, refs. (AFOSR-
TR-59-78) (AF 49(638)375) AD 220754; PB 143150
Unclassified

An outline is presented of a series of experiments and
theoretical calculations performed to determine the
rate of heat transfer from gases in detonation waves.
For the experimental measurements, a wire heat trans-
fer gage was developed and calibrated, and was used in
conjunction with a regular shock tube through which the
detonations were passed. Tests were performed using
stoichiometric H_2-O_2 mixtures at various initial pres-
sures, and also a number of C_2H_2-O_2 mixtures at an
initial pressure of 1 atm. In both these series of tests,
additional experiments were run to evaluate the effect
on the heat transfer of coating the gage with iodine. A
theoretical treatment of the heat transfer rates, based
on stagnation point heat transfer theory, is presented
as well as a detailed examination of the thermodynam-
ic and transport processes taking place at the surface
of the gage. The heat transfer to the coated gages is
explained in terms of a non-catalytic wall effect. The
total heat transfer is less than expected for the Mach
and Reynolds' numbers of the experiments. (Contrac-
tor's abstract)

1026

Massachusetts Inst. of Tech. Dept. of Mechanical
Engineering, Cambridge.

PRELIMINARY RESULTS OF MEASUREMENT OF EF-
FECTS OF DIFFUSION OF HELIUM INTO THE LAMI-
NAR BOUNDARY LAYER OF A SUPERSONIC FLOW OF
AIR IN A TUBE AT MACH 5, by S. W. Gouse, Jr., G. A.
Brown, and J. Kaye. [1959] [3]p. incl. diagrs. (Spon-
sored jointly by Air Force Office of Scientific Re-
search under [AF 49(638)442] and Office of Naval Re-
search) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 533-535,
Aug. 1959.

The experiments were carried out in a continuously op-
erating, axially symmetric wind tunnel. The length of
the overall test section was 41 diam, comprising a po-
rous test section, approx 7.2 diam, whose leading edge
was approx. 1.8 diam from the nozzle exit plane, and 4
nylon sections of 8 diam each. A total of 15 runs were
made, 5 without injection and 10 with helium injection.
The overall behavior of the apparatus, with and without
injection, was excellent in terms of the design specifi-
cations, as was the control of independent variables
during operation of the tunnel. From the results it
was concluded that the presence of a diffusion field of

helium in a laminar boundary layer of supersonic flow
of air had no effect, within 1% on the average recovery
factor over the injection region as long as the basic
flow pattern is not disturbed. The results compare
well with those of other investigators to the effect that
the injection of helium leads to a slight increase in the
recovery factor.

1027

Massachusetts Inst. of Tech. Dept. of Mechanical
Engineering, Cambridge.

ANALYSIS OF EFFECTS OF DIFFUSION OF A FOR-
EIGN GAS INTO THE LAMINAR BOUNDARY LAYER
OF A SUPERSONIC FLOW OF AIR IN A TUBE, by
J. R. Radbill and J. Kaye. [1959] [2]p. incl. diagrs.
(Sponsored jointly by Air Force Office of Scientific Re-
search under [AF 49(638)442] and Office of Naval Re-
search) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 602-603,
Sept. 1959.

A brief summary is presented of analytical studies of
the diffusion of a foreign gas by means of uniform in-
jection into the laminar boundary layer of a supersonic
flow of air, with known and controllable boundary condi-
tions. The basic equations were derived by means of
kinetic theory, statistical mechanics, and the thermo-
dynamics of irreversible processes and were then ex-
panded into cylindrical coordinates and subjected to an
order-of-magnitude analysis to yield boundary layer
equations.

1028

Massachusetts Inst. of Tech. [Dept. of Physics]
Cambridge.

THE USE OF POLARIZED NEUTRONS IN DETERMIN-
ING THE MAGNETIC SCATTERING BY IRON AND
NICKEL, by R. Nathans, C. G. Shull and others. Nov.
19, 1958, 1v. incl. diagrs. table, refs. (Technical rept.
no. 3) (AFOSR-TN-59-61) (In cooperation with
Brookhaven National Lab., Upton, N. Y.) (Sponsored
jointly by Air Force Office of Scientific Research
under AF 18(603)84, Atomic Energy Commission, and
National Security Agency) AD 209324; PB 142541
Unclassified

Also published in Jour. Phys. Chem. Solids, v. 10: 138-
146, July 1959.

The polarized neutron beam technique is discussed and
utilized in determining the magnetic scattering by iron
and nickel. Procedures for obtaining and using polar-
ized beams of monochromatic neutrons are outlined,
and experimental data are presented on the perform-
ance of two polarizing crystals, Fe_3O_4 and 92Co-8 Fe
alloy. The reflectivity of neutrons of different polari-
zation state by single crystals of iron and nickel was

studied and used for determining the magnetic scattering amplitudes at different scattering angles. Comparison is then made between the observed magnetic form values and theoretical values derived from calculated 3d wave functions. (Contractor's abstract)

1029

Massachusetts Inst. of Tech. [Dept. of Physics]
Cambridge.

RECENT MAGNETIC STRUCTURE STUDIES BY NEUTRON DIFFRACTION, by C. G. Shull. [1959] [6]p. incl.
diagrs. table. [AF 18(603)8:] Unclassified

Presented at Internat'l. Colioq. on Magnetism, Grenoble (France), July 2-6, 1958.

Published in Jour. Phys. et Radium, v. 20: 169-174, Feb.-Mar. 1959.

A review is presented of several magnetic structure studies performed recently by neutron diffraction methods. These include a study of the low temperature transition in Fe_3O_4 by Hamilton and experiments by

Roth on the magnetic structure ambiguities of the transition element monoxides. Recent studies using polarized neutron beam techniques are described and data presented on the ferromagnetic scattering by iron and nickel. (Contractor's abstract)

1030

Massachusetts Inst. of Tech. [Dept. of Physics]
Cambridge.

STATISTICAL THERMODYNAMICS, XIV, by L. Tisza.
[1959] [3]p. (AFOSR-TN-59-601) (AF 49(638)05)
AD 264337 Unclassified

Application is made of the thermodynamic theory of chemical reaction to nuclear chemistry. It is pointed out that with reactions involving the transformations of elementary particles both criteria of molecular reactions including conservation of mass and validity of a structure formula break down. It is stated that structure formulas can be established only within the range of reactions consisting of the rearrangement of nucleons. The suggestion is made that the dynamic character of the reactions equations can be extended to irreversible processes such as reaction kinetics.

1031

[Massachusetts Inst. of Tech. Dept. of Physics, Cambridge].

STATISTICAL THERMODYNAMICS, XI. A. THE THERMODYNAMIC THEORY OF LINE SINGULARITIES IN ONE-COMPONENT SYSTEM. B. DISTRIBUTION

FUNCTIONS IN STATISTICAL THERMODYNAMICS, by L. Tisza and P. M. Quay. [1959] [4]p. (AFOSR-TN-59-1248) (AF 49(638)95) Unclassified

A scheme is presented for the analysis and correlation of the experimental data concerned with the λ-anomalies in 1-component systems. By assuming that the Gibbs function can be represented as $G(p,T) = f(p) + h(T-T_\lambda)$

where $f(p)$ is a slowly varying function representing the Gibbs function along the λ-line, and $h(t)$ is a singular function with the properties that $h(0) = 0$, $h'(0) = $ finite, $h''(0) = -\infty$, it is shown that the significant thermostatic function can be obtained. Entropy, volume, specific heat, expansion coefficient and the isothermal compressibility equations are all derived. It is indicated that this approach should be verified by its use on experimental data. Certain questions left open in the author's thesis are solved, and the material revised for future publication.

1032

Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

REVIEW OF UNSTEADY AERODYNAMIC STUDIES IN THE FLUID DYNAMICS RESEARCH GROUP, 1955-1958, by H. Kennet and H. Ashley. Dec. 1958 [57]p. incl.
diagrs. tables, refs. (MIT Fluid Dynamics Research Group rept. no. 58-5) (AFOSR-TR-59-6) (AF 18(600)-961) AD 212285; PB 140000 Unclassified

A review is presented of theoretical research on unsteady aerodynamics. The configurations investigated at transonic, supersonic, and hypersonic speeds were wings, bodies, and wing body combinations. An iterative technique is used in transonic and supersonic flows to estimate aerodynamic loads on slender symmetrical configurations performing small lateral oscillations. Strip theory is applied to analyze wings with subsonic leading edges and supersonic trailing edges. For thin wings at high M the perturbation velocity potential is expanded in a series of M^{-2}. Only first and second-order terms in the perturbation velocities are considered. Oscillating hypersonic airfoils are analyzed by modified piston theories. The changes in the variables of state and flow direction are approximately taken into account for moderately strong shock waves. For strong shock waves which produce dissociation, the modified piston relation was derived by considering a simple wave in a dissociated flow in chemical equilibrium. A theory for estimating unsteady loads in the nose region of blunt-nosed bodies in hypersonic flow is described. It is based on small perturbations on an approximate steady flow field.

1033

Massachusetts Inst. of Tech. [Fluid Dynamics Research Group] Cambridge.

FORCES AND MOMENTS ON OSCILLATING WING-BODY COMBINATIONS AT SUPERSONIC SPEED, by H. Kennet and H. Ashley. [1959] [2]p. incl. diagrs. (AF 18(600)961)   Unclassified

Published in Jour. Aero/Space Sci.. v. 26: 605-606, Sept. 1959.

The lift and moment due to small translational and pitching oscillations are determined. The development follows the original scheme of Adams and Sears and its application in the transonic case by Landahl. Graphs give the theoretical fixed axis damping in pitch at supersonic speed for slender midwing-body combinations, with various wing planforms, and various diam-wing-span ratios, and a comparison between theoretical and experimental values of static stability and fixed-axis damping in pitch.

1034

Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

TWO-DIMENSIONAL TF   NIC UNSTEADY FLOW WITH SHOCK-WAVES, by W. Eckhaus. May 1959, 79p. incl. diagrs. refs. (MIT Fluid Dynamics Research Group rept. no. 59-3) (AFOSR-TN-59-491) (AF 49-(638)160) AD 215844   Unclassified

A study is made of the unsteady flow around an airfoil at transonic Mach numbers. For the unsteady part of the flow, small perturbations technique is employed and the interaction with the shock wave is considered. The case of an oscillating aileron is studied, and a solution is derived for the pressure distribution on the aileron. It is found that the solution has a simple form when the shock-wave is well ahead of the hinge-axis of the aileron. As the shock approaches the hinge-axis a correction must be added to the solution. An interpretation of these results is given. The results are compared with results of a theory which neglects the presence of the shock and it is found that both agree for $M - 1$. For $M \neq 1$, however, neglecting the presence of the shock waves introduces errors of

the order of magnitude $(1 - M)^{\frac{1}{2}}$, where M is the local Mach number behind the shock. (Contractor's abstract)

1035

Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

ON THE STABILITY OF LAMINAR FLAME-FRONTS,

by W. Eckhaus. May 1959, 94p. incl. diagrs. tables. (MIT Fluid Dynamics Research Group rept. no. 59-4) (AFOSR-TN-59-562) (AF 49(638)160) AD 216757
                    Unclassified

A study is made of the stability of a plane laminar flame-front. The effects of the disturbances on the internal flame structure are investigated in detail, using small perturbations technique, and including the mechanism of diffusion, heat conduction and unsteady combustion. A formula for the non-steady flame propagation velocity is derived, on the assumption that flame thickness is small compared to the wavelength of the disturbances. The flame velocity is shown to depend on the curvature of the flame and on the perturbations of fluid velocities on the flame-boundary. The expression for the flame velocity contains coefficients which depend on the physical properties of the mixture that is being burned. Using these results in stability analysis, it follows that the properties of the mixture, as expressed in terms of coefficient of heat-conductivity and various coefficients of diffusion, actually determine the stability picture. For some estimated values of these parameters, the theoretical results are shown to agree with the general trend of the experimentally observed behavior. (Contractor's abstract)

1036

Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

ESTIMATION OF UNSTEADY AIRLOADS ON BLUNT BODIES IN A HYPERSONIC STREAM. PART I. THEORY, by H. Kennet. Oct. 1959, 42p. incl. diagrs. refs. (MIT Fluid Dynamics Research Group rept. no. 59-6) (AFOSR-TN-59-1273) (AF 49(638)160) AD 232606; PB 146335   Unclassified

A theoretical method is developed for estimating aerodynamic loads on symmetric blunt-nosed bodies, at zero angle of attack, performing small-amplitude harmonic oscillations in a main hypersonic stream. Time dependent effects are introduced as small perturbations superimposed on an approximate steady field. A power series solution yields the perturbation pressure distribution on the body. Shock amplitude and phase angle are also obtained. The results are applied to a spherical cap, in which case the leading terms of the series solution are evaluated. (Contractor's abstract)

1037

Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

UNSTEADY BOUNDARY LAYERS: A SURVEY OF THE LITERATURE, by R. E. Kelly. Sept. 1, 1959, 59p. incl. refs. [AF 49(638)160]   Unclassified

The existing literature on the role of the boundary layer

in studies of dynamic, aeroelastic phenomena is reviewed. The report is divided into 2 parts. The 1st approach involves an attempt to solve directly the unsteady viscous flow equations. Discussion is made of basic, well-known solutions, attempts at linearization of the boundary-layer equations, the calculation of higher-order approximations, integral methods, unsteady stagnation-point flow, the inclusion of turbulence and the problem of the unsteady separation point. In the 2nd line of approach to the investigation of viscous effects in aeroelastic phenomena, certain knowledge of the unsteady boundary layer and its effect on pressure distribution is assumed, i.e., the position of the separation points, the displacement thickness, or various aerodynamic derivatives. Thus, the 2nd part is composed of investigations which assume certain knowledge of the boundary layer and base their results upon this knowledge.

1038

Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

ON SOME PROBLEMS IN RADIATIVE HEAT TRANSFER, by S. S. Abarbanel. Apr. 1959, 205p. incl. diagrs. refs. (MIT Fluid Dynamics Research Group rept. no. 59-1) (AFOSR-TN-59-531) (AF 49(638)207) AD 216538   Unclassified

The time dependent and steady temperature distributions in radiating homogeneous solid conductors are considered. Solutions to the unsteady heat conduction equations were sought for the cases of a semi-infinite solid, a flat plate, a solid sphere and a spherical shell. The initial temperature is taken to be uniform. Radiation into vacuum takes place at the boundaries and follows the Stefan-Boltzmann law or a generalized form thereof. All cases show that the spatial temperature distribution can be deduced from the surface temperature through a Duhamel Integral. The surface temperature problem is then formulated as a singular, nonlinear Volterra integral equation, the kernel of which depends on the particular geometry of the body in question. The problems are considered of steady state temperature distribution and radiative heat transfer in high speed free molecule flow. The radiation boundary condition assumes grey body radiation according to the Stefan-Boltzmann law. The cases considered include the infinite geometries with zero and infinite, as well as finite, thermal conductivities. When the temperature is nondimensionalized appropriately, the problem is found to possess similitude properties. Solutions for this dimensionless temperature are found in terms of a similarity parameter. The expected range of the similarity parameter in the upper atmosphere for flight conditions and material properties, is discussed. (Contractor's abstract)

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Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

TEMPERATURE-DEPENDENT LAG IN POLYCRYSTALLINE YTTRIUM-IRON GARNET, by D. J. Epstein and B. Frackiewicz. Jan. 1959, 10p. incl. diagrs. (Technical rept. no. 135) (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Research, and Signal Corps under Nonr-184110 and Rome Air Development Center under AF-0(635)2872) AD 209818   Unclassified

Presented at Fourth Conf. on Magnetism and Magnetic Materials, Philadelphia, Pa., Nov. 17-20, 1958.

Also published in Jour. Appl. Phys., Suppl., v. 30: 295S-296S, Apr. 1959.

Certain samples of polycrystalline yttrium-iron garnet are characterized by a room-temperature permeability spectrum having 2 regions of dispersion, 1 at microwave, the other at radio frequency. The former dispersion is identified as gyromagnetic in origin. The radio-frequency dispersion, which exhibits a temperature-activated shift to lower frequency with decreasing temperature, appears due to an electron-diffusion controlled domain-wall relaxation. The activation energy for the process is 0.38 ev. (Contractor's abstract)

1040

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

PRINCIPLES OF MODERN MATERIALS RESEARCH, by A. von Hippel. Mar. 1959, 24p. incl. diagrs. table, refs. (Technical rept. no. 136) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps und. r Nonr-184110; Air Force under AF 30(635)2872 and Atomic Energy Commission under AT(30-1)1937) AD 214074
                    Unclassified

Published in Proc. Symposium on Materials Research in the Navy, Philadelphia, Pa. (Mar. 17-19, 1959), Dept. of the Navy, Washington, D. C., v. 2: 387-411, 1959.

The various aspects of modern materials research are presented and contrasted with classical materials research. It is pointed out that the former explores and designs on the molecular level. It starts with elementary building stones: the atoms and molecules composed of positive nuclei and compensating electron clouds, which react to electric and magnetic fields with electric and magnetic dipole moments; and the charge carriers, the ions and electrons, directed by such fields and influences by the structure and properties of their surroundings. An example is used to illustrate the method, and the advantages that the new method could offer to science are pointed out.

1041

Massachusetts Inst. of Tech. Lab. for Insulation
Research, Cambridge.

TEMPERATURE AND SPACE-CHARGE EFFECTS IN
LIQUID HYDROCARBONS, by R. Coelho and M. Bono.
June 1959, 13p. incl. illus. table, refs. (Technical
rept. no. 137) [Sponsored jointly by Air Force Office
of Scientific Research, Office of Naval Research, and
Signal Corps under Nonr-184110] AD 219687
Unclassified

Preliminary results on the residual d-c conduction and
space-charge polarization in n-hexane and n-heptane
under highly inhomogeneous field conditions (thin wire
in coaxial cylinder) are presented. A residual current
is observed under high applied voltage for either po-
larity of the test cell. At 20°C the current is 1 order
of magnitude larger when the wire is the positive elec-
trode. As temperature is increased, the residual cur-
rent for the wire positive decreases and for the wire
negative increases, until at 50°C it is about the same
for both polarities. By heating only the wire, observa-
tions supporting and extending these findings were
made. The gross features of the current-voltage
characteristics can be explained by dissociation of po-
lar impurities in the region of high field strength.
The dependence on polarity can be explained by space-
charge distortion of the field. For negative wire, field
emission appears to occur from the wire, surrounding
it with a current-limiting space charge. (Contractor's
abstract)

1042

Massachusetts Inst. of Tech. Lab. for Insulation
Research, Cambridge.

IONIC CONDUCTIVITY OF SILVER IODIDE PELLETS
FOR SOLID-ELECTROLYTE BATTERIES, by J. N.
Nirgudich. June 1959, 22p. incl. illus. tables. (Tech-
nical rept. no. 138) [Sponsored jointly by Air Force
Office of Scientific Research, Office of Naval Research,
and Signal Corps under Nonr-184110] AD 219686
Unclassified

Silver amalgam electrodes were found to provide po-
larization free contacts for the measurement of the
ionic conductivity of compressed AgI powder pellets.
Correlation of the conductivity data with x-ray diffrac-
tion studies established the presence of a deformed
hexagonal phase as an important factor in determining
pellet conductivity. Deformation can be induced by
compression, but care must be taken to avoid trans-
formation into the face-centered cubic phase with some
resultant decrease in conductivity. Preliminary evi-
dence is presented to the fact that hexagonal deforma-
tion can be induced by proper control of the AgI powder.
(Contractor's abstract)

1043

Massachusetts Inst. of Tech. Lab. for Insulation
Research, Cambridge.

SATURATION OF THE MAGNETIC ABSORPTION IN
DILUTE INHOMOGENEOUSLY BROADENED SYSTEMS,
by J. S. Hyde. Oct. 1959, 18p. incl. diagr. refs. (Tech-
nical rept. no. 141) (Sponsored jointly by Air Force
Office of Scientific Research, Office of Naval Research,
and Signal Corps under Nonr-184110) AD 228364
Unclassified

Also published in Phys. Rev., v. 119: 1492-1495,
Sept. 1, 1960

The existing theory due to Portis for the saturation of
inhomogeneously broadened resonances is discussed
and a new theoretical formulation of the problem is de-
veloped using an expression for the transition proba-
bility first given by Rabi. For γH_1 greater than both
T_1^{-1} and T_2^{-1}, the rf field interacts with spins pre-
cessing in the frequency interval γH_1; this expression
permits explicit calculation of the resulting magnetic
loss. No assumption is made of the shape of the indi-
vidual (homogeneously broadened) spin packets in weak
exciting fields. For F centers in alkali halides, the
results are identical with those of Portis, but the under-
lying physical reasons differ. (Contractor's abstract)

1044

Massachusetts Inst. of Tech. Lab. for Insulation
Research, Cambridge.

MAGNETIC RESONANCE AND RAPID PASSAGE IN
IRRADIATED LiF, by J. S. Hyde. Oct. 1959, 29p. incl.
diagrs. table, refs. (Technical rept. no. 142) (Bound
with its Technical rept. no. 141, AD 228364) (Sponsored
jointly by Air Force Office of Scientific Research,
Office of Naval Research, and Signal Corps under Nonr-
184110) AD 228364 Unclassified

Also published in Phys. Rev., v. 119: 1483-1492, Sept. 1,
1960.

The experimental result of Portis that at room tempera-
ture the paramagnetic dispersion signal ($d\chi'_m/dH$) of
radiation induced paramagnetic centers in LiF has the
shape of an undifferentiated Gaussian curve and lags
the modulation field by 90 degrees has been confirmed.
His theory, explaining this result as a manifestation of
rapid-passage behavior, has been tested over a range of
experimental parameters and appears valid. In terms
of this theory we found the spin-lattice relaxation time
$T_1 = 1.5 \times 10^{-4}$ sec at room temperature. The predic-
tion has been made by Portis that, if $\omega_m T_1 \gg 1$, where
ω_m is the modulation frequency, the rapid-passage

signal should lag the modulation field by 180 degrees. A lag of 130 degrees has been found at $4°K$ in LiF, using a modulation frequency of 23 cps, and the phase appears to approach a constant value. The same phase shift (130°) can be found at room temperature by using 400-cps modulation and can be interpreted as indicating that $T_1 = 2.6 \times 10^{-3}$ sec at $4°K$. It seems more likely, however, that at $4°K$ the assumption made by Portis that $T_2 \gg T_1$ fails, and that spin-spin effects made the situation more complex. An argument is presented that the magnetic resonance arises from the F center. From its shape we have obtained a value for the hyperfine splitting: $h_y = 32 \pm 1$ gauss. This result is compared with those of other workers who have reported resolved structure in LiF, and the conclusion is reached that the resolved structure resonances do not arise from the F center. (Contractor's abstract)

1045

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

SOME OPTICAL PROPERTIES OF THE CUPROUS HALIDES AND RELATED COMPOUNDS, by R. Coelho. Oct. 1959, 34p. incl. illus. tables, refs. (Technical rept. no. 143) [Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-184110] AD 229194
Unclassified

The optical absorption spectra of evaporated films of cuprous chloride, bromide, and iodide have been investigated at various temperatures, in an attempt to find how the partial covalence of these compounds affects their optical excitation. Fundamental similarities of structure and shape between the spectra of the alkali and cuprous halides suggest that the localized excitation model is also valid in the latter case. However, noticeable differences in energy, intensity, and splitting indicate that the wave function of the excited electron spreads further away from the halogen nucleus than in the case of the alkali halides. This is supported by the observation of an inner photoeffect which seems to involve the diffusion of excitation. The position and shape of the absorption bands depend somewhat on the thickness of the films and on their state of annealing. Interesting observations on the influence of defects, crystal structure, and lattice distortion in CuCl, CuI, and CuBr, respectively, are reported. The absorption spectra of the cubic (sphalerite) and hexagonal (wurtzite) forms of CuI have been identified with the help of electron diffraction. In CuBr, a band splitting is observed at low temperature for films evaporated on a cleaved NaCl crystal and is attributed to a tetragonal distortion resulting from epitaxy with the substrate. All the observations can be explained qualitatively by regarding the excited state as a (p^5s) electronic configuration perturbed by the crystalline field of the lattice. (Contractor's abstract)

1046

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

K-MESON-NUCLEON TOTAL CROSS SECTIONS FROM 0.6 TO 2.0 BEV, by H. C. Burrowes, D. O. Caldwell and others. [1959] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098]) Unclassified

Published in Phys. Rev. Ltrs., v. 2: 117-119, Feb. 1, 1959.

An experiment to measure the K-nucleon total cross sections at high energy using the K-meson beam of the Bevatron is described. The cross sections for K^+-N, K^+-p, and K^--p were measured. The lifetimes of K^+ and K^- were determined. The K^+-p and K^+-n cross sections are about the same in this energy range, but the K^--p cross section is twice as large.

1047

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

PION-PROTON RESONANCE SCATTERING NEAR 900 MEV, by E. C. Burrowes, D. O. Caldwell and others. [1959] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098]) Unclassified

Published in Phys. Rev. Ltrs., v. 2: 119-121, Feb. 1, 1959.

The scattering of negative and positive pions by hydrogen in the laboratory energy range 470 to 1200 mev was investigated in order to clarify the broad resonance occuring near 900 mev. The target was five feet of liquid hydrogen. The experimental setup is described, and results given.

1048

Massachusetts Inst. of Tech. [Lab. for Nuclear Science] Cambridge.

Ni^{60}(d, p)Ni^{61} STRIPPING ANALYSIS (Abstract), by R. A. Fisher and H. A. Enge. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 287, Apr. 30, 1959.

The MIT-ONR Van de Graaff generator and the broad-range spectrograph have been used to study the angular distribution of protons emitted from a Ni^{60} target bombarded with the 7.5-mev deuterons. Some preliminary results of the stripping analysis of the most intense proton groups are given. The excitation energies of other Ni^{61} levels have been given by Paris in a previous report.

1049

Massachusetts Inst. of Tech. [Lab. for Nuclear Science] Cambridge.

(p,p') AND (d,p) REACTIONS FROM SILVER (Abstract), by A. Sperduto, M. Mazari, and W. W. Buechner. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 287, Apr. 30, 1959.

Thin targets of natural silver and separated isotopes of silver 107 and 109 have been bombarded with protons and deuterons accelerated by the MIT-ONR Van de Graaff generator with energies up to 7.5 mev. The emitted proton groups have been analyzed with the broad-range magnetic spectrograph with observations being made at several angles between 20 and 130 degrees. Proton groups from inelastic scattering have been identified with levels in Ag^{107} at 0.328, 0.425, 0.784, and 0.984 mev and in Ag^{109} at 0.313, 0.416, 0.701, and 0.861 mev. Evidences for a weak inelastic group, corresponding to an excitation energy of about 100 kev, have been observed from both isotopes. Increased exposures are being planned to obtain more precise measurements. The measurements of several proton groups from the (d,p) reactions have been made. The Q value of the ground-state transition for the $Ag^{107}(d,p)Ag^{108}$ reaction is 4.968 ± 0.010 mev and that for the $Ag^{109}(d,p)Ag^{110}$ reaction is 4.585 ± 0.005 mev.

1050

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

ION FOCUSING PROPERTIES OF A QUADRUPOLE LENS PAIR, by H. A. Enge. [1959] [4]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098)
Unclassified

Also published in Rev. Scient. Instr., v. 30: 248-251, Apr. 1959.

The focusing properties of a quadrupole lens were studied, and the results of thick-lens calculations are presented in graphic form showing the field strength parameters and magnifications as functions of object. It is hoped that this paper will fill the need for results of calculations on focusing properties in a convenient form.

1051

Massachusetts Inst. of Tech. [Lab. for Nuclear Science] Cambridge.

SINGLE QUANTUM ANNIHILATION OF POSITRONS (Abstract), by R. Weinstein. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])
Unclassified

Presented at meeting of the Amer. Phys. Soc., Milwaukee. Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 325, June 18, 1959.

The annihilation of positrons via single quantum emission has been experimentally investigated using a 3-mc Na^{22} source, a large collection efficiency (3.5%) poor resolution beta spectrometer, NaI(Tl) gamma- and x-ray detectors, 2 differential discriminators and a 10^{-7} sec coincidence circuit. The need for large nuclear recoil momenta requires that the annihilation takes place with a K-shell electron. A coincidence is required between a gamma ray and a K x-ray of the proper energies. Initial data on Pb, Pt, Ta, and Al targets is consistent with $\sigma \propto Z^n$, where $n = 5 ^{+3}_{-1}$ This rules out 2 quantum annihilation in the K shell, and agrees well with the expected Z^5 dependence. This salient feature of single quantum annihilation has not previously been observed. The counting rate decreased as expected for x-ray energies above and below the K x-ray peak. The absolute magnitude of the cross section was evaluated to $\pm 50\%$ at $E_\beta - 400$ kev. Within experimental accuracy the results agree with the Jager-Hulme cross section. The Born approximation cross section is clearly ruled out.

1052

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

SCATTERING OF 50- TO 140-MEV PHOTONS BY PROTONS AND DEUTERONS, by L. G. Hyman, R. [P.] Ely and others. [1959] [4]p. incl. diagrs. refs. (Sponsored

jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])   Unclassified

Published in Phys. Rev. Ltrs., v. 3: 93-96, July 15, 1959.

A report is given on Compton scattering of photons by protons below π meson photothreshold. Experimental and theoretical cross sections for scattering of photons by hydrogen are plotted as a function of lab. energy at a center of mass angle of 90°. They are in good agreement with previous results. It is concluded that (1) the observed scattering of photons at 90° c.m. over the energy range 0-300 mev is described well by a model of the proton as a Dirac particle plus strong pion interactions giving the well-known $3/2$, $3/2^+$ and $1/2$, $3/2^-$ resonances, provided the half-life of the π-meson is greater than 10^{18} sec; and (2) the scattering of photons by deuterons below meson threshold is more than expected.

1053

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

ENERGY LEVELS OF A BOSE-EINSTEIN SYSTEM OF PARTICLES WITH ATTRACTIVE INTERACTIONS by K. Huang. [1959] [13]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])   Unclassified

Published in Phys. Rev., v. 115: 765-777, Aug. 15, 1959.

An N-body Bose-Einstein system of particles with long-range attraction and hard-sphere repulsion between particles is considered. It is shown that if the constants of the interaction have values within a certain range it is possible to calculate the ground-state energy of the system as a function of Ω/N, where Ω is the volume of the box containing the system, in the limit $N \to \infty$, $\Omega \to \infty$, with $N/\Omega = \rho$ fixed. The results show that the system can possess an N-body bound state, which has an equilibrium density and negative energy, and that the interactions can be saturating. Excited states are also considered. It is shown that low-lying excitations consist purely of phonons, whose velocity agrees with that computed from the macroscopic compressibility, furnished by the ground state energy. The formula for the general excited energy levels suggests that thermodynamically the system has a "gas" phase and two "liquid" phases, the transition between the two "liquid" phases being the analog of the Bose-Einstein condensation of the ideal gas. Thermodynamic considerations are, however, not contained in this paper.

1054

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

RESULTS OF STRIPPING ANALYSIS OF THE REACTION $K^{39}(d,p)K^{40}$, by H. A. Enge, E. J. Irwin, Jr., and D. H. Weaner. [1959] [7]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098)   Unclassified

Published in Phys. Rev., v. 115: 949-955, Aug 15, 1959.

The MIT-ONR electrostatic generator and the broad-range spectrograph have been used to study the energies and angular distributions of protons emitted from a KI target bombarded with 6-mev deuterons. Excitation energies are given for 52 levels in K^{40}. Orbital angular momenta of captured neutrons in the stripping process are given for 38 of these excited levels and for the ground state. The reaction energy for the ground-state transition has been measured as $Q = 5.569 \pm 0.010$ mev. (Contractor's abstract)

1055

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

TWO BODY FORCES IN LIGHT DEFORMED NUCLEI, by D. M. Brink and A. K. Kerman. [1959] [13]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098)   Unclassified

Published in Nuclear Phys., v. 12: 314-326, Aug. 1959.

There is evidence that the light nuclei in the aluminum region have rotational states. It is well known from studies of heavy rotating nuclei that an independent particle model for a deformed well as used by Nilsson is a surprisingly good approximation for many of the properties of these collective states. However, it has been clear for some time that 2 body correlations are important for a more complete understanding of the situation. Because of the number of single particle states for the light nuclei is relatively small and because isobaric spin is a good quantum number, some studies have been undertaken on the effect of 2 body forces on binding energies and energy levels. The method of Bacher and Goudsmit has been employed to find relations among binding energies which depend only upon the existence of 2 body forces and the assumption that the deformed wave function coupling scheme is a good first approximation. The relations so obtained are remarkably well fulfilled by the data while corresponding relations obtained for the spherical shell model are not. Some of the possible excited states in these nuclei are also discussed and estimates made of their energies.

1056

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

PHOTOPRODUCTION OF NEUTRAL MESONS FROM HYDROGEN NEAR THRESHOLD, by P. D. Luckey, L. S. Osborne, and J. J. Russell. [1959] [3]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])
Unclassified

Published in Phys. Rev. Ltrs., v. 3: 240-242, Sept. 1, 1959.

The differential cross section for the reaction $\gamma + p \rightarrow p + \pi^\circ$ was measured for mean incident γ-ray energies of 170 and 190 mev by measuring single π°-decay γ-ray yields from a liquid hydrogen target at laboratory angles 48°, 81°, and 141°, and bremsstrahlung peak energies 160, 180, and 200 mev. The details of the absorption spectrometer are given. The spectrum of π°-decay γ rays in the center of mass of the reaction $\gamma + p \rightarrow p + \pi^\circ$ is given by an effective γ-ray production cross section $\dfrac{d^2\sigma^\gamma}{d\Omega dE_\gamma} = \dfrac{2}{q} \sum_n a_n P_n(\theta_\gamma) P_n(\varphi)$, if the original π° cross section is written as $d\sigma^\pi/d\Omega = \sum_n a_n P_n(\theta_\pi)$, where $\varphi = \cos^{-1}(1/\beta - u^2/2qE\gamma)$ is the angle between the observed γ ray and its parent π°; u, β, and q are the π° mass, velocity, and momentum in the center-of-mass system respectively; and P_n is the Legendre polynomial of order n. The data were divided into bins of $\Delta(\cos \varphi) = 0.2$ wide and for each bin the coefficients $a_0 P_0(\varphi)$, $a_1 P_1(\varphi)$, and $a_2 P_2(\varphi)$ were determined and plotted. A fit to the various $P_n(\varphi)$ was made to determine the coefficients a_0, a_1, and a_2. The errors associated with these values include 3 sources: (1) statistics; (2) uncertainty in the counter-efficiency at low energies; and (3) uncertainty in the location of the energy E_γ corresponding to a particular value of $\cos\varphi$. In addition, γ-ray yields were also measured at a peak bremsstrahlung energy of 140 mev.

1057

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

SCINTILLATION CHAMBER WORK AT M.I.T., by H. S. Bridge, D. O. Caldwell and others. [1959] 4p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098)
Unclassified

Published in Proc. Internat'l. Conf. on High-Energy Ac-

celerators and Instrumentation - CERN 1959, Geneva (Switzerland) (Sept. 14-19, 1959), Geneva CERN, Scientific Information Service, 1959, p. 572-575.

A brief report is given on fiber scintillation chambers sufficiently large enough to yield a useful rate of events. A chamber of plastic scintillating fibers 5 x 5 x 10 in. is proposed that is thought to meet this requirement. Its reported resolution is expected to be about 1 mm.

1058

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

THE USE OF ELECTROSTATIC GENERATORS AS INJECTORS FOR ELECTRON SYNCHROTRONS, by D. Luckey. [1959] [3]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098)
Unclassified

Published in Nuclear Instr. and Methods, v. 5: 266-268, Oct. 1959.

Some experiences with the use of electrostatic generators as injectors for electron synchrotrons at Cornell U. and M.I.T. are described. At M.I.T. the injection energy was changed without any other essential modifications to the synchrotron. A factor of 10 in intensity has been obtained, along with greater stability. Space charge does not appear to be the limiting mechanism of the beam current. (Contractor's abstract)

1059

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

NUCLEAR POLARIZATION OF Co^{55}, by R. W. Bauer and M. Deutsch. [1959] [13]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098)
Unclassified

Presented at meeting of the Amer. Phys. Soc., Cleveland, Ohio, Nov. 27-28, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 425-426, Nov. 27, 1959.

Also published in Nuclear Phys., v. 16: 264-277, May 1, 1960.

The angular distribution and linear polarization of the gamma rays emitted from 18-hr Co^{55}, polarized at low temperatures in cerium-magnesium nitrate crystals, have been measured. The amplitude mixing ratios $\kappa(E2/M1)$ of mixed multipole gamma transitions in Fe^{55}

have been determined. With a spin of 7/2 for Co^{55}, we find a spin sequence of $7/2 \to 5/2 \to 3/2$ in the main decay in Fe^{55}, and for the 0.935 mev gamma ray a g of $+0.36 \pm 0.11$. A possible spin sequence $5/2 \to 7/2 \to 3/2$ in Fe^{55} has been eliminated by our linear polarization measurements. The ratio of the nuclear g-values of Co^{58} and Co^{55} has been found from a simultaneous measurement of the angular distribution of the gamma rays from the two isotopes grown into the same crystals. The magnetic moment of Co^{55} is 5.3 ± 0.4 n.m., if the 1.03 mev beta branch is predominantly a G.T. transition, or 4.6 ± 0.4 n.m., if a pure Fermi transition. (Contractor's abstract)

1060

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

IMAGINARY PART OF THE OPTICAL POTENTIAL, by L. C. Gomes. [1959] [4]p. incl. diagrs. table. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(40-1)2098])   Unclassified

Published in Phys. Rev., v. 116: 1226-1229, Dec. 1, 1959.

The imaginary part of the optical potential has been investigated for low-energy incoming neutrons, by means of the nucleon-nucleon cross sections in nuclear matter. The cross sections have been calculated under the assumption that pair correlations for low excited states of nuclear matter are the same as those formed in the ground state. The dependence of the effective mass on the single-particle momentum has been taken into consideration using an empirical solution which reproduces the present assumptions for the single-particle spectrum. The results have been applied to the nuclear surface in the Thomas-Fermi approximation. The maximum in the imaginary potential was found to be at the surface outside of the half-density radius. For low incident energies it is about 1.5×10^{-13} cm beyond this radius. (Contractor's abstract)

1061

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

MEASUREMENT OF THE SPIN AND PARITY OF THE ANOMALOUS INELASTIC STATES IN Ni^{58} AND Ni^{60}, by M. Crut and N. S. Wall. [1959] [3]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])

Unclassified

Published in Phys. Rev. Ltrs., v. 3: 520-522, Dec. 1, 1959.

In this note experiments establishing the spin and parity of the 4.5-mev structure in Ni^{58} and Ni^{60} are reported on. Angular distribution of alpha particles scattered from Ni^{58} and Ni^{60}, respectively, leaving the target nucleus in the ground state and 1st excited state are shown. Measurements of the distribution show that the parity of the "anomalous state" in Ni^{58} and Ni^{60} is different from that of the ground state whereas the parity of the 1st excited state is the same as the ground state. The angular correlation results can be interpreted as showing that the "anomalous state" is 3^- and decays to the 1st excited 2^+ state through the emission of electric dipole radiation.

1062

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

SEA-LEVEL COSMIC-RAY MASS SPECTRUM IN THE INTERVAL $30m_e$-$2000m_e$, by G. G. Fazio and M. Widgoff. [1959] [4]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])   Unclassified

Published in Phys. Rev., v. 116: 1263-1266, Dec. 1, 1959.

In nuclear emulsion stacks exposed to sea-level cosmic radiation under 180 g cm^{-2} of iron, no evidence for mass values in the regions $30m_e$ to $100m_e$ and $400m_e$ to $900m_e$ was found. If such particles do exist, their intensity relative to that of μ mesons stopping in the same range interval must be as follows: for $30m_e$ to $100m_e$, $\leq 0.13\%$; for $400m_e$ to $900m_e$, $\leq 0.04\%$.

1063

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

SEARCH FOR ANOMALOUS LIFETIME VALUES IN SEA-LEVEL COSMIC RADIATION, by G. G. Fazio and D. M. Ritson. [1959] [3]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])   Unclassified

Published in Phys. Rev., v. 116: 1267-1269, Dec. 1, 1959.

By use of a scintillation counter telescope, sea-level cosmic radiation was investigated for the existence of

particles of mass greater than $60m_e$, decaying with lifetimes in the msec region. If such particles exist, their intensity, relative to μ mesons, for various lifetime ranges, must be as follows: for 10^{-4} to 10^{-2} sec, $\leq$ 0.03%; for 10^{-4} to 5×10^{-2} sec, $\leq$ 0.1%; for 10^{-4} to 10^{-1} sec, $\leq$ 0.14%; for 10^{-4} to 10^{-1} sec (for decay into a light meson), $\leq$ 0.03%; for 10^{-4} to 1.0 sec, $\leq$ 1.4%.

1064

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

MESON-NUCLEON SCATTERING AND NUCLEAR FORCES, by V. F. Weisskopf. [1959] [3]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098]) Unclassified

Published in Phys. Rev., v. 116: 1615-1617 Dec. 15, 1959.

A simple derivation which does not make use of field theory is given of the main results of the static theory of π-meson scattering by nucleons. The derivation serves to elucidate the connection between low-energy meson scattering and the nuclear forces of large distances.

1065

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

SEARCH FOR $\pi_{10}^0 \rightarrow 3_\gamma$, by R. P. Ely and D. H. Frisch. [1959] [3]p. incl. diagr. tables. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098]) Unclassified

Published in Phys. Rev. Ltrs., v. 3: 565-567, Dec. 15, 1959.

This note discusses an experimental search for a neutral meson of isotopic spin zero, using a method which covers only a small part of the possible mass spectrum, and which can detect the 3_γ decay of a neutral meson of mechanical spin 1, the π_{10}^0, but which cannot detect the 2_γ decay of the ordinary π^0. A detailed description of the experimental apparatus is given explaining why it can detect the π_{10}^0, but not the $\pi^0 2_\gamma$ decay. Results, given in table form, show that a $\alpha \geq$ 95, the net rate observed at 160 mev is (2.0 ± 0.6)% of that from 3 pairs of counters counting ordinary π^0's in the $\alpha = 150°$ position. Only the following conditions

in background considerations are expected to contribute appreciably to this net rate: (1) cosmic-ray coincidences, measured to give (20 ± 2)% of the above rate, (2) coincidences between 1 of the electrons and the gamma in the Dalitz pair decays, $\pi^0 \rightarrow e^+ + e^- + \gamma$, estimated to give (10 ± 3)% and (3) coincidences between 1 of the γ rays from the π^0 and the nuclear γ ray in the reaction $p + Li^7 \rightarrow Be^8 + \pi^0 \rightarrow Be^8 + \gamma$ (17 mev) + 2_γ, estimated to give (± 4)%. The corrected net rate at $E_p = 160$ mev, after subtracting these 3 backgrounds, is (1.2 ± 0.6)% of the $\alpha = 150°$ ordinary π^0 equivalent counting rate.

1066

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

AN AID IN THE DETERMINATION OF NUCLEAR SPINS, by R. K. Sheline, H. L. Nielsen, and A. Sperduto. [1959] [5]p. incl. diagrs. table. (In cooperation with Florida State U., Tallahassee) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098) Unclassified

Published in Nuclear Phys , v 14: 140-144, Dec. 1959.

Intensities of the α groups collected in the backward angle from the $Al^{27}(d,\alpha)Mg^{25}$ reaction have been analyzed after recording them on nuclear emulsions over an extended range of excitation. Given intensities are determined with an average deviation of ≈ 15%. Normalizing the intensities by $2I + 1$ and barrier penetration factors produces intensities which are the same within an average deviation of 33%. Use of intensities as an aid in determining spin is suggested.

1067

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

NUCLEAR ORIENTATION OF Mn^{56}, by R. W. Bauer an M. Deutsch. [1959] [7]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098]) Unclassified

Published in Phys. Rev., v. 117: 519-525, Jan. 15, 1960.

The angular distribution and circular polarization of the gamma rays emitted from 2.6-hr Mn^{56}, polarized at low temperatures in cerium magnesium nitrate, have been measured. Comparing the angular distribution results with angular correlation data it is possible

to establish the spins of the 2.65- and 2.98-mev excited states of Fe^{56} as 2 uniquely. The amplitude mixing ratios $\delta(E2/M1)$ for the 1.81- and 2.13-mev γ-rays are shown to be $+0.11 \pm 0.06$ and -0.27 ± 0.03, respectively.

Gamma anisotropies from aligned Mn^{56} in the same cooling salt have been studied; the results are compared with other Mn alignment experiments. From a simultaneous measurement of the angular distribution of the γ-rays from polarized Mn^{52} and Mn^{56}, the ratio of the nuclear g-values $(g_{52}/g_{56}) = 0.47 \pm 0.05$ has been determined, giving $\mu_{56} = 3.35 \pm 0.35$ nm. The results of the circular polarization experiment determine μ_{56} to be positive. (Contractor's abstract)

1068

Massachusetts INST° OF Tech. Naval Supersonic Lab., Cambridge.

RESEARCH ON HEAT TRANSFER CHARACTERISTICS OF DIFFUSION BOUNDARY LAYERS. Final rept. Apr. 1959, 7p incl. refs. (Technical rept. no. 374) (AFOSR-TR-59-41) (AF 18(603)82)   Unclassified

The mass transfer investigation at the Naval Supersonic Lab is concerned with the consequences of binary-mixture flow in the high-speed boundary layer. Such flow is of interest as a possible means for overcoming the severe thermal problem associated with supersonic flight. The object of the investigation is two-fold: (1) to conduct experimental programs which will enable comparison to be made with available theoretical results which indicate profound alterations of both heat transfer rates and equilibrium temperatures upon the injection of certain types of coolants, and (2) to conduct associated analyses which will further define the limits and effects of both the injection process and mass diffusion phenomena so as to provide some insight into the criteria for such systems.

1069

Massachusetts Inst. of Tech. Naval Supersonic Lab., Cambridge.

AN "INSULATING" BOUNDARY-LAYER EXPERIMENT, by F. H. Durgin. [1959] [2]p. incl. diagr. table. (AF 18(603)82)   Unclassified

Published in Aero/Space Sci., v. 26: 450-451, July 1959.

Quantitative confirmation of the fact that the heat transfer at any point is influenced by the upstream history of the flow are presented. It is shown that the measurements for laminar flow are 0.5 and 1.5 for m(flat plate) and m(cone) respectively. The turbulent flow calcula-

tions are 0.8 for the flat plate and 1.8 for the cone. It is concluded that the persistence of cooling (the "insulating" property) is appreciable even 1 nose length behind the copper section.

1070

Massachusetts Inst. of Tech. Naval Supersonic Lab., Cambridge.

SUBLIMATION OF A HEMISPHERE IN SUPERSONIC FLOW, by R. Weiss. July 1959, 61p. incl. illus. diagrs. tables, refs. (Technical rept. no. 391) (AFOSR-TN-59-870) (AF 49(638)245) AD 227553; PB 144496
Unclassified

Mass transfer cooling with a light gas has been shown to reduce the large heat transfer rates to a body that is moving rapidly through the atmosphere. The possibility of using a subliming body so as to provide self governing mass transfer cooling has been suggested. To make a preliminary evaluation of this approach, an investigation of the heat transfer rates to several subliming bodies of hemispherical shape has been carried out. Tests were run at a Mach number of 3.5 with solid carbon-dioxide, naphthalene and camphor, 3 relatively "heavy" materials. Additional tests with camphor models determined the effect of Reynolds number on the heat transfer rate. It was found that heat transfer was reduced in proportion to the mass-injection rate, that a greater reduction was effected with a lesser weight material, and that increasing Reynolds number also produced a lower level of heat transfer coefficient. The bodies tended to assume a conical shape, a phenomenon more noticeable with increasing Reynolds number; only 1 model appeared to have reached a state of equilibrium. The investigation indicated both the feasibility of conducting an experiment of this nature and the applicability of subliming bodies both in reducing and absorbing aerodynamic heating. (Contractor's abstract)

1071

Massachusetts Inst. of Tech. Naval Supersonic Lab., Cambridge.

AN INVESTIGATION OF POROUS WALL COOLING, by R. P. Bernicker. June 1959, 59p. incl. illus. diagrs. table, refs. (Technical rept. no. 393) (AFOSR-TN-59-873) (AF 49(638)245) AD 227555; PB 144473
Unclassified

Equations are developed to describe the thermal exchange when a coolant is forced through a heated porous wall, and solutions are obtained on the basis of a simplified model consisting of identical cylindrical channels replacing the actual capillary-like passages. The solutions depend upon Reynolds and Prandtl numbers, geometric parameters involving wall porosity and pore size, and Nusselt number. Experiments were performed with 1 family of porous materials, and Nusselt numbers were correlated in terms of Reynolds and Prandtl

numbers, and porosity. Nusselt number varies almost
linearly with Peclet number. Temperature distribu-
tions obtained indicate a very small difference between
solid and coolant temperatures at the exit surface.
(Contractor's abstract)

1072

Massachusetts Inst. of Tech. Naval Supersonic Lab.,
Cambridge.

SOME APPROXIMATIONS TO THE SOLUTION TO
THE BINARY BOUNDARY-LAYER PROBLEM, by
E. E. Covert. Sept. 1959, 23p. incl. diagrs. tables.
(Technical rept. no. 390) (AFOSR-TN-59-1091)
(AF 49(638)245) AD 235990; PB 147781 Unclassified

Some approximate relations between shear, mass trans-
fer and heat transfer are developed for the case of ar-
bitrary external velocity, blowing distribution, and
wall temperature. The approximations are compared
with known solutions and are in satisfactory agree-
ment with them. (Contractor's abstract)

1073

Massachusetts Inst. of Tech. Naval Supersonic Lab.,
Cambridge.

HEAT AND MASS TRANSFER FOR FLOW PAST AN
ARBITRARY CYLINDER, by P. B. Scott. Sept. 1959,
87p. incl. diagrs. tables, refs. (Technical rept. no.
383) (AFOSR-TN-59-1268) (AF 49(638)245)
AD 235991 Unclassified

Previous investigators have indicated that heat trans-
fer to aerodynamic surfaces can be materially re-
duced by the injection of a foreign gas of high specific
heat through a porous wall into the boundary layer. A
method is presented which determines the heat trans-
fer to a cylinder of arbitrary cross section, under-
going foreign gas injection, and specifically that injec-
tion distribution corresponding to an isothermal wall.
A step-by-step solution is obtained by matching the
boundary-layer flow at any station of a cylinder to the
flow at a corresponding station on an equivalent wedge.
The necessary parameters are derived by considera-
tion of the boundary-layer equations. The matching
criteria are presented and 2 methods of solution
(graphical and numerical) are described The neces-
sary set of wedge flow solutions have been obtained
for various wedge apex angles and helium injection.
Sample calculations using the numerical method are
presented. (Contractor's abstract)

1074

Massachusetts Inst. of Tech. Research Lab. of
Electronics. Cambridge.

A LINEAR CIRCUIT VIEWPOINT ON ERROR-COR-

RECTING CODES, by D. A. Huffman. [1956] [9]p. incl.
diagrs. tables. (Sponsored jointly by Air Force Office
of Scientific Research, Office of Naval Research, and
Signal Corps under [DA 36-C39-sc-64637])
Unclassified

Presented at 1956 Symposium on Inform. Theory,
Massachusetts Inst. of Tech., Cambridge, Sept. 10-12,
1956.

Published in I R.E. Trans. on Inform. Theory, v. IT-2:
20-28, Sept. 1956.

Presented at Internat'l. School of Physics, Varrena
(Italy), July 7-14, 1958.

Also published in Nuovo Cimento, Series X, Suppl.,
v. 13: 389-396, 1959.

A linear binary filter has as its output a binary se-
quence, each digit of which is the result of a parity
check on a selection of preceding output digits and of
present and preceding digits of the filter input sequence.
The terminal properties of these filters may be de-
scribed by transfer ratios of polynomials in a delay op-
erator. If 2 binary filters have transfer ratios which
are reciprocally related then the filters are mutually in-
verse in the sense that, in a cascade connection, the 2nd
filter unscrambles the scrambling produced by the 1st.
The coding of a finite sequence of binary information
digits for protection against noise may be accomplished
by a binary sequence filter, the output of which becomes
the sequence to be transmitted. The inverse filter is
utilized at the receiver. (Contractor's abstract)

1075

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

OBSERVATIONS ON INHARMONIC SIGNALS (Abstract),
by E. DeBoer. [1957] [1]p. (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval
Research, and Signal Corps under [DA 36-039-sc-
64637])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., New
York, May 23-25, 1957.

Published in Jour. Acoust. Soc. Amer., v. 29: 780, June
1957.

Schouten's "residue" can be readily observed when a
group of closely spaced Fourier components is pre-
sented. Such a sound often exhibits a basic pitch, es-
pecially when the complex stimulus is harmonic. The
pitch level is then judged to be the fundamental frequen-
cy (which in this case equals the difference frequency).
In the present study signals consisting of a restricted
number of equally spaced components were investigat-
ed. The sound observed is steady in both pitch and
timbre even when the stimulus is inharmonic. The pitch
level however corresponds not necessarily to the

difference frequency as can be demonstrated when all components are displaced by the same amount in frequency. For small departures from harmonicity, the pitch appears to follow the direction of this frequency shift of the complex. More specifically, the relative pitch change is approximately equal to the relative frequency change of the central component, the timbre not being affected much. The timbre depends strongly upon the relative phases of the components, so that it seems closely tied to the shape of the envelope of the signal's wave form.

1076

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

TOPOLOGICAL ANALYSIS OF LINEAR NONRECIPRO-CAL NETWORKS, by S. J. Mason. [1957] [10]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-64637])   Unclassified

Published in Proc. Inst. Radio Engineers, v. 45: 829-833, June 1957.

Kirchhoff and Maxwell gave us topological inspection rules for evaluating the transmission of a linear reciprocal branch network. With the addition of the unistor, a branch-like element whose current is proportional to one of its two terminal potentials and independent of the other terminal potential, or the gyristor, whose current is proportional to the sum of its two terminal potentials, we can model any linear network, in general nonreciprocal. The point is that the Kirchhoff-Maxwell methods carry over to such networks without change of form, the only modification of the transmission expression being a relatively simple sign rule for gyristor admittances or a relatively simple nullification rule for unistor admittances.

1077

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE DEGREES OF FREEDOM IN RLC NETWORKS, by A. Bers. [1959] [5]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-64637])   Unclassified

Published in I.R.E. Trans. on Circuit Theory, v. CT-6, 91-95, Mar. 1959.

In networks containing only 2 kinds of elements (RL, RC, or LC), the degrees of freedom are usually found from the number of normal modes of oscillation of the system. The normal modes are readily determined from the topology of the subgraphs for each kind of element. In RL and RC networks the degrees of freedom are equal to the number of normal modes, while

in LC networks the degrees of freedom are equal to twice the number of normal modes. The present paper shows that the number of natural frequencies of any RLC network can be determined in a rather simple manner. The known results for networks containing only 2 kinds of elements are shown to be derivable as special cases. The introduction of resistance (loss) into a network (linear system) will usually change the number of degrees of freedom of the network. It is shown here that this change can be accounted for exactly from some of the topological changes in the network.

1078

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FM INTERFERENCE AND NOISE SUPPRESSION PROP-ERTIES OF THE OSCILLATING LIMITER (Abstract), by E. J. Baghdady. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-64637])
Unclassified

Presented at I. R. E. National Convention, New York, Mar. 23-26, 1959.

Published in I. R. E. National Convention Record, Part 8: 13-39, 1959.

A study of the phenomenon of oscillator locking is carried out for oscillators that are built around an amplitude limiter. A theory is presented for the locking mechanism that is involved when one or more signal carriers are impressed at the oscillator input. The bearing of the results upon interference suppression in FM reception is emphasized. Limitations imposed by phase shifts around the loop upon locking range and threshold are discussed. The oscillating limiter is revealed as a remarkable tool for minimizing cochannel FM disturbances, and for suppressing an adjacent-channel signal, whether it be stronger or weaker than the in-band signal. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

REPETITIVE DISCHARGE OF NEURONS, by P. D. Wall. [1959] [16]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-64637]; and Bell Telephone Labs. Inc., National Science Foundation, and Teagle Foundation, Inc.)   Unclassified

Published in Jour. Neurophysiol., v. 22: 305-320, May 1959.

The nature and origin of 2 types of "after-discharge" were examined. The 1st occurs in sensory afferent

fibers to the spinal cord. After the arrival of a single afferent volley, a repetitive antidromic discharge called the dorsal root reflex, DRR, is generated in the terminals of the active fibers and in their passive neighbors. The DRR was set off by stimulation of peripheral nerves. The initial latency and the variation of latency throughout the discharge depends on the nerve stimulated and the strength of stimulation. The pattern of the response differs markedly from that seen in the interneurons on which the fibers end. The time of arrival of the afferent impulse in an afferent fiber does not affect the pattern of the DRR. The interjection of an impulse into a DRR resets the rhythm and it is concluded that the site of origin of the rhythm is within the fiber. "Spontaneous" activity of peripheral sensory endings is similarly reset by the introduction of additional impulse. The 2nd type of "after-discharge" examined was that produced by dorsal horn sensory interneurons after the arrival of a single volley from a peripheral sensory nerve. The pattern of discharge of the sensory interneurons varies among 3 types of responses: a low-frequency short discharge with great variation of latency, a high-frequency prolonged discharge and a short abrupt discharge. The interjection of an additional impulse into the repetitive discharge of an interneuron fails to reset the rhythm and the discussion concludes that the repetitive firing is probably driven by bombardment from other neurons. The "spontaneous" activity of the interneurons is not obviously reset by interjected impulses. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SPECTRAL EMISSIVITY OF TUNGSTEN, by R. D. Larrabee. [1959] [7]p. incl. diagrs table. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-64637]) AD 221257   Unclassified

Also published in Jour. Opt. Soc. Amer., v. 49: 619-625, June 1959.

An experiment designed to measure the spectral emissivity of tungsten, in which a direct comparison method is utilized so that the spectral emissivity is observed as the ratio of light intensity from a tungsten source to that from a blackbody source, is described. The spectral emissivity was measured over the wavelength interval 310 mμ to 800 mμ and the temperature interval 1600°K to 2400°K. (Contractor's abstract)

1081

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EFFECT OF A PLANE ON THE POWER OUTPUT OF A MONOPOLE (Abstract), by G. C. Maling, Jr. [1958]

[1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])   Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 115, Jan. 1959.

The presence of a plane boundary is known to affect the power output of a sound source, and the effect is most conveniently expressed as a "power amplification factor (W/W_0)" which will in general depend on type of

sound source, distance from plane, and boundary admittance. For a constant strength monopole near a plane with specified normal admittance (real), the power amplification factor can be calculated rigorously in terms of tabulated functions using existing theory on the reflection of a spherical wave from an infinite plane specified by impedance boundary conditions (U. Ingard, Jour. Acoust. Soc. Amer., v. 23: 329, 1951). Plots of W/W_0

as a function of source height are presented for several values of normal admittance including $\beta = 1$.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EQUIVALENT CIRCUIT REPRESENTATION OF A FLEXIBLE, POROUS MEDIUM (Abstract), by W. W. Lang. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 115, Jan. 1959.

As an extension to the general investigation of sound propagation in a flexible, porous medium reported at the Fifty-fifth meeting (Jour. Acoust. Soc. Amer., v. 30: 670 1958), an equivalent circuit representation of such a medium has been developed. At low frequencies a flexible, porous layer which is rigidly backed and locally reacting can be represented by lumped circuit elements. The circuit studied here consists of 2 parallel branches, 1 representing the air enclosed by the structure and the other representing the structure itself. From the specific acoustic impedance of this circuit, the percentage of incident sound energy absorbed at a flexible, porous surface is determined for a range of values of the significant physical constants which characterize the material. Coupling between the structural elements and the air enclosed by the structure is not described by such a simple circuit. The extent to which

this simple representation described the influence of nonrigidity on the sound energy absorbed by the porous surface is discussed.

1083

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EXPERIMENTS ON SCATTERING OF SOUND BY TURBULENCE (Abstract), by M. D. Mintz and U. Ingard. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 115, Jan. 1959.

Some results from field measurements on the scattering of sound have been presented previously. In the present paper, results from laboratory experiments are reported. Pulses of 100 kc/sec sound, transmitted through a region of turbulence, are analyzed by means of a pulse height analyzer and counter. The pulse height distribution is determined for various scattering angles and the corresponding scattered sound energy is evaluated. In addition to these results on scattering of a collimated beam of sound, some preliminary results on the scattering of a cylindrical wave are presented.

1084

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

LOUDNESS JUDGEMENTS ON CLICKS (Abstract), by C. D. Geisler, C. M. Molnar and others. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31   ), Jan. 1959.

Two groups of experiments were performed to study the ways in which listeners will scale and categorize acoustic clicks of different intensities. The 1st group of experiments posed to listeners the task of estimating the numerical magnitude of clicks that varied in intensity over an 80-db range. In 1 experiment a standard click was presented 10 times at the beginning of each test series (81 clicks), in another experiment a standard click was presented before each stimulus, and in a 3rd experiment no standard click was given. In a 2nd

series of experiments, the listeners were asked to assign clicks according to their loudness to 1 of 5 categories; the intensity ranges covered and the number of stimulus levels varied. The results of the magnitude estimation experiments agree reasonably well with the Stevens scale of loudness $L = KI^{0.3}$; there is the usual amount of inter- and intra-listener variability. The results reflect to some extent the subjects' peculiarities in the use of numbers. The results of the categorization experiments demonstrate that the assignment of clicks to loudness categories depends not only on the intensity of the particular click which is being judged but also to some extent upon the stimulus ensemble as a whole.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MODE COUPLING ON A STRING - AN EXAMPLE OF MAGNETOMECHANICS OF EXTENDED SYSTEMS (Abstract), by U. Ingard. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 114, Jan. 1959.

The motion of a stretched string, forming 1 part of an electric circuit, is studied as the string oscillates in a magnetic field. Special attention is paid to the mode coupling provided by the magnetic field, the rate of growth of higher modes as the string is released from its fundamental mode displacement, and the "equilibrium"-energy distribution on the various modes of the string. In addition to the study of the finite string, the scattering of a wave on an infinite string running through a magnetic field is discussed.

1086

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NOISE GENERATION BY INTERACTING AIR JETS (Abstract), by U. Ingard and G. C. Maling, Jr. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 117, Jan. 1959.

Measurements of the noise produced as a result of the

interaction of 2 air jets at angles of intersection between 0° and 180° have been reported. The acoustic power from the jets was found to increase with the angle of intersection and reach a maximum when the angle is about 90°. In the present case (jet diam 2 cm, Mach number M ~ 0.5) the maximum value cf the interaction noise power is about 12 db larger than the power from the 2 jets separately. As an extension of this work measurements have been made as a function of the vertical separation of the jets, keeping the angle cf intersection constant, equal to 90°. An attempt is made to explain the results from these experiments in terms of the effect of the mean gradients in the flow, which leads to a radiated sound power proportional to the integral of $u'^6 |grad\ U|^2$ (Lighthill, 1952) where u' and U are the local fluctuating and mean velocities of the jets, respectively. The experimental results can be satisfactorily explained on this basis since the noise from 2 interacting jets seems to be predominantly a result of mean shear. On the basis of these results the noise from a single jet is discussed as a sum of contributions proportional to u'^8 and $u'^6 |grad\ U|^2$, respectively, and the relative importance of these terms is discussed.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

"STEADY-STATE" AUDITORY NERVE POTENTIALS FOR DIFFERENT STIMULUS REPETITION RATES (Abstract), by W. T. Peake, M. H. Goldstein, Jr., and N. Y-S. Kiang. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 123, Jan. 1959.

Two major difficulties encountered in recording auditory nerve potentials at high stimulus repetition rates are (1) the small amplitude of the responses, and (2) the possible contamination by aural microphonics. With the aid of an average response computer, the behavior of the N_1 and N_2 components to weak bursts of noise have been studied; the averages were computed for time intervals that start several seconds after the onset of the stimulus. Gross electrodes were placed either near the round window or in the vicinity of the internal auditory meatus of anesthetized cats. This procedure optimizes the detection of the neural components and the amplitudes of the "steady-state" neural responses can be measured as the repetition rate is changed. Above 10/sec the amplitude decreases continuously as the repetition rate increases. There are irregularities for rates near 600/sec, which may result from the interaction of N_1 with the previous N_2. The maximum rate at

which synchronized activity is detectable lies around 3000/sec. The plot of amplitude vs rate does not exhibit plateaus as Derbyshire and Davis found in recording "maximal unequilibrated" responses at the onset of pure tone stimuli.

1088

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ELASTIC CONSTANTS OF INDIUM ANTIMONIDE FROM 4.2°K TO 300°K, by L. J. Slutsky and C. W. Garland. [1959] [3]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Phys. Rev., v. 113: 167-169, Jan. 1, 1959.

The adiabatic elastic constants of a single crystal of indium antimonide have been measured by an ultrasonic pulse technique in which 10-mc/sec acoustic waves are employed. The elastic constants extrapolated to 0°K are, in units of 10^{12} dynes/cm^2, $c_{11} = 0.6918$, $c_{12} = 0.3788$, and $c_{44} = 0.3132$. A Debye characteristic temperature, θ, of 205° ± 2°K at 0°K was calculated from these values of the elastic constants. (Contractor's abstract)

1089

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

LIGHT, by G. W. Stroke. Jan. 9, 1959, 31p. incl. diagrs. refs. (Technical rept. no. 348) [Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108] AD 216193 Unclassified

This work is based on an article for publication in the McGraw-Hill Encyclopedia of Science and Technology. The following topics are covered: General Nature and Theories of Light, Classification of Phenomena and Theories Involving Light, Electromagnetic Wave Character of Light, Relativistic Effects in the Behavior of Light, and the Corpuscular Nature of Light. The treatment places particular emphasis on light as a group of electromagnetic radiations. It singles out many of the fundamental properties of light that require further investigation—for the study of light in its own right, and for the information that it gives about the subatomic world, as well as about the universe. The well-known electromagnetic and corpuscular characters of light, which form the subject matter of the classical electromagnetic theory and of quantum mechanics, are recalled, and a detailed description of the relativistic effects in the behavior of light is given. The effects that are described by the General Theory of

Relativity are not incorporated in the present quantum theories dealing with light. A need appears, therefore, for the formulation of a theory of light that would extend beyond the present quantum theories and incorporate all of the known properties of electromagnetic radiations. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DETERMINATION OF THE DIPOLE MOMENT AND ISOTOPE SHIFT OF RADIOACTIVE Hg^{197} BY "DOUBLE RESONANCE", by A. C. Melissinos. [1959] [4]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: Jan. 28, 1959.

Also published in Phys. Rev., v. 115: 126-129, July 1, 1959.

Paramagnetic resonance was established between m-sublevels ($\Delta m = \pm 1$, $\Delta F = 0$) of the $^3P_1$ state of radioactive Hg^{197} at 3000 mc/sec. From these data the nuclear interaction constant A was found to be $(513.5 \pm 1) \times 10^{-3}$ cm^{-1}, and barring hfs anomalies it leads to a ratio of moments $\mu_{197}/\mu_{199} = A_{197}/A_{199} = 1.045$; further, the nuclear spin of Hg^{197} was ascertained to be 1/2. The double resonance was combined with magneto-optic scanning to give the isotope shift of Hg^{197}, which was found to be in the 2537 A line $+ (91 \pm 5) \times 10^{-3}$ cm^{-1} from Hg^{198}. The radioactive mercury was produced by Au^{197} (d, 2n) Hg^{197} reaction and used in vapor form. Satisfactory signals were obtained with as few as 3×10^{12} atoms.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CODING AND INFORMATION THEORY, by P. Elias. [1959] [6]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])   Unclassified

Published in Rev. Modern Phys., v. 31: 221-226, Jan. 1959.

An introduction, in non-mathematical terms of "information theory", that is, the generation, storage, transmission, and processing of information is discussed. Some possible applications to biology are pointed out with emphasis placed on applications to chemical specificity in biological systems.

1092

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EFFICIENCY OF FREQUENCY MEASUREMENTS WITH AN ATOMIC CLOCK, by M. Peter and M. W. P. Strandberg. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])   Unclassified

Published in Proc. Inst. Radio Engineers, v. 48: 92-93, Jan. 1959.

A high-efficiency frequency measurement was made by building a lossless interaction space and placing molecules in it that were ready to absorb the radiations of a frequency, $\omega_a < \omega_0 < \omega_b$. The measurement was carried out by sending a certain amount of radiation into the interaction space at each different frequency and have it reflected back. The only energy used is at the resonance frequency at which the energy frequency is absorbed. The efficiency of the system is calculated to be 0.01. This efficient system is, nevertheless, not one of optimum efficiency. To obtain an atomic clock of nearly optimum efficiency, a spectroscope with a sufficiently narrow natural width must be used. However, the design of this system causes a loss in reliability.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ELASTIC CONSTANTS OF SODIUM IODIDE FROM 180°K TO 300°K, by R. Daiven and C. W. Garland. [1959] [2]p. incl. table. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], and Alfred P. Sloan Foundation)   Unclassified

Published in Jour. Chem. Phys., v. 30: 346-347, Jan. 1959.

The adiabatic elastic constants of a single crystal of sodium iodide have been measured by an ultrasonic pulse technique. An extrapolation was made to 0°K and a Debye characteristic temperature, θ_0, of 167° was calculated. (Contractor's abstract)

1094

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

THE INTERACTION OF MICROWAVES WITH GAS-
DISCHARGE PLASMAS, by S. C. Brown. [1959] [4]p.
incl. diagrs. (Sponsored jointly by Air Force Office of
Scientific Research, Office of Naval Research, and
Signal Corps under [DA 36-039-sc-78108], and Atomic
Energy Commission)   Unclassified

Published in I.R.E. Trans. on Microwave Theory and
Tech., v. MIT-7: 69-72, Jan. 1959.

The interaction of microwaves with gas-discharge
plasmas provides a valuable tool for studying the fun-
damentals of gas-discharge phenomena and methods of
controlling and switching microwave power. A summa-
ry of the present state of knowledge in this field is pre-
sented by using as particular examples the interaction
of high density and low density gas-discharge plasmas
in S-band resonant cavities, both in the presence and
absence of dc magnetic fields. (Contractor's abstract)

1095

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

A TUNABLE MASER AMPLIFIER WITH LARGE
BANDWIDTH, by R. J. Morris, R. L. Kyhl, and
M. W. P. Strandberg. [1959] [2]p. incl. diagr. (Spon-
sored jointly by Air Force Office of Scientific Research,
Office of Naval Research, and Signal Corps under
[DA 36-039-sc-78108])   Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 80-81,
Jan. 1959.

A solid-state single-cavity X-band maser that has a 20-
mc bandwidth at 10-db gain with a bath temperature of
$4.2^\circ K$ is described. The maser crystal is ruby
$(Al_2O_3 \cdot Cr_2O_3)$ chromium being the paramagnetic ion.
It is placed in the short-circuited end of a 1-cm square
waveguide. This maser has complete action in the ab-
sence of cavity resonance at the pumping frequency
and allows the amplifier to be operated at any frequen-
cy in the signal tuning range. The details of its con-
struction are further pointed out along with its out-
standing features.

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Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

SPIN-LATTICE RELAXATION FROM STATE OF NEG-
ATIVE SUSCEPTIBILITY, by S. A. Collins, Jr., R. L.
Kyhl, and M. W. P. Strandberg. [1959] [3]p. incl.

diagrs. refs. (Sponsored jointly by Air Force Office
of Scientific Research, Office of Naval Research, and
Signal Corps under [DA 36-039-sc-78108])
                                            Unclassified

Published in Phys. Rev. Ltrs., v. 2: 88-90, Feb. 1, 1959.

A state of negative magnetic susceptibility is demon-
strated in potassium chromicyanide by using a 180°
pulse technique. The spin-lattice relaxation from this
state is observed in the time domain, and the complex
susceptibility shows no change in slope as it passes
through zero.

1097

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

EFFECT OF STIMULUS REPETITION RATE ON AU-
DITORY NERVE POTENTIALS, by W. T. Peake, M. H.
Goldstein, Jr., and N. Y.-S. Kiang. [1959] [1]p. (Spon-
sored jointly by Air Force Office of Scientific Research,
Office of Naval Research, and Signal Corps under
[DA 36-039-sc-78108])   Unclassified

Presented at Second annual meeting of the Biophys.
Soc., Pittsburgh, Pa., Feb. 25-27, 1959.

Published in 1959 meeting of the Biophys. Soc. Program
and Abstracts, p. J-3.

In order to study the potentials of the auditory nerve
at high stimulus repetition rates, a special-purpose
digital computer has been utilized for computing the
average of responses recorded from gross electrodes
near the round window and near the internal auditory
meatus of anesthetized cats. This technique offers the
advantage of increasing the ratio of the neural response
amplitude to the background noise. Furthermore, if
bursts of noise are used as stimuli, the cochlear micro-
phonic potential is a random waveform with zero mean,
whereas the neural response approaches a nonzero
average value for large numbers of responses. The
neural potentials have been measured during the onset
and in the "steady state" for various repetition rates
of the noise bursts. If the amplitude of neural poten-
tials is plotted against stimulus repetition rate, results
are obtained that can be interpreted in terms of inter-
actions of responses from neural units.

1098

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

A MODEL FOR RELATING RESPONSES RECORDED
BY GROSS ELECTRODES TO ACTIVITY OF NEURAL
UNITS (Abstract), by M. H. Goldstein, Jr. [1959] [1]p.
(Sponsored jointly by Air Force Office of Scientific
Research, Office of Naval Research, and Signal Corps
under [DA 36-039-sc-78108])   Unclassified

Presented at Second annual meeting of the Biophys. Soc., Pittsburgh, Pa., Feb. 25-27, 1959.

Published in 1959 meeting of the Biophys. Soc. Program and Abstracts, p. G-8.

A probabilistic model that relates statistics of gross responses to the first-order statistics of the population of contributing units is discussed. Of necessity, the formal postulates of the model are greatly simplified in terms of known neurophysiological processes. The basic postulates concerning the model are: (1) In any very small unit of time Δt, a neural unit (NU) may either "fire" or "not fire"; (2) If an NU fires in the interval $t' < t < t' + \Delta t$, it contributes the unit waveform $U(t - t')$ to the gross response $G(t)$; (3) The probability that one of the NU's of a population will fire during the interval Δt varies as the length of the interval, and is equal to a $(t') \Delta t$; (4) The probability that more than one NU in the population fires in an interval, Δt, is negligible; (5) The gross response, $G(t)$, is the linear summation of waveforms from the units of population. The postulated model leads to the following simple relations between $U(t)$, $a(t)$, and the mean and variance of the gross response: $G(t) =$

$$\int_{-\infty}^{t} U(t-\tau)\, a(\tau)\, d\tau;\ \sigma^2(t) = \int_{-\infty}^{t} U^2(t-\tau)\, a(\tau)\, d\tau.\ \text{The}$$

uses and limitations of this model in the interpretation of certain experimental data will be considered.

1099

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME STATISTICS OF THE ELECTROENCEPHALO-GRAM, WITH EMPHASIS UPON AUTOCORRELATION (Abstract), by T. Weiss. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at Second annual meeting of the Biophys. Soc., Pittsburgh, Pa., Feb. 25-27, 1959.

Published in 1959 meeting of the Biophys. Soc. Program and Abstracts, p. J-8.

One goal of quantitative studies of physical phenomena consists in transforming a set of measured variables into another set that will describe the phenomenon under investigation in terms of meaningful parameters. Most analyses of brain waves by means of autocorrelation functions that have been carried out seem to have been based on 2 implicit assumptions: (1) that frequency-emphasizing transformations (such as autocorrelation) are relevant to the study of the EEG and (2) that probabilistic models (inherent in the use of autocorrelation analysis) are applicable. Both these assumptions were examined in the present investigation which concerned itself with the problem of estimating the autocorrelation function of the EEG from a finite

sample of the EEG time series. A narrow-band, Gaussian noise model was assumed in order to study the errors that arise from the estimation of the autocorrelation function on the basis of a finite sample of the time series. The results obtained showed in particular that the cyclic activity exhibited by EEG correlograms for "long delays" may arise from such errors of truncation.

1100

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STATISTICAL ANALYSES OF EVOKED ELECTRO-CORTICAL ACTIVITY (Abstract), by T. Sandel, T. Weiss, and C. E. Molnar. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at Second annual meeting of the Biophys. Soc., Pittsburgh, Pa., Feb. 25-27, 1959.

Published in 1959 meeting of the Biophys. Soc. Program and Abstracts, p. J-7.

Sensory stimuli produce evoked responses, at the mammalian cerebral cortex, whose quantitative description requires statistical analysis. The cortical activity evoked by various auditory stimuli in the unanesthetized cat has been studied. Such an approach is predicated on large samples of evoked responses, and hence various digital computer techniques have been used for the analysis of the recorded data. The analysis consists of: (a) averaging large numbers of responses evoked by invariant stimuli; (b) obtaining amplitude distributions at various times following the delivery of the stimulus; and (c) computing measures of central tendency and dispersion for these amplitude distributions. The stimuli have been bursts of tone, bursts of noise, and clicks. Data are presented and discussed in terms of the representation of auditory signals at the cortex.

1101

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HIGH-CURRENT ION SOURCE, by R. G. Meyerand, Jr. and S. C. Brown. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Rev. Scient. Instr., v. 30: 110-111, Feb. 1959.

A high-current ion source is described that is of simple design and construction. It is capable of producing an ion beam of $\frac{1}{2}$ amp. The energy spread of ions is large. (Contractor's abstract)

1102

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

MEASUREMENTS OF MICROWAVE NOISE RADIA-
TION FROM PLASMAS (Abstract), by G. Bekefi and
J. L. Hirshfield. [1959] [1]p. (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval
Research, and Signal Corps under [DA 36-039-sc-
78108], and Atomic Energy Commission)

Unclassified

Presented at Eleventh Annual Gaseous Electronics
Conf., New York, Oct. 22-25, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
117, Mar. 6, 1959.

The microwave noise power radiated from the positive
column of a dc discharge in helium has been investigat-
ed over a large range of plasma parameters. Meas-
urements were made by means of a 3000 mc/sec radi-
ometer which has a 2 mc/sec band width and a sensitiv-
ity of 10^{-16} w. The noise power emitted radially from
the plasma column was measured over a range of elec-
tron density from 10^8 to 10^{13} cm^{-3} and over a range
of gas pressure from 0.05 to 20 mm Hg. The observed
changes in the radiated noise power with electron den-
sity are attributed to the changes of opacity that the
plasma presents to the electromagnetic waves generat-
ed within its volume. The nature of these variations,
in which the plasma changes from a transparent to an
opaque medium, can be calculated from the known at-
tenuation sustained by an electromagnetic wave as it
progresses through the plasma. In addition, a study
has been made of the noise radiation which results
from the application of a dc magnetic field along the
plasma column. Observed resonances in the emission
will be discussed.

1103

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

CODING THEOREMS FOR A DISCRETE SOURCE WITH
A FINITE CRITERION, by C. E. Shannon. [1959] [2]p.
incl. diagrs. (Sponsored jointly by Air Force Office of
Scientific Research, Office of Naval Research, and
Signal Corps under [DA 36-039-sc-78108])

Unclassified

Presented at I.R.E. Nat'l. Convention, New York, Mar.
23-26, 1959.

Published in I.R.E. Nat'l. Convention Record, Pt. 4:
142-163, 1959.

Also published in Information and Decision Processes,
New York, McGraw Hill, 1959, p. 93-126.

Consider a discrete source producing a sequence of
message letters from a finite alphabet. A single let-
ter distortion measure is given by a non-negative
matrix (d_{ij}). The entry d_{ij} measures the "cost" or
"distortion" if letter i is reproduced at the receiver as
letter j. The average distortion of a communications
system (source-coder-noisy channel-decoder) is taken
to be $d = \sum_{i,j} P_{ij} d_{ij}$ where P_{ij} is the probability of i be-
ing reproduced as j. It is shown that there is a func-
tion R(d) that measures the "equivalent rate" of the
source for a given level of distortion. For coding pur-
poses where a level d of distortion can be tolerated,
the source acts like one with information rate R(d).
Methods are given for calculating R(d), and various prop-
erties discussed. Finally, generalizations to ergodic
sources, to continuous sources, and to distortion
measures involving blocks of letters are developed.
(Contractor's abstract)

1104

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

FM INTERFERENCE AND NOISE-SUPPRESSION PROP-
ERTIES OF THE OSCILLATING LIMITER, by E. J.
Baghdady. [1959] [27]p. incl. diagrs. table. (Spon-
sored jointly by Air Force Office of Scientific Research,
Office of Naval Research, and Signal Corps under
[DA 36-039-sc-78108])

Unclassified

Presented at I.R.E. Nat'l. Convention, New York,
Mar. 23-26, 1959.

Published in I.R.E. Nat'l. Convention Record, Pt. 8:
13-39, 1959.

An amplitude limiter with regenerative feedback can,
under appropriate conditions, provide an effective tool
for suppressing interference from undesired signals,
as well as interstation noise. The amount of positive
narrow-band feedback that is prescribed for marked
improvement in the stronger-signal capture perform-
ance causes the limiter to oscillate in the absence of an
input signal. Although oscillation results in automatic
noise squelch, it also imposes limitations on the frequen-
cies and minimum amplitudes of receivable signals, in
the form of a locking frequency range and a locking
threshold. The alleviation of these limitations requires
careful design of the feedback phase characteristic. The
theoretical discussion is followed by a summary of ex-
perimental data which brings out several important
aspects of oscillating-limiter operation. (Contractor's
abstract)

1105

Massachusetts Inst. of Tech. [Research Lab. of
Electronics] Cambridge.

ELECTRONIC g FACTORS FOR FREE ATOMIC
STATES-Cl^{35} (Abstract), by G. J. Wolga and M. W.
P. Strandberg. [1959] [1]p. (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval
Research, and Signal Corps under [DA 36-039-sc-
73108]) Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
153, Mar. 30, 1959.

The magnetic hyperfine energy levels of the $2P_{3/2}$ free
atomic ground state of Cl^{35} have been investigated by
the method of paramagnetic resonance. The atomic
Cl^{35} was produced in a microwave gas discharge at
3000 mc. A flow system enabled observation of the
atomic state before recombination. Absorptions corre-
sponding to the $\Delta M_J = \pm 1$, $\Delta M_I = 0$ selection rules were
observed between the hyperfine states of both Cl^{35} and
Cl^{36} The two isotopes were distinguished by the rel-
ative intensities of the lines. The transitions oc-
curred at 8993 mc within the range 4600-5000 gauss.
Numerical solutions of the secular equations were
used with atomic beam values of a and b to obtain the
atomic g_J factor for Cl^{35}. The result is $g_J = 1.33376 \pm$
0.00007. This is to be compared with the value of $g_J =$
1.3341 assuming L - S coupling in the $2P_{3/2}$ state with
$g_L = 1.0000$, $g_S = 2.0023$.

1106

Massachusetts Inst. of Tech. [Research Lab. of
Electronics] Cambridge.

ELECTROPHORETIC VELOCITY OF SPHERICAL
LYOPHOBIC COLLOID PARTICLES (Abstract), by A.
L. Loeb, P. H. Wiersema, and J. T. G. Overbeek.
[1959] [1]p. [DA 36-039-sc-78108] Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
138, Mar. 30, 1959.

The speed, U, of colloid particles in an external elec-
tric field depends upon the electrical potential, ζ, at
the interface between particles and liquid. A relation-
ship between U and ζ, based on a series expansion in
ζ was previously established, but it is valid only for
low values of ζ. The present approach is based upon
the Gouy-Chapman distribution of charge and potential

and its perturbation by the applied electric field. The
resulting nonlinear system of 5 simultaneous transcen-
dental equations has been evaluated by electronic com-
putation, and the results are found to agree with those
of Overbeek for low values of ζ. Special attention is
given the relaxation effect in electrophoretic transport.

1107

Massachusetts Inst. of Tech. [Research Lab. of
Electronics] Cambridge.

NUCLEAR RESONANCE SPECTRA OF HINDRED
ROTATORS (Abstract), by J. S. Waugh and R. W.
Fessenden. [1959] [1]p. (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval
Research, Signal Corps under [DA 36-039-sc-78108],
and Alfred P. Sloan Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
162, Mar. 30, 1959.

Chemical shifts and spin-spin coupling constants ob-
served in most substituted ethanes are averages over
internal rotation. In molecules of sufficiently low sym-
metry they are experimentally temperature-dependent
and reflect the degree of rotational hindrance. By
means of suitable approximations one can thus estimate
the relative stabilities of rotational isomers. It is found,
for example, that the two distinct isomers of $CHCl_2 -$
$CClF_2$ differ in energy by about 2.2 kcal/mol. The as-
sumptions required in such measurements will be dis-
cussed with reference to CH_2Br-CF_2Br[1] and
$CHClBr--CF_2Br$ as further examples.

1108

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

FULL DECODABLE CODE-WORD SETS, by M. P.
Schützenberger and R. S. Marcus. [1959] [4]p. incl.
illus. (Sponsored jointly by Air Force Office of Sci-
entific Research, Office of Naval Research, and Signal
Corps under [DA 36-039-sc-78108]) AD 221310
Unclassified

Also published in I.R.E. Trans. on Inform. Theory, v.
IT-5: 12-15, Mar. 1959.

The question of how the decodability condition imposes
restrictions on a set of code words is discussed. A
generating function is defined that describes the compo-
sition of the code words. The relation between the gen-
erating function and a full set of code words is found.
This relation shows that the sum of arbitrary

probabilities associated with the words of a full set must be one. A full set of code words is 1 to which no code can be added and still keep the set decodable. It is also shown that a full set is completable. For a completable set of code words any string of symbols can be made into a sentence by adding a suitable prefix and a suffix. (Contractor's abstract)

1109

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

HAZARDS AND DELAYS IN ASYNCHRONOUS SE-
QUENTIAL SWITCHING CIRCUITS, by S. H. Unger.
[1959] [14]p. incl. diagrs. tables. (Sponsored jointly by
Air Force Office of Scientific Research, Office of Na-
val Research, and Signal Corps under [DA 36-039-sc-
78108])   Unclassified

Published in I.R.E. Trans. on Circuit Theory, v. CT-6:
12-25, Mar. 1959.

This paper is concerned with asynchronous, sequential switching circuits in which the variables are represented by voltage levels, not by pulses. The effects of arbitrarily located stray delays in such circuits are analyzed, and it is shown that, for a certain class of functions, proper operation can be assured regardless of the presence of stray delays and without the introduction of delay elements by the designer. All other functions require at least one delay element in their circuit realizations to insure against hazards. In the latter case it is shown that a single delay element is always sufficient. The price that must be paid for minimizing the number of delay elements is that of greater circuit complexity. (Contractor's abstract)

1110

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

HYPERFINE INTERACTIONS IN F-CENTER PARA-
MAGNETIC-RESONANCE SPECTRA IN LiF AND NaF,
by G. J. Wolga and M. W. P. Strandberg. [1959] [15]p.
incl. illus. tables, refs. (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval
Research, and Signal Corps under [DA 36-039-sc-
78108])   Unclassified

Published in Jour. Phys. and Chem. Solids, v. 9: 309-
319, Mar. 1959.

The method of paramagnetic resonance is used to study the magnetic-energy levels of F-centers in LiF and NaF. The microwave absorption spectra show a set of nearly resolved transitions; each crystal has an odd number of almost equally spaced lines symmetrically located about a central resonance. The spectra are found to be isotropic with respect to relative orientation of the 100-axis and the applied magnetic field. The

scalar magnetic hyperfine interaction and the spectro-scopic splitting factor are determined from experimental data. The experimental results are interpreted on the basis of the de Boer model of the F-center, and determine the probability density of the F-electron wave function at the sites of the nearest-neighbor nuclei. The line breadth of the inhomogeneously broadened spin packets is obtained from the dependence of the spectrum on the ratio of line width to hyperfine interaction. The packet breadth is attributed to unresolved hyperfine interaction with further nuclei, and yields an estimate of the scalar hyperfine interaction with the next-nearest-neighbor nuclei. The observed spectroscopic splitting factors, corrected for the hyperfine interaction shift, are found to be smaller than the free-electron value. This difference is attributed to spin-orbit coupling with excited states of higher orbital angular momentum, and

it yields an estimate for the expectation value of $(1/r^3)$. The predictions of the theory of inhomogeneous broadening on the dependence of the absorption upon micro-wave power are confirmed. (Contractor's abstract)

1111

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

OPTICAL METHOD FOR DETERMINING THE C AXIS
OF RUBY BOULES, by R. D. Mattuck and M. W. P.
Strandberg. [1959] [2]p. incl. diagrs. table. (Sponsored
jointly by Air Force Office of Scientific Research, Of-
fice of Naval Research, and Signal Corps under [DA 36-
039-sc-78108])   Unclassified

Published in Rev. Scient. Instr., v. 30: 195-196, Mar.
1959.

A simple method is described for locating the C axis of an uncut ruby crystal. The procedures involves measurement of the angular position of the ruby for zero light transmission when it is placed between crossed polarizer and analyzer. The precision is ± 1°. (Contractor's abstract)

1112

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

THERMIONIC DIODE AS A HEAT-TO-ELECTRICAL-
POWER TRANSDUCER, by W. B. Nottingham. [1959]
[5]p. incl. diagrs. tables. (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval
Research, and Signal Corps under [DA 36-039-sc-
78108])   Unclassified

Published in Jour. Appl. Phys., v. 30: 413-417, Mar.
1959.

The high-vacuum thermionic diode is shown to be capable of converting heat to electric power. For this

ourpose, a low work-function collector, a small spacing, and sufficient temperature difference between the emitter and the collector are necessary. A detailed understanding of both thermionic emission and space-charge phenomena are needed for evaluating the effectiveness of this transducer. With V_R defined as the critical bias potential that gives zero potential gradient at the collector, the maximum available power is given by the relation $3.7 \times 10^{-6} V_T^{\frac{1}{2}}(V_R^2/\omega^2)$ watts/m^2. Here, V_T is the voltage equivalent of the temperature T/11600. In the range of emitter temperature from 1200-1700°K, the most optimistic conversion efficiency lies between 3 and 4% for a diode of 0.001-in. spacing. With a suitable choice of emitter inhomogeneity, the introduction of cesium vapor should improve the efficiency of this device. (Contractor's abstract)

1113

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

RESPONSES OF THE AUDITORY CORTEX TO RE-PETITIVE ACOUSTIC STIMULI, by M. H. Goldstein, Jr., N. Y-S. Kiang, and R. M. Brown. [1959] [9]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Jour. Acoust. Soc. Amer , v. 31: 356-364, Mar. 1959.

Electrical responses to low-intensity repetitive clicks and bursts of noise were recorded from the cat auditory cortex. Responses decrease in size as the repetition rate is increased, and for rates higher than 50/sec are smaller than the "ongoing" activity of the cortex and become difficult to detect visually. An electronic average response computer was used to detect responses to high rates of stimulation. Stimulus-locked responses to clicks and bursts of noise were found for rates up to 200/sec in unanesthetized cats, but only up to 100/sec after anesthetization. (Contractor's abstract)

1114

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

USE OF PARAMAGNETIC-RESONANCE TECHNIQUES IN THE STUDY OF ATOMIC OXYGEN RECOMBINA-TIONS, by S. Krongelb and M. W. P. Strandberg. [Apr. 27, 1959] [15]p. incl. diagrs. refs. (Technical rept. no. 291) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 232772
Unclassified

Published in Jour. Chem. Phys., v. 31: 1196-1210, Nov. 1959.

A method of making measurements of atomic recombination times with the use of a paramagnetic-resonance spectrometer and its advantages are described. The theory of the paramagnetic-resonance spectrometer applied to these measurements is presented. Methods for using both diffusion and flow systems for determining surface and volume recombination coefficients are analyzed. The operation of the system that was used is illustrated for atomic oxygen recombination. The surface recombination coefficient for oxygen atoms on a quartz surface is shown to be 3.2×10^{-4} per collision, and the 2nd-order volume recombination coefficient was less accurately determined as 5×10^{15} cm^6 mol^{-2} sec^{-1}. The measurement of the diffusion coefficient of atomic oxygen is described. The possible application of these methods to further study of reaction rates is discussed. (Contractor's abstract)

1115

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

BRIDGE FOR MEASURING THE IMPEDANCE OF METAL MICROELECTRODES, by R. C. Gesteland and B. Howland. [1959] [3]p. incl. illus. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], and Bell Telephone Labs., Inc.) AD 221256 Unclassified

Published in Rev. Scient. Instr., v. 30: 262-264, Apr. 1959.

An ac bridge for measuring the series components of high-impedance metal-liquid interfaces is described. The real and imaginary components of the impedance may vary over a wide range. All frequency-independent residual error-introducing elements in the measuring circuit may be balanced out through a single square-wave initial balance step. This allows accurate, direct-reading measurement of the unknown. The bridge design is based upon superposition of frequency-independent bridge circuits. (Contractor's abstract)

1116

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ON TONE IN CROW, by G. H. Matthews. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Internat'l. Jour. Amer. Linguistics, v. 25: 135-136, Apr. 1959.

Following a review of previous solutions to the problem of phonemicizing the tones in Crow, another is offered which makes use of the syntactic structure of the language. This solution uses a phonemic notation and a set of 5 ordered rules that are applied thereto. These results can be incorporated into a complete phonology of Crow. (Contractor's abstract)

1117

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PROTO-SIOUAN KINSHIP TERMINOLOGY, by G. H. Matthews. [1959] [27]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Amer. Anthropologist, v. 61: 252-278, Apr. 1959.

An attempt is made to reconstruct the Proto-Siouan kinship system by the theory of linguistic change which reconstructs the kinship terms and their uses for a protolanguage postulated as the source of 2 or more languages. In this method the facts of 2 or more languages that are presumed to be related are manipulated in certain prescribed ways, with the result that facts about the common source for these languages are derived. Another method at arriving at an earlier stage of a language is known as the internal reconstruction. This method compares the facts of a single language and infers from certain types of alternation and from irregularities, facts about an earlier stage of that language, usually called a prelanguage. By applying this method to PSi, it is possible to postulate certain sound changes that occurred in Pre-Siouan. The internally reconstructed forms also provide possible reconstructions for some structural features of the PSi system.

1118

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SENSORY PERFORMANCE OF ORGANISMS, by W. A. Rosenblith. [1959] [7]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 221259 Unclassified

Also published in Rev. Modern Phys., v. 31: 485-491, Apr. 1959.

Experiments are described which were designed to discover how man detects, orders, and identifies events in his environment to which his sense organs are sensitive. This kind of study (psychophysics) tries to apply quantitative methods to sensory communications. One conclusion drawn from the experiments is that

the analysis of sensory information occupies considerable time in relation to the amount of information transmitted.

1119

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME QUANTIFIABLE ASPECTS OF THE ELECTRICAL ACTIVITY OF THE NERVOUS SYSTEM (WITH EMPHASIS UPON RESPONSES TO SENSORY STIMULI), by W. A. Rosenblith. [1959] [14]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78103]) AD 221258 Unclassified

Also published in Rev. Modern Phys., v. 31: 532-545, Apr. 1959.

A study of the electrical responses in the human nervous system, evoked by sensory stimuli is discussed. In addition to measuring the electric potential of single electrodes an attempt is made to observe the pattern of responses when a "population" of neutral units are mutually interacting. In this way it is hoped to study the "state" of the organism as it reacts selectively to sensory stimulation. The interpretation of electroencephaalogram patterns is an essential part of the techniques employed.

1120

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STRONG COUPLING IN NUCLEAR RESONANCE SPECTRA. I. THE FIVE-SPIN SYSTEM OF trans-PROPENYLBENZENE, by R. W. Fessenden and J. S. Waugh. [1959] [6]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Jour. Chem. Phys., v. 30: 944-949, Apr. 1959.

Energy levels and allowed transitions are calculated for a system of five spin-$\frac{1}{2}$ particles of the type ABX_3. An extension to the more general system ABC_3 is made by perturbation theory. The results are applied to an analysis of the proton resonance spectrum of trans-propenylbenzene, and it is found that at least one spin-spin coupling constant is negative. An "anomalous" spectrum previously reported, which shows superficial resemblances to the one studied here, is explained by assuming the presence of an impurity. (Contractor's abstract)

1121

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

ON THE MODE OF CONVERGENCE AND ITS CORREC-
TION BY METHODS OF LINEAR SUMMABILITY, by
M. V. Cerrillo. [May 3, 1959] 149p. incl. illus. tables,
refs. (Technical rept. no. 269) (Sponsored jointly by
Air Force Office of Scientific Research, Office of Na-
val Research, and Signal Corps under DA 36-039-sc-
78108) AD 246123   Unclassified

A discussion is presented of some questions relating to
the behavior of the convergence of certain sequences,
which are of interest in the theory of the synthesis of
linear systems, toward a limit function that describes
the actual behavior of linear systems under the influ-
ence of a class of excitation functions. The dynamical
behavior of linear systems is given by integral equa-
tions representing linear operators and functionals.
Convolution, Laplace, Fourier, and other integrals play
an important role in these representations. Solutions
of these representative integrals are frequently ob-
tained in the form of infinite series. The sequences are
generated by the partial sums of finite order of these
series. These sequences represent an approximate so-
lution to the integral, and are valid in certain prese-
lected intervals of time. (Contractor's abstract)

1122

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

SAMPLING MODELS FOR LINEAR TIME-VARIANT
FILTERS, by T. Kailath. May 25, 1959, 47p. refs.
(Technical rept. no. 352) (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval
Research, and Signal Corps under DA 36-039-sc-
78108) AD 230489   Unclassified

A large class of communication channels can be repre-
sented by linear time-variant filters. Different con-
straints can be imposed on these filters in order to
simulate the actual operating conditions of such chan-
nels. The constraints permit the original filter to be
replaced by another (simpler) filter that imitates the
original filter under the operating constraints. These
new filters need not resemble the physical channel at
all, and need not be equivalent to the actual channel,
except under the given constraints. The constraints
considered are those of finite input and output channel
signals and finite channel memory. Other cases can
be studied by similar methods. Methods of character-
izing linear time-variant filters are investigated in
order to determine the most convenient descriptions
for the different constraints. These descriptions are
used to obtain sampling theorems and models for the
filter under the various constraints. The theorems
are used to find the conditions under which a linear
time-variant filter can be determined by input-output
measurements only. (Contractor's abstract)

1123

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

SOME RECENT SIMPLIFICATIONS OF THE THEORY
OF FINITE AUTOMATA, by R. C. Jeffrey. May 27,
1959, 12p. incl. diagrs. (Technical rept. no. 219)
(Sponsored jointly by Air Force Office of Scientific
Research, Office of Naval Research, and Signal Corps
under DA 36-039-sc-78108) AD 218936
                                          Unclassified

Automata are defined as 4-termed relations (sets of
quadruples). Reduced automata, that is, automata in
which the states serve as output symbols, are defined
as 3-termed relations (sets of triples). A method is
given for replacing the nodes and arrows in the graphs
of such relations by neurons or by other logical ele-
ments in such a way that the resulting net realizes the
corresponding automaton. This method is applicable
whether or not the relation corresponds to a single-
valued function; that is, whether or not the next state
of the automaton is uniquely determined by the present
state and input symbol. Also proven is that a set which
does not contain the word of length zero is represent-
able by a reduced finite automaton if and only if it is
representable by a nonreduced finite automaton. (Con-
tractor's abstract)

1124

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

NONLINEAR PROPERTIES OF FM LIMITER, by L. C.
Bahiana. May 29, 1959, 47p. incl. diagrs. tables, refs.
(Technical rept. no. 350) (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval Re-
search, and Signal Corps under DA 36-039-sc-78108)
AD 228014   Unclassified

A resistive model for the double-diode amplitude lim-
iter is used in an investigation of the characteristics of
a double-diode tuned limiter. It is assumed that the
tuned circuit can be replaced by an equivalent resistance
(equal to the impedance of the tuned circuit at the given
driving frequency). The crystal diodes are assumed to
follow a square-law volt-ampere dependence when they
are conducting. A limiter coefficient K_L is suggested
and shown to be a convenient parameter for defining the
limiter performance. The characteristics calculated on
the basis of this theory agree, within a reasonable de-
gree of approximation, with available experimental data.
To solve the limiter problem with the tuned circuit
shunted by ideal diodes, a breakpoint analysis that re-
sults in a set of transcendental equations, called the lim-
iter equations, is carried out. In view of the complexity
of such equations, a numerical solution is worked out.
Subsequent correlation shows that the resistive model is
a good approximation for amplitudes, but cannot account
for a variation of phase with amplitude that is indicated

by the solution of the limiter equations. A revised model is suggested to take care of the phase distortion. The predictions of this model are shown to be qualitatively correct. Further research in this general field is suggested. (Contractor's abstract)

1125

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ALTERNATIVE DETECTION OF COCHANNEL FM SIGNALS, by E. J. Baghdady. [1959] [1]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 994, May 1959.

Details of a system designed to facilitate the extraction of the message of the weaker of 2 cochannel FM signals are presented. The system, called feedforward, has been shown to enable a receiver to deliver high-quality reproductions of programs that are carried on 2 independent FM carriers. Reception of the weaker signal is possible even when the carrier frequencies sweep the same frequency band. The system described by Farris (Proc. Inst. Radio Engineers, v. 46: 1876-1877, Nov. 1958) is discussed and explanation of its impracticaiity pointed out.

1126

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CANONICAL FORMS FOR INFORMATION-LOSSLESS FINITE-STATE LOGICAL MACHINES, by D. A. Huffman. [1959] [11]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at 1959 Internat'l. Symposium on Circuit and Information Theory, Los Angeles, Calif., June 16-18, 1959.

Published in I.R.E. Trans. on Circuit Theory, Suppl., v. CT-6: 41-51, May 1959.

Published in I.R.E. Trans. on Information Theory, Suppl., v. IT-5: 41-51, May 1959.

An important class of finite-state machines transforms input sequences of digits into output sequences in a way such that, after an experiment of any finite length on the machine, its input sequence may be deduced from a knowledge of the corresponding output sequence, its initial and final states, and the set of specifications for the transformations by which the machine produces output sequences from input sequences. These machines

are called "information-lossless." Canonical circuit forms are shown into which any information-lossless machines may be synthesized. The existence of inverses for these circuits is investigated and circuits for their realization are derived. (Contractor's abstract)

1127

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

HOW TO GROW YOUR OWN TREES FROM GIVEN CUT-SET OR TIE-SET MATRICES, by E. A. Guillemin. [17]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108] Unclassified

Presented at Internat'l. Symposium on Circuit and Information Theory, Los Angeles, Calif., June 16-18, 1959.

Published in I.R.E. Trans. on Circuit Theory, v. CT-6: 110-126, May 1959.

The method recognizes that construction of a tree (and hence the pertinent graph) from a given matrix can be done by inspection once the pattern of its growth has been established. To this end it is only necessary that we have a mechanism, applicable to a given cut-set matrix, which sorts out those rows that correspond to the outermost twigs or tips of the tree, for we can then form an abridged cut-set matrix corresponding to what is left of the total graph after the tree tips with their uniquely attached links are pruned away. This remainder again has tips which can be found and eliminated in the same way. Continuation thus reveals the desi growth pattern. Since the method cannot fail to yield a graph if its existence is compatible with the structure of the given matrix, it may be regarded as a constructive test for fulfillment of necessary and sufficient conditions. (Contractor's abstract)

1128

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NONLINEAR SYSTEM CHARACTERIZATION AND OPTIMIZATION, by A. G. Bose. [1959] [11]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at 1959 Internat'l. Symposium on Circuit and Information Theory, Los Angeles, Calif., June 16-18, 1959.

Published in I.R.E. Trans. on Circuit Theory, Suppl., v. CT-6: 30-40, May 1959.

Published in I.R.E. Trans. on Information Theory, Suppl., v. IT-5: 30-40, May 1959.

Characterization and optimization of nonlinear systems is considered from the function space point of view, and implications of this point of view are discussed. Optimization of nonlinear systems is regarded as the problem of mapping the function space of the past of the input onto a line that corresponds to the amplitude of the filter output. It is shown that a system representation that is orthogonal for all possible inputs results from any mapping that partitions this space into nonoverlapping cells. The complication of solving for optimum systems in terms of measured higher-order statistics is circumvented by formulating the problem so that particular statistical measurements directly yield the optimum systems. (Contractor's abstract)

1129

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A FREQUENCY-DOMAIN THEORY OF PARAMETRIC AMPLIFICATION, by B. J. Leon. June 5, 1959, 52p. incl. diagrs. refs. (Technical rept. no. 354) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108)   Unclassified

In the class of high-frequency amplifiers that are known as parametric amplifiers, varactors, and variable-reactance amplifiers, the active elements are variable-reactance parameters; i.e., inductances or capacitances whose values vary periodically. The power that amplifies the desired signal comes from the source which varies the parameter. A general method of analysis of circuits containing a few decoupled periodic elements in a network of lumped, linear, finite, passive, bilateral, time-invariant elements is presented. For these circuits it is shown that the characteristic frequency-domain equations that define the voltages and currents as functions of the complex frequency are linear difference equations with variable coefficients. A sinusoidally varying capacitance in an arbitrary passive network with steady-state signal excitation is discussed. By using the calculus of finite differences to find exact solutions to the difference equations three fundamental statements concerning parametric amplifier performance are proved: (a) The gain is independent of the phase of the signal relative to the varying parameter except in a degenerate case that can easily by avoided. (b) The passive circuit admittance at idler frequency, the difference between the signal frequency and the frequency of the parameter, is important. A circuit with a zero of admittance at the idler frequency will oscillate regardless of the admittance at the signal frequency. (c) Because of the interaction of the signal and the varying element, high-frequency voltages are produced; but the voltage amplitudes go to zero exponentially as frequency increases, if the varying parameter is positive for all time. The mechanics of finding a solution is discussed. (Contractor's abstract)

1130

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

UNIDIRECTIONAL PARAMAGNETIC AMPLIFIER DESIGN, by M. W. P. Strandberg. June 26, 1959 [14]p. incl. illus. diagrs. refs. (Technical rept. no. 363) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108)   Unclassified

Published in Proc. Inst. Radio Engineers, v. 48: 1307-1320, July 1960.

The radio-frequency parameters and the quantum-mechanical parameters entering into the design of paramagnetic quantum-mechanical amplifiers are described and discussed. The physical and electrical limitations on such parameters as gain-bandwidth product, gain stability, and nonreciprocity are described analytically and with design curves. Two realizations of nonreciprocal amplifiers are described and discussed. In particular, operation of a nonreciprocal amplifier at 9 kmc is described. Explanations for the observed properties of previously reported amplifiers are given, and the steps necessary to achieve high gain-bandwidth product and nonreciprocity with paramagnetic amplifiers are described. (Contractor's abstract)

1131

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ANALYSIS OF SEQUENTIAL DECISIONS (Abstract), by D. M. Green and J. A. Swets. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)1728, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])   Unclassified

Presented at meeting of the Acoust. Soc. Amer., Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 834, June 1959.

Data presented previously showed that at least on a macroscopic level, the statistical theory of sequential decision as developed by Wald provides a good description of the behavior of human observers in a sequential detection task. In a sequential decision task the observer makes as many observations as he chooses before deciding whether the sequence of observations arose from noise or from signal plus noise. The data showed the error rates and the mean number of observations preceding a terminal decision to vary appropriately with changes in the values associated with the various decision outcomes. Subsequent analysis of the number of terminal decisions made at each observation stage has suggested a simpler model for the observer's behavior in this task. This model assumes that each

decision is based upon the information obtained from the last observation, and that 1 alone, rather than upon an integration of the information gained from all of the preceding observations. This simpler model fits most of the data. That is to say, on a microscopic level, the data do not support the Wald model.

1132

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AUTOMATIC RESOLUTION OF SPEECH SPECTRA INTO ELEMENTAL SPECTRA (Abstract), by K. N. Stevens, C. G. Bell and others. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)2061, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 844, June 1959.

The acoustic output for a given configuration and excitation of the vocal tract during speech production can be described in a relatively compact manner by a transfer function characterized by a reasonably small number of poles and zeros. Thus the spectrum of a speech sound (log amplitude vs frequency) may be considered to be the sum of several elemental spectra, each associated with 1 pole or zero. The spectrum envelope of any vowel, for example, could be approximated reasonably accurately by combinations of spectra drawn from a catalog of 30 to 40 curves that represent simple resonances at a number of different frequencies. A digital computer has been programmed to perform such an approximation on spectra of vowel and some consonant sounds sampled periodically in time. Successive comparisons are made between a particular speech spectrum and spectra constructed from a catalog of elementary curves that are stored in the memory. The computer is programmed to converge rapidly from a 1st approximation of the spectrum based on previous examinations of adjacent samples towards the synthesized spectrum that yields the best fit with the input spectrum, and reads out numbers that identify the particular elemental spectra that are finally selected.

1133

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AVERAGES OF RESPONSES EVOKED BY TONAL STIMULI IN THE AUDITORY CORTEX OF THE CAT (Abstract), by T. Sandel. [1959] [1]p. (Sponsored

jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer. Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 842, June 1959.

Because of the variability of responses evoked by auditory stimuli in the auditory cortex of the cat, it is difficult, if not impossible, to quantify responses to total stimuli without resorting to techniques which alter the physiological state of the nervous system being studied. Such techniques include the use of deep barbiturate anesthesia and the local application of strychnine at the recording sites in order to potentiate the responses, making them visually detectable. In the present study, a digital computer has been used to average large numbers of responses evoked at various locations on the auditory cortex, without the complications of either deep anesthesia or strychnine. Data obtained using this technique are presented showing the organization of responses to tonal stimuli over the surface of the primary auditory areas of the cortex.

1134

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CUEING AS A DETERMINER OF APPARENT VARIABILITY (Abstract), by E. F. Shipley. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)1728, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 834, June 1959.

The groupings of correct and of incorrect responses in psychophysical experiments have been attributed to changes in sensitivity. This paper suggests another way of accounting for such data. It is hypothesized that a given trial can offer cues to the nature of the stimulus. The adequacy of the cue is presumably determined by the effective stimulus intensity. Stronger stimuli should provide on the average better cues than weaker stimuli. Also trials on which correct responses are made should offer better cues than do incorrect trials. Thus correct responses should follow correct responses. Data were collected in a 2-alternative forced-choice detection experiment in which a strong and a weak signal were presented at random. The proportion of correct responses was higher following correct responses to the strong signal than following correct responses to the weak signal. This is consistent with the notion that the

adequacy of the cues on preceding trials influences the probability of a correct response. The opposite results would be expected if only fluctuations in sensitivity are involved since a correct response to a weak signal implies a greater average sensitivity than a correct response to a strong signal.

1135

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

ON CERTAIN FORMAL PROPERTIES OF GRAMMARS, by N. Chomsky. [1959] [31]p. incl. refs. (In cooperation with Inst. for Advanced Study, Princeton, N. J.) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 221311
Unclassified

Also published in Inform. and Control, v. 2: 137-167, June 1959.

A grammar can be regarded as a device that enumerates the sentences of a language. We study a sequence of restrictions that limit grammars 1st to Turing machines, then to 2 types of system from which a phrase structure description of the generated language can be drawn, and finally to finite state Markov sources (finite automata). These restrictions are shown to be increasingly heavy in the sense that the languages that can be generated by grammars meeting a given restriction constitute a proper subset of those that can be generated by grammars meeting the preceding restriction. Various formulations of phrase structure description are considered, and the source of their excess generative power over finite state sources is investigated in greater detail. (Contractor's abstract)

1136

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

STIMULUS AND RESPONSE THEORIES OF SIGNAL UNCERTAINTY (Abstract), by J. A. Swets and S. A. Sewall. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)1728, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Presented at meeting of the Acoust. Soc. Amer , Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 835, June 1959.

The theory of individual choice behavior developed by Luce and adapted by Shipley finds support in experimental results reported by Pollack at the Chicago meeting for the suggestion that one can account for the dec-

rement in the detectability of signals in noise that results from uncertainty about the signal frequency without postulating a sensory filtering. Tanner, Swets, and Green had proposed a single-band model and Green had proposed a multiband model to account for the decrement. The former model predicts a larger decrement than the latter. Luce's theory implies that the uncertainty affects the response alternatives rather than the mechanism of observation and, as Shipley has observed, implies in particular that if the observer is informed of the signal frequency after his observation, but before making his response, the decrement will not appear. This paper describes the results of an experiment that provides a direct test of this proposition. The experiment also attempts to distinguish more clearly than heretofore the validity of the 2 predictions concerning the size of the decrement by employing experimental conditions which maximize their difference.

1137

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SYNTHESIS AND PERCEPTION OF NASAL CONSONANTS, by K. Nakata. [1959] [6]p. incl. illus. diagrs. table, refs. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)2061, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 221358
Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 661-666, June 1959.

The generation of nasal consonants can be simulated approximately by a cascade connection of simple electrical tuned circuits excited by a quasi-periodic electrical buzz source. The lowest resonance for nasal consonants is in the vicinity of 200 to 300 cps, and the damping of this resonance is greater than that for the 1st resonance of vowels. A terminal-analog synthesizer and control device have been used to generate a number of synthetic syllables, each consisting of a nasal consonant followed by a vowel, with smooth formant transitions between consonant and vowel portions. Systematic listening tests have shown that the identification of the nasal consonant is determined largely by the frequency position of the 2nd resonance of the nasal portion of the syllable, and thus by the direction and extent of the 2nd formant transition of the vowel, as noted in other studies. The identification of the nasal consonant is also dependent to some extent on the duration of the consonant and transition portions of the syllable. Isolated nasal consonants generated by this procedure can also be identified with reasonable consistency. (Contractor's abstract)

1138

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

TONOTOPIC ORGANIZATION OF THE CAT AUDI-
TORY CORTEX FOR SOME COMPLEX STIMULI, by
N. Y-S. Kiang, and M. H. Goldstein, Jr. [1959] [5]p.
incl. illus. diagrs. refs. (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval
Research, and Signal Corps under [DA 36-039-sc-
78108]) AD 221255   Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 786-
790, June 1959.

There is psychophysical evidence that both spectrum
and periodicity of acoustic signals may be cues for
pitch judgments. At the level of the auditory nerve,
these stimulus characteristics seem to be coded in
terms of place and time pattern. Very little is known
of their representation at higher levels of the nervous
system. Tonotopic organization of the auditory cortex
has been demonstrated in anesthetized cats by the
evoked strychnine potential technique. In these demon-
strations only tonal stimuli were used. We use simi-
lar physiological preparations but employ acoustic stim-
uli that permit independent manipulation of spectrum
and periodicity. The results show that the previously
reported tonotopic organization is based only upon spec-
tral characteristics of the stimulus. (Contractor's
abstract)

1139

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

DIPOLE AND QUADRUPOLE MOMENTS OF THE
ISOMERIC Hg^{197*} NUCLEUS; ISOMERIC ISOTOPE
SHIFT, by A. C. Melissinos and S. P. Davis. [1959]
[8]p. incl. illus. diagrs. tables. refs. (Sponsored
jointly by Air Force Office of Scientific Research,
Atomic Energy Commission, Office of Naval Research,
and Signal Corps under [DA 36-039-sc-78108])
                                    Unclassified

Published in Phys. Rev., v. 115: 130-137, July 1, 1959.

The hyperfine structures of 5 optical lines of 65-hr
radioactive Hg^{197} and 25-hr isomeric Hg^{197*} were
measured. Radioactive mercury produced by cyclotron
bombardment and excited in electrodeless discharge
tubes containing as few as 5×10^{12} atoms, free of
natural mercury, gave adequate light intensities. The
analysis of the hyperfine structure confirmed the mag-
netic dipole moment and isotope shift of Hg^{197} in its
ground state (I = 1/2), and gave the following values for
Hg^{197*} (based on I = 13/2): $\mu_{197*} = -1.04 \pm 0.01$ nm;

$Q_{197*} = (1.5 \pm 0.3) \times 10^{-24}$ cm^2; isotope shift displace-
ment (from Hg^{198} in the 2537A line) $+ 70 \pm 7 \times 10^{-3}$ cm^{-1}.
Thus an isomeric shift of atomic energy levels resulting
from the excitation of the nucleus from its ground state
I = 1/2 to the isomeric state I = 13/2 is observed. In
the 2537A line of mercury this shift amounts to $- 21 \pm$
6×10^{-3} cm^{-1}.

1140

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

PROCESSING NEUROELECTRIC DATA, by W. M.
Siebert. July 7, 1959, 121p. incl. diagrs. refs. (Tech-
nical rept. no. 351) (Sponsored jointly by Air Force
Office of Scientific Research, Office of Naval Research,
and Signal Corps under DA 36-039-sc-78108)
AD 218859   Unclassified

This Technical report primarily attempts to bring to-
gether in one place the views that this group (Communi-
cations Biophysics Group) has developed over the past
half dozen years on processing the electrical data that
is recorded from the nervous system. Another motivat-
ing influence was the need to clarify divergent views by
making an over-all assessment of the techniques that
are used in everyday research. The presentation that
is given here will permit reference to this monograph
instead of having to include lengthy and perhaps not al-
ways appropriate discussions of data-processing
techniques.

1141

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

SHORT-TIME MEASUREMENT OF TIME DILATION
IN AN EARTH SATELLITE, by R. S. Badessa, R. L.
Kent, and J. C. Nowell. [1959] [2]p. incl. diagr. (Spon-
sored jointly by Air Force Office of Scientific Research,
Office of Naval Research, and Signal Corps under
[DA 36-039-sc-78108])   Unclassified

Published in Phys. Rev. Ltrs., v. 3: 79-80, July 15,
1959.

A description is given of a method for measuring the
gravitational red shift postulated by Einstein's theory
of relativity. Atomic clocks with stability approaching
10^{11}, and earth satellites capable of orbiting at altitudes
which provide a significant difference in gravitational
potential enable this type of experiment to be attempted.
A short-time measurement (the interval required to
permit the small rate difference of the 2 clocks to
accumulate a measurable difference in time) was con-
ducted. Because the instantaneous frequency difference
between an oscillator on the earth and an oscillator on
a satellite as received on the earth is influenced by the

variation in path length, a technique consisting of transmitting to the ground a signal which had been precorrected was used. This method is described in some detail. Briefly it consists of cancelling out the 1st order Doppler term by utilizing an oscillator of frequency 2f and subtracting from it frequency f' which is the frequency of the signal received at the satellite. This frequency difference is then transmitted to earth and received as f'''. The Doppler term is then cancelled out by means of a power series expansion.

1142

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CONTINUOUS NONLINEAR SYSTEMS, by D. A. George. July 24, 1959, 102p. incl. diagrs. refs. (Technical rept. no. 355) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) AD 246281
Unclassified

A functional representation, which is a generalization of the linear convolution integral, is used to describe continuous nonlinear systems. Emphasis is placed on nonlinear systems composed of linear subsystems with memory, and nonlinear no-memory subsystems. An "Algebra of Systems" is developed to facilitate the description of such combined systems. From this algebraic description, multidimensional system transforms are obtained. These transforms specify the system in much the same manner as 1-dimensional transforms specify linear systems. The system transforms and the transform of the system's input signal are then used to determine the transform of the output signal. Transform theory is also used for determining averages and spectra of the system output when the input is a random signal Gaussianly distributed. Certain theoretical aspects of the functional representation are discussed. (Contractor's abstract)

1143

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

INFLUENCE OF FLUID MOTION PAST A PLANE BOUNDARY ON SOUND REFLECTION, ABSORPTION, AND TRANSMISSION, by U. Ingard. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research and Signal Corps under [DA 36-039-sc-78108], and Office of Naval Research under Nonr-184142)
Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1035-1036, July 1959.

It is shown that the effect of fluid motion past a plane boundary on the reflection and absorption of sound is equivalent to an increase of the normal acoustic impedance of the boundary by a factor $(1 + M \sin \phi)$,

where ϕ is the angle of incidence of the sound wave, and M is the Mach number of the flow velocity component in the incidence-reflection plane of the wave. Similarly, the acoustic energy flux perpendicular to the boundary and the flow is shown to be increased by the same factor. Reflection and transmission coefficients of a thin solid interface between a fluid in motion and 1 at rest are given. Furthermore, some comments on the problem of transmission in ducts are given. For propagation between 2 plane parallel boundaries with the same acoustic admittance, we find, for sufficiently small values of the admittance, that the sound pressure attenuation constant of the fundamental mode is modified approximately by the factors $(1 + M)^{-2}$ and $(1 - M)^{-2}$ for downstream and upstream propagation, where M is the flow Mach number.

1144

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NOISE GENERATED BY TWO INTERACTING AIR JETS, by U. Ingard and G. C. Maling, Jr. [1959] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], and Wright Air Development Center under AF 33(616)3307)
Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1031-1033, July 1959.

It has been observed that the excess noise generated as a result of the interaction or mixing of 2 small air jets is considerably greater than the noise produced by the individual jets. The "interaction noise" produced by jets that lie in the same plane has been measured for jet intersection angles between 0 and 180°. Similar measurements have been made as a function of jet separation by using 2 jets that intersect at a 90° angle but do not lie in the same plane.

1145

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SIMPLE EXAMPLES OF MAGNETOMECHANICAL WAVE MOTION, by U. Ingard. [1959] [2]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research and Signal Corps under [DA 36-039-sc-78108], and Office of Naval Research under Nonr-184142)
Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1033-1034, July 1959.

The phase velocity on a periodic line consisting of coupled mass elements (coils) in a magnetic field is shown to be analogous to the phase velocity of a

transverse Alfvén wave in a conducting, incompressible fluid. As another example of the magnetomechanics of a simple "distributed" system, the motion of a conducting string in a magnetic field is discussed.

1146

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOUND TRANSMISSION THROUGH A VELOCITY DISCONTINUITY, by P. Gottlieb. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research and Signal Corps under [DA 36-039-sc-78108], and Office of Naval Research under Nonr-184142) Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1036-1037, July 1959.

The attenuation of a sound wave in a steady flow, with the flow gradient normal to the flow lines, is approximated by 3 different methods. The 1st method approximates the steady flow by layers of constant velocity and applies the boundary conditions of Ribner at each interface. The 2nd method uses the analytic solution for the continuous flow. The last method is similar to the 1st but uses the boundary conditions of earlier authors. It is found that the 1st and 2nd methods give the same answer, and this answer disagrees with that obtained by the 3rd method.

1147

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CONNECTIVITY IN PROBABILISTIC GRAPHS, by I. M. Jacobs. Sept. 15, 1959, 62p. incl. diagrs. tables, refs. (Technical rept. no. 356) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) AD 238476 Unclassified

A probabilistic graph is a linear graph in which both nodes and links are subject to random erasure. Such a graph is an idealized model of a communication network in which switching centers (nodes) and information channels (links) either operate perfectly or fail entirely. The reliability of the communication network is considered. Two reliability criteria are established: (1) the probability that a path exists between all pairs of nodes that remain in the associated probabilistic graph after erasure, and (2) the probability that a path exists between one pair of nodes selected at random. For small communication networks, the interesting questions concern analysis (the calculation of the reliability of a given network) and synthesis (the construction, under certain constraints, of graphs with max reliability). For large communication networks, the emphasis is on the link-to-node densities necessary and sufficient for attaining a desired reliability.

The sufficient densities are determined by approx analysis of several graph configurations. The reliability (under the first reliability criterion) is shown to approach 1 exponentially with the decrease in the difference between the link-to-node density and a constant times the logarithm of the number of nodes. This constant is a function of the graph and of the link and node reliabilities. The average reliability of graphs chosen randomly by 2 different procedures is also determined. (Contractor's abstract)

1148

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NEW DEVELOPMENTS IN FM RECEPTION AND THEIR APPLICATION TO THE REALIZATION OF A SYSTEM OF "POWER-DIVISION" MULTIPLEXING, by E. J. Baghdady. [1959] [15]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research and Signal Corps under [DA 36-039-sc-78108]) AD 241170 Unclassified

Also published in I.R.E. Trans. on Communications Systems, v. CS-7: 147-161, Sept. 1959.

Two techniques--feedforward across a limiter and dynamic trapping--are described to show how the message carried by the weaker of 2 cochannel FM signals can be extracted with negligible distortion even when its amplitude is much smaller than that of the stronger signal. The development of these techniques marks the end of the stronger-signal capture limitation of FM systems and ushers in more efficient spectrum utilization, as well as new applications for frequency modulation. (Contractor's abstract)

1149

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

QUADRUPOLE SELECTION RULE IN IRON GROUP SPIN-PHONON INTERACTIONS, by R. D. Mattuck and M. W. P. Strandberg. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Phys. Rev. Ltrs., v. 3: 369-370, Oct. 15, 1959.

This report points out the fact that spin-phonon transitions in non S-state iron-group paramagnets obey quadrupole selection rules. This means that for odd half-integer spin systems of $S > 1/2$, the direct spin-phonon transition is approximately forbidden between any pair of spin states, $|1\rangle$, $|2\rangle$, of the form $|1\rangle = a|m_s\rangle + b|-m_s\rangle$, $|2\rangle = c|m_s\rangle + d|-m_s\rangle$, $\langle 1|2\rangle = 0$. Accordingly, it should be impossible to observe acoustic

saturation of low-frequency ($\sim 10^7$ cps) paramagnetic-resonance signals within Kramers doublets in a spin-3/2 system. It is possible to predict that, in a microwave acoustic experiment, a radical decrease in phonon attenuation when H becomes parallel to the crystal optic axis can be seen. It is noted that examination of the existing data on gain-bandwidth product in ruby masers that amplify between nearly pure, and more strongly mixed, $\pm 1/2$ levels, would be desirable in order to compare the compatibility of these data with the selection rule outlined here.

1150

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PHYSICS LABORATORY ADMINISTRATION AND OPERATION, by M. W. P. Strandberg. [1959] [5]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Amer. Jour. Phys., v. 27: 503-507, Oct. 1959.

Laboratory instruction in undergraduate courses allows the student to encounter physical problems in association with physicists. The value of this experience does not derive from the experiments per se, but the administration and operation of the laboratory may be arranged to optimize its educational value. (Contractor's abstract)

1151

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SPHERICAL WAVES OF FINITE AMPLITUDE, by R. D. Fay. [1959] [3]p. (Sponsored jointly by Air Force Office of Scientific Research and Signal Corps under [DA 36-039-sc-78108], and Office of Naval Research under Nonr-184142) Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1377-1379, Oct. 1959.

A method is presented for the analysis of spherical waves of finite amplitude. An example of the application of the method is given for the case of repeated shock waves.

1152

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STRONG COUPLING IN NUCLEAR RESONANCE SPECTRA. II. FIELD DEPENDENCE OF SOME UNSYMMETRICAL THREE-SPIN SPECTRA, by R. W.

Fessenden and J. S. Waugh. [1959] [6]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Organic Chem. Div. of the Amer. Chem. Soc., New York, N. Y., Sept. 8-13, 1957.

Abstract published in 132nd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 72. (Title varies)

Published in Jour. Chem. Phys., v. 31: 996-1001, Oct. 1959.

Magnetic resonance spectra are calculated and compared with experiment for the vinyl group of styrene, 2,4-dichloroaniline, and 2,5-dichloroaniline at various magnetic field strengths. Some simple rules are presented which facilitate the determination of chemical shifts and coupling constants, including the signs of the latter. One of the spectra illustrates the occasional necessity for experiments at more than 1 field strength if the parameters are to be determined unambigously. In each case the shielding and coupling constants are found to be field-independent within experimental accuracy. (Contractor's abstract)

1153

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NOISE MEASUREMENTS ON ELECTRON BEAMS AT 3000 MC, by A. Zacharias and L. D. Smullin. Nov. 12, 1959, 23p. incl. diagrs. tables, refs. (Technical rept. no. 358) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) AD 240122
Unclassified

Noise measurements were made in a demountable system, on the electron beam produced by a new type of low-noise electron gun. The purpose of the investigation was to determine the effect of the dc electric field at the cathode on Haus' noise parameters S and Π. The noise parameter S was found to be significatnly influenced by the shape of the electric field in the vicinity of the cathode. Variation of S by a factor of 2 was observed at constant beam current, and by a factor of 4.5 when the beam current was changed. Measured values for Π/S were small, the largest being 0.16. The value of Π/S was generally not found to be greatly affected by variations in the electric field at the cathode surface. However, a significantly large negative value of Π/S was produced by a field configuration that caused higher than normal cathode current density. Agreement was not found between the noise figures predicted from a min-noise-figure equation, and the noise figures observed in traveling-wave tubes that use this type of electron gun. The measured values of S and Π predict a beam noisiness of approx 3.5 times that observed in carefully processed, sealed-off tubes. The oxide-cathode coating resistance is proposed as a possible cause

for this increased noisiness. Contaminants present in the vacuum of the measuring apparatus probably increased the coating resistance by decreasing the cathode activation. Data on coating resistivity, at frequencies near 3000 mc, were used to calculate the effect of cathode resistance on beam noise. The effect appears to be significant. The effect of cathode temperature on the noise parameters was examined. It was found that S was increased by nearly a factor of 2 by an increase of cathode temperature of 80°C (approx 10%), while the value of Π/S remained unchanged. (Contractor's abstract)

1154

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

BARRIER TO ROTATION ABOUT THE METAL-CYCLOPENTADIENYL BOND, by J. S. Waugh, J. H. Loehlin and others. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], Alfred P. Sloan Foundation, and National Science Foundation) AD 248835
Unclassified

Published in Jour. Chem. Phys., v. 31: 1434-1435, Nov. 1959.

The proton resonance of bis-(cyclopentadienylmolybdenum tricarbonyl) $[C_pMo(CO)_3]_2$, has been examined between 77°K and room temperature. A graph showing the variation of $\Delta H_2{}^2$ with temperature is given. The results at low temperatures are in agreement with calculations for a rigid lattice, but in view of the difficulties encountered at these temperatures, approximations have been made.

1155

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FORMANT TRACKING BY COMPUTER (Abstract), by C. G. Bell, F. Poza, and K. N. Stevens. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)2061, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1563, Nov. 1959.

A method of formant tracking using a digital computer was described previously. By this method synthetic speech spectra, constructed within the computer from a catalog of elemental spectra, are compared with measured spectra of a speech signal. The present paper discusses the evaluation, extension, and refinement of this method of analysis. Computer techniques which result in the display of a "synthetic sonagram" are described, together with examples of the use of the computer oscilloscope for displaying intermediate steps in the spectral matching process. Results obtained with a variety of speakers are presented. The problems of preparing a representative catalog of glottal spectra, evaluating the role of analyzing filter banks, and determining a meaningful "fit criterion" are considered. A method similar to the foregoing for synthesizing fricative spectra is also described.

1156

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FRICATIVE PRODUCTION BY A DYNAMIC ANALOG SYNTHESIZER (Abstract), by G. Rosen. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)2061, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1564, Nov. 1959.

Two series of formal listening tests were conducted with fricative consonants generated by a dynamic analog of the vocal tract. The consonants were generated using a fricative configuration consisting of a uniform tube with a single constriction and were presented in CV context, always with the vowel /a/. The variables studied in the 1st test series were the place and degree of constriction and the position of excitation relative to the constriction. Listeners were required to make 1 of 6 fricative responses in forced and nonforced tests. Responses of /s, ʃ,f/ better than 95% were obtained for some stimuli. The 2nd series of tests was made to determine how closely the temporal relations between articulatory change and buzz and noise excitation need to be specified. Stimuli were presented in pairs and subjects were asked to vote for more "natural" stimulus in each pair. A supplementary identification test showed a sharp change of response from voiceless to voiced fricative as buzz excitation was initiated at progressively earlier times.

1157

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

GRADUATE EXAMINATIONS IN PHYSICS, by M. W. P. Strandberg and B. V. Gokhale. [1959] [6]p. incl. diagrs.

tables. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])   Unclassified

Published in Amer. Jour. Phys., v. 27: 539-544, Nov. 1959.

The extensive and intensive character and the number of graduate level examinations for doctoral candidates in physics are discussed in relation to the probable objectives which the examinations are intended to serve. Results of a recent survey of graduate examination procedures in universities in the United States are presented. (Contractor's abstract)

1158

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HYPERFINE STRUCTURE OF THALLIUM^{203} AND THALLIUM^{205} IN THE $7\,^2S_{\frac{1}{2}}$ STATE, by R. J. Hull and H. H. Stroke. [1959] [2]p. incl. illus. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])   Unclassified

Published in Jour. Opt. Soc. Amer., v. 49: 1088-1089, Nov. 1959.

The hyperfine-structure separations of Tl^{203} and Tl^{205} in the $7^2S_{\frac{1}{2}}$ state were obtained from the 3776-A resonance line with a grating spectrograph. These measurements were carried out because previously quoted values resulted from a study of the 5350-A transition ending on the $6^2P_{3/2}$ state, the hyperfine structure of which was inferred to be 8 mk, while recent atomic-beam magnetic-resonance experiments showed $\Delta\nu(6^2P_{3/2}) \approx 17$ mk. Our results for $\Delta\nu(7^2S_{\frac{1}{2}})$ are 405 ± 5 mk and 412 ± 4 mk for Tl^{203} and Tl^{205}. (Contractor's abstract)

1159

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PSYCHOACOUSTIC STUDY OF THE MECHANISM OF BINAURAL FUSION (Abstract), by J. L. Hall. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])   Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1584, Nov. 1959.

The effect of masking noise on binaural interaction of disparate stimuli was studied. Stimuli were trains of pulses and trains of clicks. With continuous noise added monaurally to noise bursts, more noise was required to prevent fusion when the stimulus in the opposite ear was a noise burst than when it was a pulse. In neither case did the level of noise necessary to prevent fusion make the noise burst inaudible. In fusion of noise bursts and pulses, the level of noise added to pulses necessary to prevent fusion equalled the level which made the pulses indetectible. In another experiment, subjects were presented with trains of single pulses at one ear and closely-spaced pairs of pulses at the other. They were required to fuse the single pulse with the 2nd of the pair of pulses. It was found that the addition of noise to the pair of pulses reduced the minimum interpulse interval at which this was possible. These results are interpreted in terms of a mechanism of binaural fusion which compares the strength of the short-term integrated neural response from the 2 sides. This model receives support from previous electrophysiological observations.

1160

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME CHARACTERISTICS OF STOP CONSONANTS (Abstract), by O. Fujimura. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)2061, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], and National Science Foundation)   Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1568, Nov. 1959.

Stop-vowel syllables were synthesized by use of both the cascaded resonant circuit (POVO) and the dynamical vocal tract analog (DAVO). Variation of formant positions or of articulatory configurations, intensity envelope, and inflection of fundamental frequency were controlled. A noise source was used as excitation for unvoiced stop consonants. Unvoiced stops generated by DAVO are much superior to those generated by POVO when a noise source is inserted at the constriction point of the vocal tract. In comparing utterances produced by POVO with those produced by DAVO some interesting differences have been found. These will be discussed and an explanation will be offered. Methods involving both absolute judgments and paired comparisons have been used.

1161

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

STRONG COUPLING IN NUCLEAR RESONANCE SPEC-
TRA. III. SYSTEMS CONTAINING MANY EQUIVA-
LENT SPINS, by J. S. Waugh and F. W. Dobbs. [1959]
[5]p. incl. diagr. (Sponsored jointly by Air Force Office
of Scientific Research, Office of Naval Research, and
Signal Corps under [DA 36-039-sc-78108], and National
Science Foundation) AD 248850   Unclassified

Published in Jour. Chem. Phys., v. 31: 1235-1239,
Nov. 1959.

The spin-coupling problem is discussed for systems of
$p + q$ nuclei falling into 2 groups $A_p B_q$ where all mem-
bers of a group are magnetically equivalent. The ener-
gies are given explicitly for $p = 1$, arbitrary q, and for-
mulas are given from which the transition intensities
can be computed for this case. The results are ap-
plied to the proton resonance spectrum of isobutane
($p = 1$, $q = 9$), with the results $\delta_{CH3} - \delta_{CH} = 0.85$ ppm,
$A_{CH-CH3} = 0.8$ cps. (Contractor's abstract)

1162

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

INCOHERENT MICROWAVE RADIATION FROM
PLASMAS, by G. Bekefi, J. L. Hirshfield, and S. C.
Brown. [1959] [6]p. incl. diagrs. table, refs. (Spon-
sored jointly by Air Force Office of Scientific Research,
Atomic Energy Commission, Office of Naval Research,
and Signal Corps under [DA 36-039-sc-78108])
                                        Unclassified

Published in Phys. Rev., v. 116: 1051-1056, Dec. 1,
1959.

A study is made of the incoherent radiation from an
isotropic, quiescent plasma of a low degree of ioniza-
tion. Three cases are treated theoretically. the trans-
parent plasma, the semiopaque plasma, and the opaque.
Radiation from positive columns of dc glow discharges
in helium and hydrogen for the 3 cases treated theoreti-
cally are studied experimentally at 3000 mc/sec, and
good agreement is obtained between theory and experi-
ment. (Contractor's abstract)

1163

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

LARGE-SAMPLE SEQUENTIAL DECISION THEORY,
by E. M. Hofstetter. Dec. 9, 1959, 35p. refs. (Tech-
nical rept. no. 359) (Sponsored jointly by Air Force

Office of Scientific Research, Office of Naval Research,
and Signal Corps under DA 36-039-sc-78108)
AD 235160   Unclassified

Statistical decision theory represents the latest attempt
on the part of the statistician to formulate a general
theory of experiment design. The theory allows for se-
quential experimentation, multivalued terminal decisions.
and the use of several different types of experiment.
This investigation is devoted to the development of a
large-sample theory of experiment design. The main
achievements of this theory are a limit theorem that
describes the asymptotic behavior of the optimum experi-
ment, and a specific experiment design that realizes
this behavior. The theory sheds light on the behavior of
sequential procedures, in general, and should prove use-
ful in the solution of problems other than the specific one
that is considered. (Contractor's abstract)

1164

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

EVIDENCE THAT CUT OPTIC NERVE FIBERS IN A
FROG REGENERATE TO THEIR PROPER PLACES IN
THE TECTUM, by H. R. Maturana, J. Y. Lettvin and
others. [1959] [2]p. incl. diagr. (Sponsored jointly by
Air Force Office of Scientific Research, Office of Na-
val Research, and Signal Corps under [DA 36-039-sc-
78108]) AD 241219   Unclassified

Also published in Science, v. 130: 1709-1710, Dec. 11,
1959.

The frog's retina projects into the superficial neuropil
of the opposite tectum in 4 functionally different layers
of terminals. Each layer displays a continuous map of
the retina in terms of its particular function. The 4
maps are in register. The 4th-dimensional order is
reconstituted after section and regeneration of the op-
tic fibers. (Contractor's abstract)

1165

Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

SATURATION OF PARAMAGNETIC SPINS BY 13-
MC/SEC ULTRASONIC PHONONS, by R. D. Mattuck
and M. W. P. Strandberg. [1959] [2]p. incl. diagrs.
(Sponsored jointly by Air Force Office of Scientific
Research, Office of Naval Research, and Signal Corps
under [DA 36-039-sc-78108])   Unclassified

Published in Phys. Rev. Ltrs., v. 3: 550-551, Dec. 15,
1959.

Experiments designed to saturate spin populations in
various paramagnets through the use of 13-mc/sec
sound waves are discussed. The differences in energy
level population were monitored by paramagnetic

resonance equipment that included a Pound-Watkins oscillator followed by a narrow-band amplifier and a phase-sensitive detector, with dc and 50-cps modulating fields provided by Helmholtz coils. The 1st experiment, performed on ruby having a linewidth of 40 mc/sec gave a acoustic saturation value of $S/S_o = 1 \pm 0.01$

which is in agreement with theory within the accuracy of the experiment. With Cr^{+++}-doped MgO, however, $S/S_o \sim 1/2$, which is 10^7 times smaller than theory predicts, and the bandwidth is too large. It is thought that a possible explanation of the Cr^{+++} anomalies may lie in the fact that the Cr^{+++} ion distorts the local lattice considerably. An apparent saturation was observed in a crystal of Brazilian quartz which had been given a 1.4 x 10^7-rad dose of γ rays in a Co^{60} source. The bandwidth effect was greater than 176 mc/sec. The approximate frequency independence of the effect suggests that the phonons simply cause thermal heating of the crystal. If this is so, an even greater saturation should be seen in irradiated quartz, but it is pointed out that this postulate seems non-tenable.

1166

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FREQUENCY MULTIPLICATION WITH NONLINEAR CAPACITORS — A CIRCUIT ANALYSIS, by D. B. Leeson and S. Weinreb. [1959] [9]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])   Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 2076-2084, Dec. 1959.

This paper presents a circuit analysis of frequency multipliers employing nonlinear capacitors. The analysis applies to the case of a multiplier of any order using semiconductor nonlinear capacitors, and specifies impedance levels, power capabilities, and efficiency in terms of the characteristics of the nonlinear element and the associated linear network. From the formulas derived it is possible to specify the optimum nonlinear characteristic for a given circuit and harmonic number, and to calculate the conditions for maximum efficiency. The procedure is also applicable to frequency dividers, and to frequency multipliers employing nonlinear inductance. (Contractor's abstract)

1167

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ON THE RESPONSE OF A LINEAR SYSTEM TO AN FM SIGNAL, by E. J. Baghdady. [1959] [2]p. (Sponsored

jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]   Unclassified

Published in I.R.E. Trans. on Circuit Theory, v. CT-6: 387-388, Dec. 1959.

A reply is made to Dr. F. L. H. M. Stumpers criticism concerning his disagreement with an assumption used in an earlier paper (MIT.12:263, Vol. II). The original presentation is repeated with an extensive explanation of its use. Particular emphasis is placed on the conditions which must exist in order for the assumption to be considered valid.

1168

Massachusetts Inst. of Tech. [Research Lab. of Electronics, Cambridge.

AN APPROACH TO MICROMINIATURE PRINTED SYSTEMS, by D. A. Buck and K. R. Shoulders. [1959] 5p. incl. illus. refs. (In cooperation with Stanford Research Inst., Menlo Park, Calif.) [Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108] AD 248834   Unclassified

A possible process for producing etched wiring on a $0.1-\mu$ scale is proposed. On the wires of a 200-mesh electron microscope specimen screen was deposited a Parlodion film, and on the Parlodion film was deposited a SiO film. A Mo film of about 800A was deposited onto the SiO film in a vacuum system. The vacuum system was opened and a 400-mesh Cu specimen screen was placed up against the the Mo film. The vacuum system was again pumped down, and after admitting a small amount of tetraethoxysilane, a 1200-v electron flood beam 1 ma/sq cm in current density was turned on for 1 min. The vacuum system was opened, the 400-mesh screen removed, and the vacuum system closed again and pumped down. The substrate was heated to 300°C and Cl was admitted to the vacuum system. After 1 min, the screen was placed in the electron microscope, and the Mo film was seen to be cut up into squares about 0.001 in. on a side. The resolution is estimated to be finer than 1μ. (Contractor's abstract)

1169

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CIRCUIT THEORY OF LINEAR NOISY NETWORKS, by H. A. Haus and R. B. Adler. New York, M.I.T. Technology Press and Wiley and Sons, 1959, 79p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 2 174   Unclassified

This is 1 in a series of monograms published in an attempt to fill the need for systematic publication of research studies larger in scope than a journal article but less ambitious than a finished book. The principal motivation for this particular work arose from the desire to find a single quantity to describe the noise performance of a 2-terminal-pair amplifier. This quantity, or tag so to speak, is uniquely characterized by 2 features: (1) It clears up questions of the noise performance of low-gain amplifiers or of effect upon noise performance of degenerative feedback; (2) It provides for the 1st time a systematic treatment of the noise performance of negative-resistance amplifiers. It is also shown that the canonical form summarizes in a clear, almost visual manner the connection between the internal noise of a network at any particular frequency and its (resistive, positive, or negative) part.

1170

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A UNIDIRECTIONAL, NONRECIPROCAL, SOLID-STATE AMPLIFIER (Abstract), by M. W. P. Strandberg. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])

Unclassified

The usual methods of instrumentation for a solid-state amplifier for unidirectional operation involve the use of a ferrite circulator or of a double-arm Magic-Tee bridge to decouple input from output. The circulator realization is impossible in some frequency ranges for which circulators are not available. The stabilization and equalization of the gains of 2 paramagnetic amplifiers, which is necessary in the negative resistance bridge to achieve unidirectional operation, is too tricky to be technically desirable. In paramagnetic or ferrimagnetic systems, in which the transition selection rules are strongly controlled by the sign of the circular polarization of the electromagnetic field, unidirectional gain, as well as nonreciprocal gain, can be obtained. The objection to using a circular polarization amplifier arises mainly from the difficulty of establishing a circular polarization field. The prototype work was carried out at x-band but is readily adaptable to other frequencies, to L-band, for example. The coaxial transmission line realization of a circular polarization amplifier results in a stable and large gain-bandwidth product amplifier with low noise figure and moderate size. Furthermore, these principles, since they allow the amplifier to act as its own circulator, obviate the development of both amplifier and circulator for each new operating frequency.

1171

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

COMMUNICATION USING EARTH SATELLITES, by J. B. Wiesner. [1959] [7]p. incl. illus. table. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 241220

Unclassified

Also published in I.R.E. Trans. on Military Electronics, v. MIL-4: 52-58, Jan. 1960.

A review of the use of earth satellites for reliable, ionospheric-independent communication circuits includes considerations of losses in the propagating path, directivity features, and influences such as Doppler shift. The effects of such influences on bandwidth and range are illuminated. (Contractor's abstract)

1172

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

CORD CELLS RESPONDING TO TOUCH, DAMAGE, AND TEMPERATURE OF SKIN, by P. D. Wall. [1959] [14]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]; Bell Telephone Labs. Inc., Public Health Service, and Teagle Foundation) AD 241214 Unclassified

Also published in Jour. Neurophysiol., v. 23: 197-210, Mar. 1960.

Primary afferent neurons of skin and the cells on which they end in the spinal cord have been studied in spinal cats with intracellular microelectrodes. The results concerning afferent fibers are as follows: (1) Single fibers that respond to light touch on the skin of the leg innervate a contiguous area of skin with an oval shape averaging 5 x 4 mm. (2) Pressure-sensitive A fibers form a continuous group within which the threshold varies with fiber diameter. As the fiber diameter decreases within the single group, the threshold for a pressure stimulus increases, and the rate of adaptation to a maintained stimulus decreases. (3) The pattern of discharge in a single fiber is fixed by the intensity and duration of the stimulus, and by the position of the stimulus within the sensitive area. (4) Some of the smaller fibers respond both to pressure and to temperature changes of the skin. Primary central cells results are as follows: (1) Cells that respond to light touch are arranged in a definite lamina in the dorsal part of the dorsal horn. Within this lamina there is a topographic organization, with the peripheral part of the leg medial and the proximal part lateral. (2) Each central cell responds to light touch in a contiguous oval area of skin with an average size of 63 x 32 mm. (3) The afferent fiber projection shows no signs of a subliminal

fringe, and so the peripheral area subserved by a single cell is unaffected by post-tetanic potentiation, strychnine, asphyxia, small doses of barbiturate or temperature changes. (4) The afferent fibers converging onto a single cell run together in a small microbundle in the dorsal root. Each dorsal rootlet contains many such microbundles from different parts of the leg. (5) All cells that respond briefly to light touch also respond with a prolonged discharge to heavy pressure. (6) All cells that respond to light touch also respond to temperature changes of the skin. (7) It is suggested that fibers of many different diameters converge onto these cells so that they respond to all modalities of skin sensation, but differences in the pattern of discharge depend on the nature of the stimulus. (Contractor's abstract)

1173

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A STATISTICAL MODEL FOR INTERPRETING NEU-ROELECTRIC RESPONSES, by M. H. Goldstein, Jr. [1959] 17p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 241138   Unclassified

Also published in Inform. and Control, v. 3: 1-17, Mar. 1960.

Neuroelectric activity recorded after presentation of a controlled stimulus is called an evoked response. Evoked responses are random, in that repeated presentations of a stimulus do not produce identical responses despite all effort to maintain identical conditions for all stimulus presentations. Responses may then be described statistically. The present model attempts to relate statistical characteristics of evoked responses, recorded by gross electrodes, to the statistical activity of the neural elements that contribute to the responses. The model postulates 1 or more populations of elements which, when they fire, contribute elemental waveforms to a gross response in which these waveforms are linearly summed. The statistical behavior of the elements in a population is described by their instantaneous firing rate, which is a function of time. In terms of the model, the statistical properties of the gross response (such as the mean and variance, both of which are functions of time) are shown to be related in a simple way to the instantaneous firing rates and elemental waveforms of the populations that contribute to the response. The model is an extension of the shot-noise model to time-variant phenomena; but some of the assumptions of the shot-noise model (specifically, statistical independence of firings) are relaxed. (Contractor's abstract)

1174

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A METHOD OF EVALUATING DIFFUSION COEFFI-CIENTS IN CRYSTALS, by O. P. Manley. [1959] [7]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 33(616)3984, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108, and Office of Naval Research under Nonr-1841151) AD 248123
Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 13: 244-250, June 1960.

The mechanism of diffusion is reconsidered with the aid of an extension of Kac's theorem. The analysis yields an activation energy which is simply related to the minimal local deformation energy. It is also found that in contrast with Rice's treatment, the activation energy may be calculated directly from the atomic force constants without resorting to normal mode analysis. (Contractor's abstract)

1175

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DESIGN AND OPERATION OF A MOLECULAR OSCIL-LATOR, by H. G. Venkates and M. W. P. Strandberg. [1959] [15]p. incl. illus. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 241724   Unclassified

Also published in Proc. Indian Acad. Sci., v. 51: 123-136, 1960.

Theoretical applications of the design of a 2-level maser of the molecular-beam type are presented. The design and operation of a microwave maser that employs a beam of ammonia molecules are described. (Contractor's abstract)

1176

Massachusetts U. Dept. of Chemistry, Amherst.

OXIDATIVE REACTIONS OF HYDRAZINES. V. SYN-THESIS OF 1,1-DISUBSTITUTED HYDRAZINES AND THEIR SULFONYL DERIVATIVES, by L. A. Carpino, A. A. Santilli, and R. W. Murray. [1959] 13p. incl. refs. (AFOSR-TN-59-284) (AF 18(603)114) AD 212917; PB 140221   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 2728-2731, June 5, 1960. (Title varies)

A series of 1,1-disubstituted hydrazines were prepared

by standard methods which involve nitrosation of the secondary amine and subsequent reduction of the N-nitroso compound by means of Zn-AcOH, Na-EtOH, or LiAlH$_4$. In I case, an N-nitramine (N-nitropiperi-dine) was substituted advantageously for the corresponding nitrosamine by LiAlH$_4$ reduction. I-Butyl, 1-tert-butyl, and I-allyl-1-benzyl-hydrazine were prepared by benzylation of the primary amine, nitrosation, and reduction. I-Benzyl-I-benzoylhydrazine was prepared by benzoylation of tert-butyl-2-benzylcarba-zate followed by the removal of the carbo-tert-butoxy group.

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Massachusetts U. Dept. of Chemistry, Amherst.

O-ACYLHYDROXYLAMINES. II. REACTION OF DI-BENZYLAMINE WITH O-MESITOYLHYDROXYLA-MINE, by L. A. Carpino. [1959] 3p. (AFOSR-TN-59-285) (AF 18(603)114) AD 212918; PB 140220
Unclassified

Conversion of O-mesitoylhydroxylamine to 1, 1-diben-zylhydrazine. A mixture of 5.3 g of crude, freshly prepared O-mesitoylhydroxylamine and 17.5 g of di-benzylamine became warm spontaneously and a solid separated after 10-15 min. The mixture was then heated in a water bath at 70-75° for 15 min and treat-ed with 10 ml of H$_2$O, 15 ml of acetic acid and 3.5 g of benzaldehyde. The resulting mixture was heated in the water bath at 70-75° for 15 min, 250 ml of water added and then extracted with 4 25-ml portions of ether. The ether extracts were washed with water, 10% sodium hydroxide solution and dilute sodium bi-sulfite solution. Removal of the solvent gave 6.2 g (70%) of the benzal derivative, mp 77-79°. Recrys-tallization from 60-90° ligroin gave 5.1 g (57.5%) of faintly yellow crystals, mp 81-83°. (Contractor's abstract)

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Massachusetts U. Dept. of Chemistry, Amherst.

O-ACYLHYDROXYLAMINES. II. O-MESITYLENE-SULFONYL-, O-p-TOLUENESULFONYL- AND O-MESITOYLHYDROXYLAMINE, by L. A. Carpino. [1959] 11p. incl. table, refs. (AFOSR-TN-59-1242) (AF I8(603)114) AD 230298; PB I44962 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 3133-3135, June 20, 1960.

O-Mesitylenesulfonyl- and O-p-toluenesulfonylhydroxyla-mine was prepared by the hydrofluoric acid and per-chloric acid cleavages of the corresponding t-butyl N-arenesulfonoxycarbamates. The structures of the O-arenesulfonylhydroxylamines were established by (a) iodometric analysis, (b) reaction with acetone which

gave the corresponding O-sulfonylacetoximes and (c) infrared examination. O-Mesitoylhydroxylamine was prepared similarly from t-butyl N-mesitoyloxycarba-mate. Reaction of O-mesitoylhydroxylamine with diben-zylamine gave I,1-dibenzylhydrazine. (Contractor's abstract)

1179

Materials Research Corp., Yonkers, N. Y.

TRAVEL REPORT TO RUSSIA AND CAMBRIDGE U., CAVENDISH LAB. (GT. BRIT.) (Unclassified title), by S. Weinig. [1959] 6p. (MRC rept. no. 131) (AF 49-(638)572)   Confidential

1180

[Maudsley Hospital] London (Gt. Brit.).

THE RETICULAR FORMATION, STRESS, AND ENDO-CRINE ACTIVITY, by G. W. Harris. [1958] [15]p. incl. diagrs. refs. (AF 61(514)953)   Unclassified

Published in Proc. Henry Ford Hospital Internat'l. Sym-posium on Reticular Formation of the Brain, Detroit, Mich. (Mar. 14-16, 1957), Boston, 1958, p. 207-221.

In a review of the gross anatomy and principle functions of the reticular formation, attention is call d to specific changes in the pattern of activity of the pituitary and to nonspecific changes in pituitary function (greater secre-tion of antidiretic and adrenocorticotropic hormones and suppressed secretion of thyrotropic hormones), both of which may be brought about by diverse sources of sensory input. The effect of 24-hr electrical stimulation of the hypothalamus (supraoptico-hypophysial tract) upon thyroid function was determined in 43 normal rab-bits. Thirty-three showed inhibition or no change, and 10 showed increased thyroid activity. Thirty-two of those showing inhibition or no change were adrenalec-tomized, where upon the same stimulation showed 13 with inhibition or no change and 19 with varying degrees of increased thyroid activity. Other experiments indi-cate that implants of stilbestrol di-n. butyrate in the mamilliary region of the hypothalamus may result in full sexual behavior in female cats.

1181

Maudsley Hospital, London (Gt. Brit.).

HYPOTHALAMIC MECHANISMS AND THE CONTROL OF SEXUAL BEHAVIOR IN THE FEMALE CAT, by G. W. Harris and R. P. Michael. [1958] [I]p. [AF 61(514)953]
Unclassified

Presented at meeting of the Physiol. Soc., London (Gt. Brit.), Mar. 21-22, 1958.

Published in Jour. Physiol., v. 142: 26P, June 18, 1958.

A method is described by which small amounts of hormone can be directly applied to various sites in the central nervous system. Using ovariectomized female cats, small implants were introduced locally, by means of a stereotaxic technique, into the hypothalamus, thalamus, amygdala, pre-optic area, caudate nucleus and cerebellum. The release rate from solid implants of esters of stilboestrol diminishes with increasing length of the fatty acid side-chain. In experiments employing the dibutyrate ester, 13 of 17 animals with oestrogen applied locally to the posterior hypothalamus showed sustained mating behavior, while only 1 of the 19 animals with implants in other parts of the brain mated, though some showed signs of sexual activity. These findings indicate that the behavioral effects are due to local and not general hormone action and support the conclusion that there exists in this basal area of the brain a mechanism for integrating simpler reflexes into the complex pattern of sexual behavior.

1182

Maudsley Hospital, London (Gt. Brit.).

NEUROENDOCRINE CONTROL OF TSH REGULATION, by G. W. Harris and J. W. Woods. [1959] [21]p. incl. illus. diagrs. refs. (AF 61(514)953)   Unclassified

Published in Proc. Internat'l. Symposium on Comparative Endocrinology, Cold Spring Harbor, N. Y. (May 25-29, 1958), New York, Wiley and Sons, 1959, p. 202-222.

Regulation of the thyroid gland secretion is discussed with particular emphasis placed on the factors involved in cold stimulation and stress inhibition of thyroid activity. Evidence is presented to support the suggestion that a cold stimulus excites a nervous reflex, via the hypothalamus, to stimulate the anterior pituitary secretion of TSH. It is shown that the latent period of the thyroid response to a cold stimulus is $1/2$-4 hr. The anterior pituitary responds with TSH in less than $1/2$ hr to cold stimuli, and the thyroid gland responds to exogeneous TSH in 5-30 min. The central nervous system's role in thyroid function is examined. It is shown by responding to emotional stimuli that the c.n.s. must play a part. Thyroid activity is reduced to zero within 3 hr of application of stressful stimuli. This suggests that the inhibition of TSH from the anterior pituitary is by means other than hormonal. The vagus nerve supply to the thyroid is reviewed along with the autonomic innervation of its blood vessels. It is thought that this nerve supply can affect the sensitivity of the thyroid cells to the thyrotropic hormone. The hypothalamic nerve influence is shown by lesions which inhibit the secretion of TSH and localized electrical stimulation which should elicit TSH secretion if the electrodes are properly placed. This is complicated by the fact that ACTH is a thyroid inhibitor. Results here indicate that the TSH secretion can be elicited.

1183

Maudsley Hospital, London (Gt. Brit.).

THE ACUTE EFFECTS OF INJECTION OF THYROTROFIC HORMONE, OR OF ELECTRICAL STIMULATION OF THE HYPOTHALAMUS, ON THYROID ACTIVITY, by H. J. Campbell, R. George, and G. W. Harris. [1959] [2]p. [AF 61(514) 3]   Unclassified

Presented at meeting of the Phys. al Soc., Cambridge (Gt. Brit.), May 23, 1959.

Published in Jour. Physiol., v. 148: 5P-6P, Oct. 1959.

In order to investigate acute changes in thyroid function, the radioactivity of blood samples taken from the thyroid vein (V) were compared with the radioactivity of arterial blood samples (A). Rabbits, injected with 20-80 μc I^{131} 48 hr previously, were anesthetized with chloralose and urethane, and fine polythene cannulae inserted into a thyroid vein and a saphenous artery. Small blood samples were collected at 15 min intervals, and the difference in radioactivity of the venous and arterial samples (V-A) measured. The results show that (1) an acute preparation may be satisfactorily used for investigations of factors influencing thyroid function; (2) the thyroid responds rapidly to an increased concentration of TSH in the blood; and (3) electrical stimulation of the region of the supraoptico-hypophysial tract in the hypothalamus causes an increase in thyroid activity.

1184

Max-Planck-Inst. für Strömungsforschung, Göttingen (Germany).

THE SCATTERING OF SOUND BY A SINGLE VORTEX AND BY TURBULENCE, by E.-A. Müller and K. R. Matschat. Jan. 1959, 50p. incl. diagrs. refs. (AFOSR-TN-59-337) (AF 61(514)1143) AD 213658; PB 140691   Unclassified

The results of the single-vortex theory are applied to scattering by turbulence. The turbulent flow is represented by statistically distributed vortices. Isotropic and extreme nonisotropic turbulence are considered. The total scattering power turns out to be proportional to the 5th or 2nd power of the frequency of the incident sound wave, depending on whether the frequency is low or high.

1185

Méditerranéen de Recherches Thermodynamiques, Nice (France).

USE OF THE REVOLVING ARM METHOD FOR THE DETERMINATION OF THE STAGNATION TEMPERATURE IN AN IONIZED GAS, by F. M. Devienne, A. F.

Roustan and others. Feb. 1959 [21]p. incl. illus. diagrs. (AFOSR-TN-59-196) (AF 61(514)1126) AD 211473; PB 139554   Unclassified

The use of the revolving arm method was described with regard to the determination of phenomena which occur during the displacement of a body in an ionized atmosphere. The method enables one to measure the state of ionization of the gas and to study the influence of the displacement velocity of a body on the recombination rate of the ions on the surface of the moving body.

1186

Méditerranéen de Recherches Thermodynamiques, Nice (France).

STUDY OF THE FLOW INSIDE MACH 4 NUMBER NOZZLE IN THE VERY LOW DENSITY WIND TUNNEL, by F. M. Devienne, G. M. Forestier, and J. Souquet. Mar. 1959 [13]p. incl. diagrs. (AFOSR-TN-59-482) (AF 61-(514)1126) AD 215735; PB 142722   Unclassified

Measurements were made in order to study the variations of the static and impact pressures inside the nozzle of the highly rarefied wind tunnel. The measurements indicate that the pressure varies in a continuous manner inside the nozzle and that the different flow regimes (slip-flow, transition and free-molecular) establish themselves gradually. (Contractor's abstract)

1187

Méditerranéen de Recherches Thermodynamiques, Nice (France).

REALISATION OF A MOLECULAR GUN OR COSMIC WIND TUNNEL, by F. M. Devienne. Oct. 1959, 57p. incl. illus. diagrs. refs. (AFOSR-TN-59-1292) (AF 61-(052)296) AD 232218; PB 146134   Unclassified

The building conditions are described of a molecular gun, an apparatus by means of which it is possible to reproduce conditions to which a solid body, moving at a cosmic speed, in a rarefied gas, is submitted. The apparatus is based on the exchange momentum between 2 crossed beams, 1 of these being a molecular beam corresponding to an ordinary temperature, and the other an ion beam in which the ions are accelerated by voltages included between a few volts and a few hundred volts. After having outlined the principles of the apparatus and its different parts, the calculations are given on the probabilities of collision between a high speed ion and a low speed molecule. The means by which a slight dispersion of molecules may be obtained is indicated, so that the paths of the high speed molecules shall not be disturbed as a result of intermolecular collisions. The specifications that the ion beam must comply and in what way the ions and the high speed molecules must be separated are discussed. The possible intensities of the high speed molecular beams, corresponding to a static pressure of $1/10\ \mu$

of mercury and to a speed capable of attaining 20 to 30 km/sec are also discussed. Finally, it is indicated how, by means of a special device, the speed of fast moving molecules can be measured. (Contractor's abstract)

1188

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

HELICAL FLOW OF GENERAL FLUIDS, by B. D. Coleman and W. Noll. [1959] [5]p. (AFOSR-TN-59-506) (In cooperation with Carnegie Inst. of Tech., Pittsburgh, Pa.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)541 and National Science Foundation) AD 215931   Unclassified

Also published in Jour. Appl. Phys., v. 30: 1508-1512, Oct. 1959.

The problem of the helical flow of a general fluid is solved making no special constitutive assumptions other than incompressibility. It is shown that from a knowledge of the rheologists' viscosity function one can calculate the dependence of the velocity field in helical flow on the geometry and applied forces. The complete stress distribution (including normal stresses) may be calculated from a knowlege of 3 basic material functions which can, in principle, be determined from an experimental study of simple shearing flow Expressions are derived for the discharge rate and for the angular velocities of the bounding cylinders as functions of the applied forces. (Contractor's abstract)

1189

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

ON THE THERMOSTATICS OF CONTINUOUS MEDIA, by B. D. Coleman and W. Noll. July 1959, 77p. incl. refs. (AFOSR-TN-59-852) (In cooperation with Carnegie Inst. of Tech., Pittsburgh, Pa.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)541 and National Science Foundation) AD 225435; PB 144320   Unclassified

Also published in Arch. Rational Mech. and Anal., v. 4: 97-128, 1959.

An attempt is made to develop a rigorous theory of thermostatics for continuous bodies in arbitrary states of strain, deriving some of the fundamental laws of hydrostatics and elastostatics from thermodynamic principles. The theory is based on 2 physical postulates. The 1st asserts that, at a material point, any local thermomechanic state can be an equilibrium state provided the local temperature and local forces have appropriate values. The 2nd postulate is essentially the assumption that, at least in continuum mechanics, absolute temperatures are never negative. From these postulates proof is presented of the relationships between

the stress-strain equation and the caloric equation of state, and various inequalities restricting the form of the caloric equation of state are derived.

1190

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

INTERMOLECULAR INTERACTIONS IN THE SOLID STATE. EXTENT OF FREEDOM OF ROTATIONAL MOTION OF SMALL MOLECULES, by R. M. Hexter and D. E. Milligan. June 1, 1959 [25]p. incl. diagrs. tables, refs. (AFOSR-TN-59-569) (AF 49(638)542) AD 217003 Unclassified

The high resolution spectra in matrix isolation was investigated of H_2O, D_2O, NH_3, CH_4, SiH_4, and GeH_4 using A, N, and GeH_4 as matrices. Spectral measurements were made on NH_3 suspended at great dilution in solid argon (A/NH_3 = 500-1200) and nitrogen (N_2/NH_3 = 500-1700). A total of 9 lines with widths comparable to those observed in the spectrum of gaseous NH_3 were observed in the 950-1030 cm^{-1} region in the spectrum of NH_3 suspended in solid A. The frequencies of these lines and their relative intensities are given. Lines observed in the spectrum of NH_3 suspended in solid N are also given. The spectral features under consideration correspond to the symmetric bending mode ($\nu_{2\|}$) of NH_3. The spectrum of gaseous NH_3 in A appears from the table to have only lines in the R branch. Support of the R branches is found in the matrix spectrum of ND_3 in A. Two series are again found, with separation within each of approximately 10 cm^{-1} as in the gas. It appears that the modification of the barrier to inversion imposed by an A matrix becomes gross in a N matrix. The NH_3 molecule is unable to invert in this material.

1191

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

INTERMOLECULAR COUPLING OF VIBRATIONS IN MOLECULAR CRYSTALS, by R. M. Hexter. Oct. 22, 1959 [35]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1139) (AF 49(638)542) AD 228614; PB 144867 Unclassified

The theory of Davydov of the origin of correlation field splittings is applied to the non-degenerate modes of solid methyl chloride. Intermolecular coupling constants and dipole derivatives for these modes in the solid are derived. An isotope effect on such splittings is reported for the 1st time in CH_3I and is accounted for by means of Davydov's theory. The effect of intermolecular transition dipole coupling on intensities is derived and compared with implications of the dipole

derivatives derived from the correlation field splittings. The possible use of other bases for correlation field splittings is discussed. (Contractor's abstract)

1192

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

INFRARED SPECTROSCOPIC EVIDENCE FOR THE ROTATION OF THE AMMONIA MOLECULE IN SOLID ARGON AND NITROGEN, by D. E. Milligan and R. M. Hexter. Dec. 18, 1959 [13]p. incl. diagrs. tables. (AFOSR-TN-59-1327) (AF 49(638)542) AD 230764; PB 144908 Unclassified

Also published in Jour. Chem. Phys., v. 34: 1009-1012, Mar. 1961.

High resolution infrared ammonia spectra of the symmetric bending mode suspended at high dilution in solid argon and nitrogen were obtained. More than a half dozen extremely sharp bands have been observed in the 950-1040 cm^{-1} region in the spectrum of ammonia in these materials under conditions where there should be little if any absorption due to polymeric species. The frequency separations of the bands, their temperature dependence and their extreme sharpness appear to be compatible with a model in which the ammonia molecule executes quantized rotation in these solids. (Contractor's abstract)

1193

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

THE ROLE OF THE STRONG MARKOV PROPERTY IN PROBABILITY THEORY, by D. G. Austin. Sept. 1959 [10]p. incl. refs. [Research rept. no. 11] (AFOSR-TN-59-1035) (AF 49(638)184) AD 231319; PB 145557 Unclassified

Stochastic processes are described which are linked to the strong Markov property and its applications. Markov chains are considered. A sample function property and a version of the strong Markov theorem are also considered for processes with separable metric state space and with no stationarity assumption on the conditional probabilities. (Contractor's abstract)

1194

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

THE GENERALIZED BACKWARD KOLMOGOROV EQUATION IN ABSTRACT FORM, by D. G. Austin. [1959] [6]p. (AFOSR-3274) [AF 49(638)184] Unclassified

Also published in Illinois Jour. Math., v. 3: 532-537, Dec. 1959.

Let $(\mathfrak{I},x)$ denote an abstract space X and a Borel field $\mathfrak{I}$ of subsets of X containing X and all 1-point sets, and let $P_t(x,E)$ $(t \geq 0, x \in X, E \in \mathfrak{I})$ denote a stationary Markov transition function such that $P_t(x, \{x\})$ is $\mathfrak{I}$-measurable for each t, tends to $P_0(x, \{x\})$ $(= 1)$ as $t \downarrow 0$ for all x, and has a finite right-hand derivative at t = 0 for some one x (x^*, say). Then the derivative $\dot{P}_t(x^*, E)$ exists for t > 0 and all E in $\mathfrak{I}$, and $P'_t(x^*,)$ is an uniformly bounded measure of $\mathfrak{I}$ satisfying $P'_{t+s}(x^*, E) = \int_X P_s(\cdot, E)dP'_t(x^*, \cdot)$. (Math Rev. abstract)

1195

Miami U. [Dept. of Physics] Coral Gables, Fla.

STUDIES OF IONIZATION PARAMETERS IN NUCLEAR EMULSIONS, by M. Blau, S. C. Bloch and others. Feb. 4, 1959 [31]p. incl. diagrs. refs. (AFOSR-TN-59-229) (AF 49(638)97) AD 211842; PB 140224
Unclassified

Also published in Rev. Scient. Instr., v. 31: 289-297, Mar. 1960.

A semi-automatic instrument for ionization measurements in emulsion is briefly described. The instrument was used in the investigation of the various ionization parameters. Deviations from a purely exponential gap length distribution were observed, a result found earlier by Cortini et al. This observation casts some doubt on the unrestricted use of the mean gap length as a parameter. A new parameter, based on the blob length distribution, and which is useful over the entire ionization range, is proposed. The relation of this parameter to grain density is discussed. It is shown that the behavior of the latter (as determined from the blob length distribution) as a function of restricted ionization loss seems to be in agreement with theoretical expectations, with the exception of the very dense region, where appropriate corrections are proposed.

1196

Miami U. [Dept. of Physics] Coral Gables, Fla.

NEGATIVE PION INTERACTIONS AT 1.3 $\frac{Bev}{C}$, by M. Blau, C. F. Carter, and A. Perlmutter. July 10, 1959 [35]p. incl. diagrs. tables, refs. (AFOSR-TN-59-788) (AF 49(638)97) AD 220514; PB 145040 Unclassified

Also published in Nuovo Cimento, Series X, v. 14: 704-721, Nov. 16, 1959.

A total of 340 m of track of negative pions of momentum 1.3 $\frac{bev}{C}$ have been followed in emulsion, and pion interactions have been recorded. Special emphasis is placed

on inelastic scattering on free protons (single meson production). The resulting angular and momentum distributions of the emitted particles are investigated and compared with previous experiments at similar energies. An attempt is made to explain these results on the basis of an isobar decaying into a nucleon and the slower pion. In the case of reaction $\pi^- + p \rightarrow \pi^- + \pi^\circ + p$, it appears that there exists an anisotropy in the isobar frame of reference, in which the slower pion is emitted predominantly backward, with respect to the isobar direction. The results are compared with the $\pi - \pi$ coupling model. Angular and energy distributions of mesons emitted in nuclear interactions are investigated and compared with other results and Monte Carlo calculations. The meson multiplicity and energy degradation in these collisions are also discussed. Strange particles found during the investigation are analyzed. (Contractor's abstract)

1197

Miami U. [Dept. of Physics] Coral Gables, Fla.

ON THE HIGH-TEMPERATURE EXPANSIONS OF THE SUSCEPTIBILITY OF A HEISENBERG FERROMAGNET, by H. [A.] Brown. Final rept. [Oct. 1, 1959] [16]p. incl. diagrs. tables. (AFOSR-TR-59-154) (AF 49(638)630) AD 231828; PB 145663 Unclassified

The work done in correcting the values of a_5 (the 5th-approximation coefficient) for the QL (quadratic layer), SC (simple cubic), and BCC (body-centered cubic) lattices as formerly published (Phys. Rev., v. 104: 624-625, Nov. 1, 1956) is described and the results therein extended to the FCC (face-centered cubic) and HL (hexagonal layer) lattices. The evaluation of a_6 is also begun for these 5 lattices. The error in question was found to have been computed incorrectly and it vanished for spin 1/2. The counting problem is discussed for n = 1 through 6 explaining the number of graphs possible under each condition. A short evaluation of the traces is also given.

1198

Miami U. [Dept. of Physics] Coral Gables, Fla.

SURFACE STATES IN A FINITE ONE-DIMENSIONAL LATTICE (Abstract), by H. A. Brown. [1959] [1]p. [AF 49(638)630] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 275, Apr. 30, 1959.

Using a method similar to Kramer's treatment of 1-dimensional repetitive potential, a finite 1-dimensional lattice of N atoms is considered. By continuity conditions, the wave function in successive cells is generated by means of a 2 x 2 matrix, M, whose elements are

known in terms of the values of the even and odd solutions in 1 cell and their derivatives evaluated at the edge of the atomic cell. For a given potential, these elements are functions of the energy only. The electron probability density in the nth cell is obtained in terms

of the matrix elements of M^n, which is found from a recurrence formula for M, and a surface is defined as 1 for which the probability density increases monotonically away from the center of the lattice. It is then easy to obtain the following results already found by Shockley by means of a somewhat different procedure. As an adiabatic compression from infinite separation is carried out and the atomic levels spread out into bands, no surface states occur until bands cross, after which they occur in pairs for large enough N. Furthermore, the larger the value of N, the closer in energy do the pairs lie.

1199

Michigan State U., East Lansing.

ON THE CASIMIR OPERATOR, by H. E. Campbell. [1957] [7]p. [AF 49(638)511]   Unclassified

Published in Pacific Jour. Math., v. 7: 1325-1331, 1957.

A new definition of the Casimir operator for associative, Lie and alternative algebras, which keeps desirable properties of the usual Casimir operator and which is useful for arbitrary characteristic is presented. It is shown that under certain conditions the Casimir operator is the identity transformation, and for non-degenerate alternative (or associative) algebras that it is the transformation into which the identity element of the algebra maps. The results are applied to obtain the 1st Whitehead lemma for non-degenerate alternative algebras of arbitrary characteristic. A special case of the Levi theorem for Lie algebras of prime characteristic is also discussed.

1200

Michigan State U. Dept. of Physics and Astronomy, East Lansing.

THE BETA DECAY OF K^{40}, by W. H. Kelly, G. B. Beard, and R. A. Peters. July 20, 1959 [7]p. incl. diagrs. refs. (AFOSR-TN-59-75) (AF 49(638)10) AD 209917   Unclassified

Also published in Nuclear Phys., v. 11: 492-498, June 1959.

The beta decay of K^{40} was studied using a 1 in. diam x 1 in. high KI(Tl) scintillation crystal. The Kurie plot of the beta spectrum was made linear down to less than 200 kev by the use of the exact third forbidden correction factor. The uncertainty in the correction for electron escape is suggested as the main source of non-linearity below this energy. The extrapolated end point energy

was 1.35 ± 0.02 mev. A specific activity of 27.2 ± 0.5 betas/sec/g of natural potassium was obtained. This corresponds to a decay constant $\lambda(\beta) = (4.72 \pm 0.09) \times 10^{-10} y^{-1}$ and a half-life $t(\beta) = (1.47 \pm 0.03) \times 10^9 y$. (Contractor's abstract)

1201

Michigan State U. [Dept. of Physics and Astronomy] East Lansing.

BETA DECAY OF Rb^{87} (Abstract), by G. B. Beard and W. H. Kelly. [1959] [1]p. [AF 49(638)10]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Milwaukee, Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 324, June 18, 1959.

A 1-in. x 3/4 in. NaI(Tl) crystal containing a few tenths % rubidium has been used to investigate the beta activity of Rb^{87}. The scintillation efficiency of the crystal for gamma rays was measured and found to be about 80% of that obtained using a comparison NaI(Tl) crystal grown under the same conditions. For the 662 kev Cs^{137} gamma ray, the resolution of the rubidium doped crystal was 13.6% compared to 12.4% for the undoped crystal. Measurements of the specific activities of small sections taken from the ingot both above and below the mounted crystal volume showed that the rubidium iodide added to the melt did not distribute evenly throughout the ingot. Therefore, a qualitative determination of the rubidium content in the crystal is necessary before the specific activity of the Rb^{87} can be calculated. Preliminary results of this and beta spectrum analysis will be presented.

1202

Michigan State U. [Dept. of Physics and Astronomy] East Lansing.

NATURAL ALPHA ACTIVITY OF Nd^{144} (Abstract), by W. H. Kelly and G. B. Beard. [1959] [1]p. [AF 49(638)-10]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Milwaukee, Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 324, June 18, 1959.

The natural alpha activity of Nd^{144} has been measured using a loaded liquid scintillator containing 2% neodymium by weight. Preliminary results give a specific activity of about 4 counts/sec/g of Nd^{144}. This

corresponds to a Nd^{144} half-life of 2×10^{13} yr. The observed activity could also be accounted for by the presence of about 0.9% samarium as an impurity. However, the neodymium used in the scintillator has been analyzed and found to contain less than 0.01% samarium so that the presence of much samarium impurity is unlikely.

1203

Michigan State U. [Dept. of Physics and Astronomy] East Lansing.

ELECTRICAL RESISTIVITY OF THIN METALLIC WIRES, by H. G. Satz. July 25, 1959, 1v. incl. diagrs. refs. (AFOSR-TN-59-639) (AF 49(638)70) AD 220470; PB 143671   Unclassified

Measurements by Olsen (Helv. Phys. Acta, v. 31: 713, 1958) on thin indium wires at low temperatures have demonstrated that not only the residual but also the temperature dependent part of the resistivity increases as the wire diam decreases. It was suggested by Olsen that small angle phonon scattering, which may take electrons to the surface, where they suffer diffuse scattering, might give rise to the observed effect. Since an exact solution of the transport equation in this case is beset with nearly insurmountable difficulties, an extremely crude analysis has been resorted to, similar to that employed by Nordheim (Act. Sci. et Ind.) no. 131 [Paris, Hermann]). Two mechanisms are considered: (1) Electron-phonon scattering, which takes electrons to the surface in a time shorter than τ_{ph}, where τ_{ph} is the electron-phonon relaxation time in the bulk; and (2) Electron-electron scattering, which, although of no consequence in the bulk, may also contribute to the resistivity of a thin wire by bringing carriers to the surface. (Contractor's abstract)

1204

Michigan State U. Dept. of Physics [and Astronomy] East Lansing.

POLARIZATION OF THE Al^{27} NUCLEI IN RUBY, by J. A. Cowen, W. R. Schafer, and R. D. Spence. [1959] [6]p. incl. illus. diagr. (AFOSR-TN-59-263) (AF 49-(638)613) AD 217687   Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 13-14, July 1, 1959.

It is found that it is possible to observe either enhanced nuclear absorption or emission signals by driving a microwave transition of the chromium impurity. Results show that with the magnetic field adjusted so that the chromium spin resonance occurs at the low-field end of the magnetic field sweep, all the components of the aluminum nuclear resonance show an enhancement if sufficient microwave power is applied. With the magnetic field adjusted so that the chromium spin res-

onance occurs at the high-field end of the sweep, all of the components of the nuclear resonance give strong emission signals if sufficient microwave power is applied. The enhanced or emission signals build up exponentially with a characteristic time which varies from less than a second to a few seconds depending on the orientation of the crystal.

1205

Michigan U., Ann Arbor.

A STUDY OF INSTABILITY OF THE FLOW AND BOUNDARY LAYER TRANSITION NEAR THE NOSE OF BLUNT BODIES OF REVOLUTION. PART II. A WIND TUNNEL FACILITY FOR BOUNDARY LAYER TRANSITION STUDIES ON A COOLED BLUNT BODY IN SIMULATED HYPERSONIC FLOW, by R. Dunlap and A. M. Kuethe. Final rept. Sept. 1959, 29p. incl. illus. diagrs. refs. (AFOSR-TR-59-144) (AF 49(638)-336)   Unclassified

The development of apparatus for an experimental study of the stability of the laminar boundary layer over supercooled blunt bodies under simulated hypersonic flight conditions is described. The method involves hot-wire measurements of the growth of disturbances in the boundary layer on a cooled hemisphere. A shroud around the model is designed to cause the pressure distribution to be identical with that observed in hypersonic flight. The analysis leading to the shroud design is new and given in detail. The apparatus has been constructed and excellent agreement is found between measured and theoretical pressure distributions on the hemisphere. (Contractor's abstract)

1206

Michigan U. Dept. of Chemical and Metallurgical Engineering, Ann Arbor.

THE EFFECTS OF STRAIN ON THE INTERFACIAL ENERGIES OF SOLIDS, by S. Floreen, E. E. Hucke, and D. V. Ragone. Nov. 9, 1959, 15p. incl. tables, refs. (AFOSR-TN-59-1253) [AF 49(638)422] AD 233780; PB 146740   Unclassified

A relationship is developed to show that the surface energy and the grain boundary energy of a solid changes with the elastic strain in the following manner: $\gamma = \gamma_0 + k\epsilon^2$, $\beta = \beta_0 + j\epsilon^2$ where γ and β are the average surface energy and grain boundary energy at strain ϵ, γ_0 and β_0 are the respective energies at zero strain, and j and k are constants. On the basis of elastic properties that have been reported and also of some preliminary tests on metal wires, it is concluded that the order of magnitude of k is 10^8 ergs/cm^2. The order of magnitude of j is unknown at the present.

1207

Michigan U. Dept. of Chemical and Metallurgical
Engineering, Ann Arbor.

WHISKER GROWTH ON VANADIUM PENTOXIDE
SURFACES, by V. J. Lee and G. Parravano. Mar.
1959, 30p. incl. illus. diagrs. (Rept. no. 2832-1-T)
(AFOSR-TN-59-184) (AF 49(638)493) AD 211324;
PB 140548   Unclassified

The growth of whiskers has been observed on single
crystals and polycrystalline samples of vanadium
pentoxide. Detailed data on the growth rate are pre-
sented for temperatures 546 to 650° in air, steam and
vacuum, for closed and open atm. From the kinetic
expressions a growth mechanism has been derived.
The mechanism involves gas phase condensation and
surface diffusion on the whisker top together with bulk
diffusion within the whisker. The interplay of different
factors in determining the type of growth is discussed.
In open systems, whiskers were found to grow by dif-
fusion from the base, while evaporation was predomi-
nant at the top. Whiskers, which upon growing on the
surface of a vanadium pentoxide microsphere at uni-
form cross section, meet a neighboring sphere, grow
suddenly in diam. It is suggested that whisker forma-
tion represents the first stage of sintering of vanadium
pentoxide particles. (Contractor's abstract)

1208

Michigan U. Dept. of Chemical and Metallurgical
Engineering, Ann Arbor.

SINTERING OF VANADIUM PENTOXIDE, by G.
Parravano and V. J. Lee. June 1959, 6p. incl. diagrs.
(Rept. no. 2832-2-T) (AFOSR-TN-59-481) (AF 49-
(638)493) AD 215734; PB 142357   Unclassified

The sintering of vanadium pentoxide microspheres has
been studied in the temperature range of from 560 to
650°C in air and with spheres of diameters varying
from 0.2 to 0.9 mm. Rate data have been interpreted
in terms of a sintering mechanism involving migration
of vacancies along the surface and grain boundaries of
the spheres. The role of whisker growth on sintering
is discussed. The overall sintering process is shown
to be the result of several steps: the initial stage of
the kinetic sequence is the growth of oxide whiskers.
(Contractor's abstract)

1209

Michigan U. Dept. of Electrical Engineering, Ann Arbor.

DETECTION OF A SIGNAL SPECIFIED EXACTLY
WITH A NOISY STORED REFERENCE SIGNAL, by T.
G. Birdsall. Sept. 1959, 22p. incl. diagrs. table. (Tech-
nical rept. no. 93; rept. no. 2803-1-T) (AFOSR-TN-59-
909) (AF 49(638)369) AD 229517; PB 144784
                                      Unclassified

This report treats the optimization problem of detecting
the presence of a signal in a background of white
Gaussian noise, under the restriction that the signal is
specified exactly but the receiver memory contains only
a noisy version of the signal. The optimum receiver is
specified. The performances of both the optimum re-
ceiver and the cross-correlation receiver with a noisy
memory are calculated and compared for a special case.
(Contractor's abstract)

1210

Michigan U. Dept. of Electrical Engineering, Ann Arbor.

LABORATORY FACILITIES EMPLOYED IN PSYCHO-
PHYSICAL MEMORY EXPERIMENTS, by R. C. Bilger.
Sept. 1959, 17p. incl. illus. diagr. (Technical memo. no.
72; rept. no. 2803-2-T) (AFOSR-TN-59-923) (AF 49-
(638)369) AD 229518; PB 144793   Unclassified

Equipment and operating procedures used in psycho-
physical memory experiments are described. This
equipment gives precise control of signal parameters
and permits large quantities of data to be collected.
The random selection of input waveforms, the rate of
signal presentation, and the observer's responses are
programmed by PSYTAR (PSYchological Testing And
Recording); ROMPAR (Random Orthogonal Message
Presenter and Recorder) is the message-storage de-
vice used with PSYTAR. (Contractor's abstract,
modified)

1211

Michigan U. [Dept. of Electrical Engineering] Ann Arbor.

GRAPHICAL PRESENTATION OF DATA IN THE
FRAMEWORK OF THE THEORY OF SIGNAL DETECTA-
BILITY, by W. P. Tanner, Jr. [1959] [2]p. incl. diagr.
[AF 49(638)369]   Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 243-244,
Feb. 1959.

A discussion is presented on the graphical presentation
of data relating measures of performance to signal en-
ergy in psychophysical experiments.

1212

Michigan U. [Dept. of Electrical Engineering] Ann Arbor.

EFFECT OF MEMORY FOR AMPLITUDE ON AMPLI-
TUDE DISCRIMINATION (Abstract), by W. P. Tanner,
Jr. [1959] [1]p. [AF 49(638)369]   Unclassified

Presented at meeting of the Acoust. Soc. Amer.,
Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1575,
Nov. 1959.

A 2 alternative forced-choice experiment (2 AFC) in which the observer is asked to state which is the larger of 2 segments of tones presented sequentially in time, is analyzed as an experiment involving only amplitude memory. Frequency, phase, starting time, and duration information is provided each trial by the stimuli. The 2 AFC experiment is conceived as 1 in which a measure of the intensity of the 1st signal serves to establish a cutoff value against which the measure of the 2nd can be compared. If the measure of the 2nd exceeds the cutoff then it is reported to be larger. If the measure of the 2nd is less than the cutoff then the 1st is reported to be larger. The variable in these experiments was the time interval, τ, between the 2 signals. Intervals from 50 to 9600 msec were studied. The efficiency in these experiments varied as the produce $(1 - e^{-c\tau})1/1 + A\tau$, where C is a damping constant and A is a constant describing the variance of the cutoff.

1213

Michigan U. [Dept. of Electrical Engineering] Ann Arbor.

FREQUENCY DISCRIMINATION AS A FUNCTION OF INTERPRESENTATION INTERVAL (Abstract), by C. D. Creelman. [1959] [1]p. [AF 49(638)369]
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1577, Nov. 1959.

In a 2-alternative forced-choice frequency discrimination task observers were instructed to respond by indicating the presentation interval in which the higher of the 2 tones had appeared. The frequency difference between the 2 tones was fixed at 15 cps. The independent variable manipulated was the time between the 2 presentation intervals within each trial. Discrimination was measured at 9 separation times from 30 msec to 9.6 sec. The data indicate a peak in discrimination, varying among the 4 observers, with about 1-sec separation. The data are accounted for by 2 "memory" mechanisms. A short-term effect causes the 1st of 2 closely spaced signals to interfere with the 2nd. When the signals are separated by longer intervals a decaying memory of the frequency of the 1st makes comparison with the 2nd signal less precise, lowering discrimination.

1214

Michigan U. [Dept. of Mathematics] Ann Arbor.

APPLICATIONS OF THE THEORY OF MORSE TO SYMMETRIC SPACES, by R. Bott and H. Samelson. Mar. 1959 [66]p. incl. diagrs. refs. (AFOSR-TN-59-130) (AF 49(638)104) AD 210769; PB 142401
Unclassified

Also published in Amer. Jour. Math., v. 80: 964-1029, Oct. 1958.

Results announced by the authors (Proc. Nat'l. Acad. Sci., v. 4: 490-493, 1955) are proved in the present paper. Let Ω be the loop space on the connected compact Lie group K and let S be the set of geodesics on K leading from a general point to the identity. Then an explicit isomorphism γ of S_*, the free module generated by the elements of S, into $H_*(\Omega Z)$, the integral singular homology group of Ω is given. To carry out the program, the authors deal with the loop space of a manifold M on which a compact Lie group K acts with at least one fixed point. Then it is proved that if the action of K on M satisfies a certain infinitesimal condition, called variational completeness, there is an isomorphism γ of S_* onto $H_*(\Omega;Z)$ provided that S is K-orientable (or, without assuming the K-orientability of S, an isomorphism of S_*, the vector space with integer mod 2 coefficients generated by the elements of S, onto $H_*(\Omega;Z_2)$, the singular homology group of Ω with integer mod 2 coefficients). The validity of variational completeness is established in various instances all of which are associated with symmetric spaces. The rest of the paper is devoted to applications of these results to the topology of Lie groups and symmetric spaces in general.

1215

Michigan U. [Dept. of Mathematics] Ann Arbor.

A NOTE ON CARTAN'S CRITERION, by H. Samelson. June 1959, 6p. (AFOSR-TN-59-467) (AF 49(638)104) AD 215226
Unclassified

Also published in Portugal. Math., v. 18: 181-185, 1959.

A self-contained version is presented for the proof of Cartan's criterion for semi-simplicity of Lie algebras. Cartan's criterion states: the Lie algebra g is semi-simple if and only if the Killing form β is non-degenerate (i.e., $\beta (X_0, Y) = 0$ for all $Y \epsilon$ g implies $X_0 = 0$).

1216

Michigan U. [Dept. of Mathematics] Ann Arbor.

ON THE THEOREMS OF GROSS AND INVERSEN, by A. J. Lohwater. July 1959 16p. incl. refs. (AFOSR-TN-59-550) (AF 49(638)104) AD 216660; PB 143006
Unclassified

The theory of cluster sets is considered, where the topological properties of meromorphic functions are separated from the analytic properties. The principal results are generalizations of theorems of Gross and Iversen, asserting the inclusion of the frontier of the cluster set of a function f at P in the boundary cluster set of f at P. The generalization is obtained by the introduction of a retined boundary cluster set relative to

a set of measure O on the unit circle. Every value of the cluster set minus the modified boundary cluster set is assumed infinitely often near P, with the exception of a set of logarithmic capacity O. The results include a generalization of Picard's theorem to non-isolated essential singularities. (Contractor's abstract)

1217

Michigan U. [Dept. of Mathematics] Ann Arbor.

ON IMMERSION OF MANIFOLDS, by H. Samelson. Oct. 1959, 10p. (AFOSR-TN-59-853) (AF 49(638)104) AD 229991; PB 145309   Unclassified

Also published in Canad. Jour. Math., v. 12: 529-534, 1960.

A simple geometrical proof, using vector fields, is given for the theorem of R. Lashof and S. Smale (Ann. Math., v. 68: 562-583, 1958) to the effect that for an imbedding of a compact manifold M into a manifold M' the normal degree equals the characteristic of M modulo, that of M' (or zero if M' not compact); the relevant homology class is identified. A 2nd proof using the theory of Morse is given for the special case where M' is Euclidean space. (Contractor's abstract)

1218

Michigan U. [Dept. of Mathematics] Ann Arbor.

RADIAL CLUSTER SETS AND THE DISTRIBUTION OF VALUES OF MEROMORPHIC FUNCTIONS, by W. B. Woolf. Oct. 1959, 31p. incl. refs. (AFOSR-TN-59-1041) (AF 49(638)104) AD 229490; PB 144772
Unclassified

An investigation is presented of the behavior near a singularity of a function $w = f(z)$ meromorphic in the unit disk. Emphasis is placed on the problem of deriving meaningful results for non-isolated singularities. The background of the study is traced from the classical theorems of Weierstrass and Picard to the definitions of the cluster set and various subsets thereof. The concept of capacity is reviewed and the techniques of Lohwater and a theorem of Lindelöf are adapted to prove that, if $f(z)$ is meromorphic in $|z| < 1$, then $f(z)$ assumes infinitely often in every neighborhood of a singularity P on $|z| = 1$ every value of $C(f,P) - C_R(f,P)$, with the exception of at most 2 values. Every such omitted value is an asymptotic value of $f(z)$ at P. The main theorem is proved: if $f(z)$ is meromorphic in $|z| < 1$, E is of capacity zero, P is a point of $|z| = 1$, and S is any component of $C(f,P) - C_{R-E}(f,P)$, then $f(z)$ assumes every value of S, save at most 2, in any neighborhood of P. Every such omitted value is an asymptotic value either at P or at a sequence of boundary points having P as limit point. The strength and significance

of these results lies in their application to cases where the singularities are non-isolated, and to the case that $|z| = 1$ is a singular line. (Contractor's abstract)

1219

Michigan U. [Dept. of Mathematics] Ann Arbor.

AN ACTION OF A FINITE GROUP ON AN n-CELL WITHOUT STATIONARY POINTS, by E. E. Floyd and R. W. Richardson. [1959] [4]p. (AF 49(638)104)
Unclassified

Published in Bull. Amer. Math. Soc., v. 65: 73-76, Mar. 1959.

A simplicial action of A_5, the group of even permutations on 5 letters, on an n-cell without stationary points is given. Proof of 2 lemmas is given including (1) the coset space SO(3)/I has the integral homology groups of the 3-sphere S^3; and (2) the action of I on SO(3)/I is simplicial.

1220

Michigan U. Dept. of Mathematics, Ann Arbor.

ASYMPTOTIC SOLUTION OF ORDINARY DIFFEREN-TIAL EQUATIONS, by N. D. Kazarinoff. Final rept. Apr. 1959, 5p. (Rept. no. 2657-4-F) (AFOSR-TR-59-49) (AF 49(638)192) AD 215714; PB 142190
Unclassified

Three mathematical problems are investigated: (1) a Peano-like existence proof for solutions of the Goursat problem for quasi-linear equations, (2) a Runge-Kutta process for the numerical solution of this problem, and (3) the asymptotic behavior of solutions of ordinary linear differential equations having 2 simple turning points. (Contractor's abstract)

1221

Michigan U. Dept. of Mathematics, Ann Arbor.

RESTRICTED CLUSTER SETS, by P. Erdös and G. Piranian. Jan. 1960, 5p. (Rept. no. 2913-1-T) (AFOSR-TN-59-1122) (AF 49(638)633) AD 231397; PB 145543   Unclassified

Collingwood has shown that if a function f is continuous in the upper half-plane, then the real axis contains a residual set at each of whose points each Stolz cluster set of f coincides with the complete cluster set of f. It is shown that the hypothesis of continuity can be dropped from Collingwood's theorem. A function whose segmental cluster sets exhibits a large measure of independence is also described.

1222

Michigan U. Dept. of Physics, Ann Arbor.

GALVANO-MAGNETIC EFFECTS. PART I, by W. Tantraporn and E. Katz. Final rept. Aug. 1959, 51p. incl. illus. diagrs. tables, refs. (Rept. no. 2613-8-F) (AFOSR-TR-59-122, pt. 1) (AF 49(638)69) AD 226081; PB 144121   Unclassified

A historical preface is given. The phenomenological theory, as developed previously, is summarized, with special emphasis on applications to bismuth and gallium. The experimental method of measurement and results for bismuth are described. It is found that all resistivity brackets can be represented by the formula

$\{ \ \} = \Gamma_0 \, Te^{-\beta} \sqrt{T}$, where Γ_0 is a constant, different

for each bracket and β depends almost exclusively on the order of the bracket. This dependence is roughly given by $\beta_n = 2n/(n+4)$. Results from the literature

for gallium are analyzed in terms of our phenomenological constants. The procedure of testing and its complications are sketched, as is the direction in which an entire new series of bracket relations is in process of being discovered by the present analysis. Comparison of limiting low-intensity reciprocity failure slope from sequence loops is made with previous measurements. A study is made of the number of quanta active in the formation of a just developable latent image as a function of grain size, density, and type of development by means of sequence loops. The method of sequence exposures is briefly described along with experimental results. The results confirm qualitatively the trend of the theoretical work but lead to quantitative difficulties, which are discussed. The conclusions are summarized. (Contractor's abstract)

1223

Michigan U. Dept. of Physics, Ann Arbor.

THE PHOTOGRAPHIC SEQUENCE EFFECT. PART II, by J. H. Enns and E. Katz. Final rept. Aug. 1959, 20p. incl. diagrs. (Rept. no. 2613-9-F) (AFOSR-TR-59-122, pt. 2) (AF 49(638)69) AD 226082; PB 144152   Unclassified

The motivation of this study is a comparison of limiting low-intensity reciprocity failure from sequence loops with direct measurements by Martin, and a study of the number of quanta active in the formation of a just developable latent image as a function of grain size, density, and type of development by means of sequence loops. The method of sequence exposures is described experimentally and theoretically. The experimental results were obtained with Eastman Kodak type 33 emulsions and with a set of emulsions consisting of nonsensitized pure AgBr emulsions of different average grain sizes. The results confirm qualitatively the trend of the theoretical work but lead to quantitative difficulties. For qualitative use the theory and the method of se-

quence-loop studies seem useful tools for the determination of the number of quanta that are involved in the formation of one just developable speck. Values in the range 3 to 20 quanta were found. This number tends to be lower for grains that require a larger total number of quanta received to become developable, indicating that the efficiency of concentrating the received energy on one speck tends to be lower for grains with smaller just developable specks. No explanation of this trend is presently available. (Contractor's abstract)

1224

Michigan U. [Engineering Research Inst.] Ann Arbor.

THE CHEMICAL AND PHYSICAL STRUCTURES OF PbS FILMS IN RELATION TO PHOTOCONDUCTIVE SENSITIVITY, by L. O. Brockway, M. S. Wasserman, and E. A. Meyers. Final rept. Dec. 1958, 56p. incl. illus. diagrs. tables, refs. (Rept. no. 2037-8-F) (AFOSR-TR-59-9) (AF 18(600)175) AD 209492   Unclassified

A study has been made of lead sulfide films with emphasis on relations between the method of preparation, physical and chemical composition, and photoconductivity. The 2 main features have been (a) an examination of particle size and orientation and of the chemical phases occurring as a function of the conditions of treatment, and (b) the relation of these compositional factors to the magnitude of the photoconductive sensitivity. The film composition was studied mainly by electron diffraction and microscopy, and the photoconductivity was measured in terms of the d-c biased film when illuminated with interrupted "black body" radiation.

1225

Michigan U. [Engineering Research Inst.] Ann Arbor.

[STRONG LUMINOUS SHOCKS PRODUCED IN SHOCK TUBES] by O. Laporte. Final rept. July 10, 1959, 3p. (Rept. no. 2189-4-T) (AFOSR-TR-59-81) (AF 18(600)-983)   Unclassified

The progress on this study of the properties of gases heated to a state of high temperature in a shock tube is summarized. At the end of 1957, a technique for the direct photography of shock waves and boundary layers in high temperature gases was developed. In early 1958, the gas properties behind the shock wave reflected from the closed end of a shock tube were studied with respect to (1) the direct and inferential measurement of hydrodynamical variables, and (2) spectrophotometric measurement of the oxidation temperature up to 10,000°K. The results were compared to the theoretical ones. Within 10% error was observed (1) in the cases with fluid density and kinetic temperature variables, and (2) in the temperature range between 5000 - 5900°K. It is suggested that future studies should be concentrated in the areas of (a) microwave emission from

shock-ionized gases, (b) discharge-induced blast and
shock waves, and (c) magnetohydrodynamics in con-
ducting liquids and gases.

1226

Michigan U. [Engineering Research Inst.] Ann Arbor.

AN EXPERIMENTAL INVESTIGATION OF THE POSSI-
BILITY OF ACHIEVING A STANDING DETONATION
WAVE, by J. A. Nicholls, E. K. Dabora, and R. S. B.
Ong. Final rept. July 1, 1954-Jan. 31, 1959. July 1959,
23p. incl. illus. diagrs. refs. (Rept. no. 2284-23-F)
(AFOSR-TR-59-132) (AF 18(600)1199) AD 226658;
PB 143908   Unclassified

The properties of gaseous detonation waves and the con-
ditions that must be met to generate stable waves are
described and discussed, as is the experimental facility
which evolved as a result of these considerations. Pre-
liminary experiments leading to the 1st known case of a
stabilized detonation wave (probably very close to the
Chapman-Jouguet case) are also described. In these ex-
periments an ignition time delay has been detected be-
tween the shock wave and onset of combustion. It ap-
pears that this experimental technique has great poten-
tial in the study of chemical kinetics as well as in the
study of stabilized detonation waves. Preliminary ana-
lytical work on the stability of a plane detonation wave is
discussed.

1227

Michigan U. [Engineering Research Inst.] Ann Arbor.

STABILIZED GASEOUS DETONATION WAVES, by J.
A. Nicholls. [1959] [2]p. incl. diagr. (AF 18(600)1199)
                                              Unclassified

Published in ARS Jour., v. 29: 607-608, Aug. 1959.

An elaboration of the experimental procedure and re-
sults obtained in this laboratory on stabilized detonation
wave research is presented as a reply to Gross's com-
ments (FEA.01:005, Vol. II and 526, Vol. III) on this
work. A review of the research is presented starting
with the 1st AFOSR supported work done in 1954. At-
tention is directed to the work concerned with the igni-
tion time delay for the given pressure, temper. re,
and mixture ratio existing downstream of the s' k. It
is shown that since the ignition time delay is a nen-
tial function of reciprocal temperature, it is not a
prising that in those cases in which partial premature
combustion in the nozzle is experienced, the delay de-
creases to shorter times than can be resolved experi-
mentally. It is also pointed out that the light emission
realized for appreciable distances downstream can be
due to the sodium chloride injected into the air stream.

1228

Michigan U. [Engineering Research Inst.] Ann Arbor.

COMBUSTION EXPERIMENT WITH A 50,000-CURIE
GOLD SOURCE, by S. W. Churchill, A. Weir, Jr. and
others. Nov. 1959, 15p. incl. illus. diagrs. (Rept. no.
2226-9-T) (AFOSR-TR-59-185) (AF 18(600)1218)
AD 234757   Unclassified

The data obtained in a previous experiment (MIC.09:001,
Vol. I) in which the flame zone and preflame zone of
premixed propane and air were both irradiated with a
12,000-curie gold source have been reworked and re-
interpreted for journal publication (Ind. Eng. Chem.,
v. 49: 1419-22, 1423-28, Sept. 1957; see also item nos.
MIC.09:002, 003, Vol. II). The previously reported ef-
fects of irradiation on the flame speed and emission
spectra of the flames were reconfirmed, but the uncer-
tainty in the recomputed OH-rotational temperature was
found to be greater than the observed variation with
source strength and hence was not determinable from
these data. A new experiment was designed to irradiate
the flame and preflame zones separately under essential-
ly the same conditions. An accidental explosion in the
test chamber shortly after installation of the radioactive
gold damaged the burner and the optical transmission
system used for remote observation of the flame, pre-
venting collection of the intended data. The details of
the experimental design and the history of the experiment
are nevertheless reported as a guide to future research
of a similar nature.

1229

Michigan U. [Engineering Research Inst.] Ann Arbor.

AN INVESTIGATION OF REACTIONS INVOLVED IN
THE PREPARATION OF FERRITES, by C. F.
Jefferson. Jan. 1959 [115]p. incl. illus. diagrs. tables,
refs. (Technical rept. no. 7) (AFOSR-TN-59-218)
(AF 18(603)6) AD 211780; PB 140623   Unclassified

The purpose of this study was to investigate some
solid-state reactions involved in the preparation of fer-
rites. By means of microscopic examination of polished
sections, chemical analysis, x-ray analysis, density
measurements, and magnetic measurements such as the
Curie temperature and saturation moment/gram, the
phase relationships, kinetics of the spinel reaction in
several different atmospheres, and the densification
process have been studied in the systems $(Ni, Zn)O-$
Fe_2O_3 and $Li_2O-Fe_2O_3$. Some magnetic properties of
ferrites contained in the system $Ni_xZn_{1-x}Fe_2O_4-Fe_2O_3$
are correlated with the method of preparation. By dif-
ferential thermal analysis, chemical analysis, and satu-
ration moment measurements, the progression of the
oxidation of the systems $Ni_{.474}Zn_{.526}Fe_2O_4-Fe_3O_4$ and
$LiFe_5O_8-Fe_3O_4$ has been followed. The temperature at

which γFe_2O_3, which forms during the oxidation of the above systems, transforms to αFe_2O_3, has been determined as a function of the composition.

1230

Michigan U. [Engineering Research Inst.] Ann Arbor.

MAGNETIC PROPERTIES OF POLYCRYSTALLINE MATERIALS, by D. M. Grimes, R. D. Harrington, and A. L. Rasmussen. Feb. 1959 [37]p. incl. diagrs. tables. (Technical rept. no. 8) (AFOSR-TN-59-272) (AF 18-(603)8) AD 212706; PB 140777   Unclassified

Also published in Jour. Phys. Chem. Solids, v. 12: 28-40, Dec. 1959.

The variation of the magnetic Q with internal magnetization is discussed using the domain rotation and the domain-wall motion model of magnetization change. The variation of the reversible susceptibilities with magnetic moment is reported on 4 samples, and the results are compared with results from the frequency spectra in the initial and remanent states. The distribution of magnetic moments in the system as a function of angle between individual and averaged moments is discussed in terms of an infinite series expansion in Legendre polynomials. The coefficients of the first 4 terms can be measured. Experimental data are given for the first 3. (Contractor's abstract)

1231

Michigan U. [Engineering Research Inst.] Ann Arbor.

SOME DETAILS OF THE TRANSITION TO TURBULENT FLOW IN POISEUILLE FLOW IN A TUBE, by A. M. Kuethe and K. R Raman. June 1959, 31p. incl. illus. diagrs. refs. (AFOSR-TR-59-84) (AF 18(603)34) AD 232746   Unclassified

Measurements of velocity fluctuations, Reynolds stresses and shearing stresses at the wall in the transition region of a tube are presented. The measurements are made in a tube at a Reynolds number of 6000 behind 3 disturbance generators placed in the fully developed laminar flow 620 diam from the entrance. The results show the way in which some of the statistical details of the transition depend on the nature of the disturbance generated. The Reynolds stresses and the shearing stress at the wall can reach very high values during the early stages of transition. Implications are pointed out regarding possible causes for the high temperature recovery factor during transition in high speed flow over surfaces. (Contractor's abstract)

1232

Michigan U. [Engineering Research Inst.] Ann Arbor.

STAGNATION POINT FLUCTUATIONS ON A BODY OF REVOLUTION, by A. M. Kuethe, W. W. Willmarth, and G. H. Crocker. [1959] [3]p. incl. diagrs. table, refs. [AF 18(603)34]   Unclassified

Published in Phys. Fluids, v. 2: 714-716, Nov.-Dec. 1959.

Results of investigations carried out on bodies of revolution in a low-turbulence tunnel and in a supersonic tunnel are presented. The measurements of relative rms velocity fluctuations are shown. It is pointed out that the bodies had hemispherical noses with diameters 2 in., 11.7 in., and 20 in., and fineness ratios 17, 6.3 and 5.2, respectively. Results indicate that the low frequency components in the free stream fluctuations are amplified strongly in the region near the stagnation point. A measurement of the correlation coefficient was made on the 2-in.-diam model at a Mach number of 2.44 in the supersonic tunnel. The observations indicate that at supersonic as well as at subsonic speeds a random wandering of the stagnation point occurs.

1233

Michigan U. Engineering Research Inst., Ann Arbor.

ON AXISYMMETRIC VIBRATIONS OF THIN SHALLOW VISCO-ELASTIC SPHERICAL SHELLS, by P. M. Naghdi and W. C. Orthwein. Jan. 1959, 27p. incl. diagrs. refs. (Technical note no. 5; rept. no. 2500-6-T) (AFOSR-TN-59-109) (AF 18(603)47) AD 210389; PB 140239   Unclassified

Transverse vibrations of shallow viscoelastic spherical shells subjected to axisymmetric loads which are harmonic in time are discussed. In particular, the steady state solution is obtained for an unlimited viscoelastic shallow shell subjected to an oscillating load uniformly distributed over a small circular region about the apex. Numerical results for axial displacement and stresses are obtained for 2 special viscoelastic media (Maxwell and Kelvin) as well as for the elastic shell, and comparison is made with known results. (Contractor's abstract)

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Michigan U. [Engineering Research Inst.] Ann Arbor

THERMO-ELASTICITY AND VISCO-ELASTICITY IN STRUCTURES, by P. M. Naghdi. Final rept. Feb. 1959, 6p. (Rept. no. 2500-7-F) (AFOSR-TR-59-33) (AF 18-(603)47) AD 212470   Unclassified

The results of the work completed under this contract are described in the following publications: (1) On Elastic Plates of Variable Thickness, by F. Essenburg and P. M. Naghdi (item no. MIC.18:001, Vol. II); (2) On

Axially Symmetrical Plates of Variable Thickness, by F. Essenburg (item no. MIC.18:002); (3) Response Of Shallow Viscoelastic Spherical Shells to Time-Dependent Axisymmetric Loads, by P. M. Naghdi and W. C. Orthwein (item no. MIC.18:003); (4) On Thermo-Elastic Stress Relations For Thin Isotropic Shells, by P. M. Naghdi (item no. MIC.18:004); and (5) On Axisymmetric Vibrations of Thin Shallow Viscoelastic Spherical Shells, by P. M. Naghdi and W. C. Orthwein (item no. 1233, Vol. III).

1235

Michigan U. [Engineering Research Inst.] Ann Arbor.

APPLICATION OF LOGIC TO THE DESIGN OF COM-PUTING MACHINES, by A. W. Burks, H. Wang, and J. Holland. Final rept. Aug. 1959 [9]p. (Rept. no. 2512-4-F) (AFOSR-TR-59-106) (AF 18(603)72) AD 226604; PB 146390   Unclassified

The results previously obtained on fixed automata (MIC.13:001, Vol. I) are summarized. Results obtained on growing automata are reviewed. A universal computer is described which is capable of simultaneously executing an arbitrary number of sub-programs. The number of such sub-programs vary as a function of time under program control or as directed by input to the computer. Three features of the computer are: (1) the structure of the computer is a 2-dimensional modular (or iterative) network; (2) each sub-program is spatially organized, thus facilitating the simulation of highly parallel systems having many points or parts; and (3) the computer's structure and behavior can, with simple generalizations, be formulated so as to make it a useful abstract tool for investigating problems in automata theory.

1236

Michigan U. [Research Center for Group Dynamics] Ann Arbor.

REDUNDANCY IN TASK ASSIGNMENTS AND GROUP PERFORMANCE, by R. B. Zajonc and W. H. Smoke. [1959] [9]p. incl. diagrs. refs. (AFOSR-TN-59-657) [AF 49(638)367]   AD 238805   Unclassified

Published in Psychometrika, v. 24: 361-369, Dec. 1959.

The problem of combining abilities of group members to maximize the performance of the group as a whole is examined in terms of redundancy in task assignments. In particular, ways of distributing a given number of items of information among a given number of individuals to obtain the maximum probability of each item being recalled by at least one individual are studied. It is shown that there exists an optimal distribution scheme which is independent of the amount of material originally given, the size of the group, and individual differences in ability. (Contractor's abstract)

1237

Michigan U. Willow Run Labs., Ann Arbor.

SUM RULES AND RELATIVE INTENSITIES FOR PARAMAGNETIC IONS OF SPIN 3/2, by C. Kikuchi. [1959] 16p. incl. tables. (AFOSR-TN-59-219) ([Sponsored jointly by] Air Force Office of Scientific Research under AF 49(638)68 and [Signal Corps under ,A 36-039-sc-78801]) AD 211801; PB 142751   Unclassified

Certain sum rules for cross-checking numerical calculations needed in the design of masers are derived, and the results obtained by using these sum rules are compared with the values calculated by machines. In addition, it is shown that the intensities for complementary transitions are equal when the r-f field is parallel to the d-c magnetic field. (Contractor's abstract)

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Michigan U. Willow Run Labs., Ann Arbor.

RESONANCE ABSORPTION OF PARAMAGNETIC IONS WITH SPIN 5/2: $CaCO_3$:Mn, by C. Kikuchi. Feb. 18, 1959 [29]p. incl. diagrs. tables, refs. (AFOSR-TN-59-220) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)68 and Signal Corps under [DA 36-039-sc-78801]) AD 211802; PB 143181
                                Unclassified

The theory of the paramagnetic resonance absorption of ions with S = 5/2 in crystalline fields of trigonal symmetry is presented using manganous ions in calcite as an example. It is shown that the experimental results observed by Hurd, Sachs, and Hershberger (Phys. Rev., v. 93: 373, 1954) can be accounted for by assuming that the manganous ions occupy the 2 nonequivalent Ca^{++} sites at random. Much of the theory presented here is also applicable to Al_2O_3:Fe, which is a potential material for a zero-field maser. (Contractor's abstract)

1239

Michigan U. Willow Run Labs., Ann Arbor.

SPIN RESONANCE OF V^{2+}, V^{3+}, V^{4+} IN α-Al_2O_3, by J. Lambe and C. Kikuchi. Nov. 1959, 30p. incl. diagrs. table, refs. (Rept. no. 2616-12-R) (AFOSR-TN-59-922) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)68 and Signal Corps under DA 36-039-sc-78801) AD 229527; PB 144569
                                Unclassified

Also published in Phys. Rev., v. 118: 71-77, Apr. 1, 1960.

Divalent vanadium has properties similar to those of trivalent chromium in sapphire, which has wide application in masers. The electron-spin resonance absorption

properties of vanadium sapphire are reported here. It is shown that vanadium normally is predominantly trivalent, with a small amount being in the tetravalent state. By x- or gamma-irradiation, vanadium is converted to the divalent state. The hyperfine-structure component separation for V^{2+}, V^{3+}, and V^{4+} are about 88, 110, and 140 gauss, respectively. Because of its readily recognizable spin-resonance signature due to its nuclear spin, and because of the ease of producing different oxidation states, it is suggested that vanadium may be a suitable probe with which to study ionization effects in certain solids. (Contractor's abstract)

band frequency of di- and tri-valent vanadium in corundum single crystal, grown by Linde from $0.1\% V_2O_5$ powder mixture have been detected. In the magnetic resonance spectrometer, a lavite cavity was used. After x- and Co-60 gamma-irradiation, a spectrum detectable at room temperature can be developed, consistent with the assignment $S = 5/2$ and $I = 7/2$, suggesting V^{++}. The tentative values of the parameters in the spin-Hamiltonian are $A \sim B = 88$ gauss; $D \sim 9.4$ kmc/sec, and $g(V^{++}) \sim g(Cr^{+++})$. The V^{+++} signal is detected at 4.2°K. The hfs is strongly anisotropic varying from 110 gauss at 0° to more than 350 gauss near 90°.

1240

Michigan U. Willow Run Labs., Ann Arbor.

CERTAIN SUM RULES APPLICABLE TO PARAMAGNETIC IONS OF SPIN 3/2 (Abstract), by C. Kikuchi. [1959] [1]p. [AF 49(638)68]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 261, Apr. 30, 1959.

In the design of masers, it is often necessary to carry out extensive numerical calculations because the crystalline field and Zeeman terms are comparable The purpose of the present paper is to indicate that certain sum rules can be used to cross-check the numerical work. For example, if the crystalline field has axial symmetry, the sums of the relative intensities of the six possible transitions are given by $\Sigma I_{M'M}^{(x)} = 12 \cos^2\theta + 5x^2$. $\Sigma I_{M'M}^{(y)} = 12 + 5x^2$, $\Sigma I_{M'M}^{(z)} = 12 \sin^2\theta$, when the rf field is along the x-, y-, and z-axis, respectively. Here the z-axis is taken along the c-axis, the dc magnetic field H in the xz-plane at angle θ from z, and $x = g\beta H/|D|$. It is interesting to note that the intensities of complementary transitions are equal for any crystal orientation, if the rf field is along the dc magnetic field.

1241

Michigan U. Willow Run Labs., Ann Arbor.

ELECTRON SPIN RESONANCE OF V^{++} AND V^{+++} IN CORUNDUM (Abstract), by J. Lambe, R. Ager, and C. Kikuchi. [1959] [1]p. [AF 49(638)68]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 261, Apr. 30, 1959.

The paramagnetic resonance absorption signals at X-

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Michigan U. Willow Run Labs., Ann Arbor.

X-RAY COLORATION OF RUBY (Abstract), by J. H. Mathews and J. Lambe. [1959] [1]p. [AF 49(638)68]
Unclassified

Presented at meeting of the Amer. Phys. Soc , Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 284, Apr. 30, 1959.

Ruby exhibits an x-ray coloration well in excess of that of white sapphire and anomalously dependent on chromium concentration. The induced optical density first increases and then decreases with chromium concentration. Absorption measurements on annealed, synthetic sapphires (Linde) with 0 to $4\% Cr_2O_3$ "nominal powder concentration" show a broad radiation-induced band, peaking at about 4700A, and a second band near the absorption edge. Induced absorption coefficients reach 5 and 25 cm^{-1} at 4700 and 2300A, respectively, at saturation. Similar effects are observed with Co^{60} gamma irradiation. The sensitizing effect of the chromium ion may be due to its providing, under irradiation, electrons for color centers. The anomalous down-turn of irradiation coloration at the higher chromium concentrations would appear to exclude as dominant sensitization mechanism a simple furnishing, by the chromium ions, of sites for potential color centers.

1243

Michigan U. Willow Run Labs., Ann Arbor.

SPIN RESONANCE OF GAMMA IRRADIATED ALKALI HYDRIDES (Abstract), by I. Scarisbrick. [1959] [1]p. [AF 49(638)68]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Milwaukee, Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 326, June 18, 1959.

The defect structure of the lithium lattice, which possesses both ionic and covalent character, has been investigated by ESR and optical methods. The ESR of crystals colored by Co^{60} gamma radiation has been examined at room temperature, 77°K and 4°K. At room temperature, two species of spin center are observable, both with g = 2.0021 ± 0.0003 relative to an assumed value of 2.0026 for polycrystalline DPPH. One is produced only by high-gamma dosages and shows a 15% angular variation in width, which is less than three-quarters that of polycrystalline DPPH at room temperature. With low dosages, a line almost ten times broader is observed. At low temperatures, highly irradiated samples show both the sharp and broad lines, together with a third of higher g value. These and other results on irradiated crystalline LiH and also polycrystalline alkali hydrides and deuterides will be presented.

1244

Michigan U. Willow Run Labs., Ann Arbor.

MICROWAVE CAVITIES FOR MAGNETIC RESONANCE SPECTROMETERS, by J. Lambe and R. Ager. [1959] [2]p. [AF 49(638)68] Unclassified

Also published in Rev. Scient. Instr., v. 30: 599, July 1959.

A study was carried out with hydrous aluminum silicate (available commercially as Grade A Lava from American Lava Corp., Chattanooga, Tenn.), which may prove to be a more flexible material in designing a cavity. In this case, a cavity operating in the TE012 mode at 9400 mc was made with the dimensions of X-band wave guide. It was split along the broad face since this did not affect the cavity operation. The material pieces were then fired and coated. A coating of Ag paint, such as Hanovia No. 32A, fired at 850°C, was satisfactory. A thin coating of Au evaporated over this, protected the Ag coating and improved the performance. The 2 pieces were then held together with teflon screws, 1 of the pieces having threaded holes. Alternatively, the cavity can be permanently cemented together with Eastman 910 cement. Such cavities have an unloaded Q of approximately 5000 at room temperature and 20,000 at He temperature. A short length of wave guide was also made with this material and coated with Ag paint. The cavity was attached to this with teflon screws so that no heavy metal parts were in the modulation field.

1245

Michigan U. Willow Run Labs., Ann Arbor.

PHOTOSENSITIVE SPIN RESONANCE IN CdS, by J. Lambe, J. Baker, and C. Kikuchi. [1959] [4]p. incl. diagr. [AF 49(638)68] Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 270-271, Sept. 15, 1959.

The direct observation of trapping centers in CdS crystals containing traces of Fe impurities was carried out by paramagnetic resonance techniques. Spin resonance was observed at 4.2°K but not at 77 or 300°K. The spin of the center is 5/2, as for a combination of cubic and axial electric fields, g = 2.01. Satellites are doubled; the $-\frac{1}{2} \leftrightarrow \frac{1}{2}$ central line is also split and is due to 2nd-order effect. Hence, the photosensitive center is assigned tentatively to Fe^{3+}. These effects are interpreted as follows: Fe^{2+} in CdS traps a hole to become Fe^{3+} which is readily observable. The electrons must be trapped elsewhere and may be restored to the Fe^{3+} by 2 micron light. This latter point is yet to be determined. It is concluded that this technique should be extremely useful in testing various models of phosphors and photoconductors.

1246

Michigan U. Willow Run Labs., Ann Arbor.

SPIN RESONANCE AND OPTICAL EFFECTS OF RADIO-ACTIVELY PREPARED Rb^{85} IN SOLID Kr, by J. Lambe and J. Baker. Oct. 12, 1959 [7]p. incl. diagrs. [AF 49-(638)68] Unclassified

Experiment was carried out by mixing 100 mc of Kr^{85} with 500 cc Kr and holding the mixture at 4.2°K in a quartz tube. Observations were then made using X-band (9100 mc) paramagnetic resonance spectrometer to study the accumulating Rb^{85}. The formation rate of Rb^{85} was 3.7×10^9 ions/sec. A spectra was obtained after 20 hr and clearly identified with Rb^{85}. It consisted of 6 lines (I = 5/2 for Rb^{85}) with a large hyperfine splitting, 1 of which was obscured by a large unknown signal at 3250 gauss. Also H_2 lines were observed. Subsequently, measurements were made at 77°K. The results showed that H_2 and quartz lines were readily detected, but the Rb spectra could barely be observed. Preliminary optical studies were made by shining light on the sample while the ESR was observed. It was found that the signal from Rb^{85} could be bleached out in about 10 min with light in the 4200A. Longer wavelengths did not give this effect. The obtained Rb^{85} is embedded in a matrix with paramagnetic centers. No anisotropy was produced with saturation microwave power on the Rb^{85}.

1247

Michigan U. Willow Run Labs., Ann Arbor.

SPIN RESONANCE OF ATOMIC TRITIUM AT 4.2°K (Abstract), by J. Lambe, J. Baker, and I. Scarisbrick. [1959] [1]p. [AF 49(638)68] Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cleveland, Ohio, Nov. 27-28, 1959.

A method of radioactive decay has been used to prepare
atomic tritium at liquid helium temperatures. In this
method molecular tritium is frozen in a container as a
small crystal of tritium or in a noble gas matrix. When
one of the atoms of a tritium molecule decays, it be-
comes He^3, leaving behind the other atom of tritium.
This atom can then be studied by conventional tech-
niques of paramagnetic resonance. In our experiment,
1 cc at STP of tritium gas was used. This is 2.6 curies.
The tritium emits a weak beta particle which is easily
shielded. This amount was frozen out in a quartz tube
at $4.2°K$. This amount of tritium will produce about 10^{11}
atoms per sec. It required about 5 min to begin meas-
urements, at which time one should have 3×10^{13} spins.
Two main hyperfine lines are observed with a separation
of 542 gauss as one would expect for tritium. This sig-
nal increases steadily. A second small hyperfine group
is observed with a spacing of 510 gauss. This group
does not grow. It is believed to be due to a species,
perhaps atomic hydrogen, present in the gas before the
freezing. High microwave power satellites were not ob-
served. To test whether self-radiation damage was a
major effect, the tritium was frozen out in a neon ma-
trix so that the neon would take up the effect of the beta
particle. The tritium signal was again present and grew
with time. It is therefore believed that the preparation
process is one of radioactive decay and not a radiation
damage process.

1248

Midwest Research Inst., Kansas City, Mo.

EXPANSION OF THE CONFLUENT HYPERGEOMET-
RIC FUNCTION IN SERIES OF BESSEL FUNCTIONS,
by Y. L. Luke. Apr. 15, 1959, 31p. incl. refs.
(AFOSR-TN-59-134) (AF 49(638)66) AD 210862;
PB 142373   Unclassified

An expansion is derived in series of Bessel functions
of integral order whose argument is independent of the
parameters a and c. The expansion is advantageous
for many purposes of computation since the parame-
ters and variable of the confluent hypergeometric func-
tion $\Phi(a, c, z)$ appear in separated form. Also, for
desk calculation, extensive tables of $I_n(z)$ are available,
while for automatic computation, Bessel functions are
easy to generate. Special cases of the confluent func-
tion such as the incomplete gamma function are also
studied. For the class of transcendents known as the
error functions, including the Fresnel integrals, it

is shown that the expansion coincides with that of
Buchholz. By specializing a parameter and passing to
a limit, expansions are derived for the exponential in-
tegral and related functions. Other expansions for er-
ror and exponential integrals are derived on altogether
different bases. Some numerical examples are pre-
sented to manifest the efficiency of the formulas. (Con-
tractor's abstract)

1249

Midwest Research Inst., Kansas City, Mo.

EXPANSION OF THE GAUSSIAN HYPERGEOMETRIC
FUNCTION IN SERIES OF FUNCTIONS OF THE
SAME KIND, by R. L. Coleman and Y. L. Luke. Aug.
15, 1959, 13p. (AFOSR-TN-59-734) (AF 49(638)66)
AD 225713; PB 143772   Unclassified

An expansion is derived of the hypergeometric function
$_2F_1$ (a, b;c;z) in series of hypergeometric functions
with changed argument. For special values of the pa-
rameters the expansion simplifies considerably and is
advantageous due to the change in argument which yields
more rapidly converging series. Known Chebyshev type
expansions are derived for the logarithm and arc tangent
functions. The Gauss transformation for the complete
elliptic integral of the 1st kind is the special case a = b =
$\frac{1}{2}$, c = 1. A rapidly converging expansion of the complete
elliptic integral of the 1st kind is derived for modulus
near 1. (Contractor's abstract)

1250

Midwest Research Inst., Kansas City, Mo.

A RADIOACTIVE TRACE INVESTIGATION OF THE
MECHANISM OF MoS_2 AND WS_2 LUBRICATION, by
M. T. Lavik and S. L. Levy. June 1958, 6p. incl. diagr.
table. (AFOSR-TR-59-10) (AF 49(638)157) AD 209493
                                    Unclassified

Tests were conducted to investigate a theory of lubri-
cation by MoS_2 (V. R. Johnson and G. W Vaughn, Jour.
Appl. Phys., v. 27: 1173-1179, Oct. 1956). Lubrication
was considered to be affected by an adsorbed S layer
supplied by the mechanical breakdown of MoS_2. The
tests were made in the friction chamber and vacuum sys-
tem described previously (Rev. Sci. Instr., v. 27: 611-
613, Aug. 1956) which had been modified to include facil-
ities for collection and detection of the evaporated S.
MoS_2 pellets were activated by neutron irradiation and
placed in the apparatus for measurements. Increases
in the coefficients of friction which had been observed
after stopping a friction run were attributed to evapora-
tion of the S layer from the test track. Measurements

of the soft β-emission of the collection chamber indicated that some evaporated S was present, but the number of counts measured above background was insufficient for the development of firm conclusions on the project.

1251

Midwest Research Inst., Kansas City, Mo.

FLUTTER OF CURVED PANELS, by J. E. Yates and E. F. E. Zeijdel Sept. 1959, 36p. incl. diagrs. (AFOSR-TR-59-163) (AF 49(638)429) AD 227985; PB 144486
Unclassified

To investigate flutter of curved panels, the general equations of motion of shallow cylindrical shells are developed. The initial curvature is then taken as circular in the chordwise direction. The special case of infinite aspect ratio is considered and appropriate equations are developed for finite aspect ratio panels. Linearized 3-dimensional aerodynamic forces are incorporated in the flutter equations of motion. For simplicity, numerical results are obtained by utilizing quasi-steady aerodynamic forces. Results are obtained for unit and infinite aspect ratio curved panels with simply supported edges for 2 Mach numbers (M = 1.5 and 2). The flutter boundaries clearly indicate the strong dependence of panel flutter on curvature. Increasing curvature has a destabilizing effect on the panel up to a certain critical value of curvature. At the critical value, the frequencies of the 1st and 2nd chordwise modes coalesce and very large thickness is required for stability. Beyond this critical value, increasing curvature has a stabilizing effect, but it is proved that 2 mode results are unconservative in this region due to a frequency coalescence between the 1st and 3rd chordwise modes. In this region, it is concluded that at least 3 or more modes must be used to obtain reliable flutter boundaries for curved panels. (Contractor's abstract)

1252

Milan U. (Italy).

STUDY OF IRIDIUM COMPOUNDS. by L. Malatesta. Oct. 31, 1958, 35p. incl. tables. (Technical scientific note no. 1) (AFOSR-TN-59-123) (AF 61(052)83) AD 210428; PB 138718 Unclassified

The previously unknown potassium bromocarbonyliridiates of the type $K_2[Ir_2(CO)_4Br_5]$ have been prepared from the reaction of carbon monoxide with K_2IrBr_6 at high pressure. The mode of formation and the possible structure of these compounds, and of their analogous ones, $K_2[Ir(CO)_4Cl_5]$, are discussed. Some other halogenocarbonyl iridiates deriving from the anions $[Ir^I(CO)_2Br_2]^-$ $[Ir_2^I(CO)_4Br_3]^-$, $[Ir_2(CO)_4Br_4]^-$, $[Ir^{III}(CO)Br_4]^-$ $[Ir^{II}(CO)Br_3]^-$ and $[Ir_2(CO)_2Cl_4]^-$ have

been obtained by condensation, splitting and oxidation reactions from $K_2[Ir_2(CO)_4Br_5]$ and $K_2[Ir_2(CO)_4Cl_5]$ and isolated as tetraphenylarsonium salts. The condensed potassium salt $K[Ir(CO)_4Cl_4]$ and the free acid $H[Ir_2(CO)_4Cl_4]\cdot4H_2O$ have been isolated. From the reaction of these chloro and bromocarbonylderivatives with amines, the very stable non electrolytic iridium(I) derivatives $Ir(CO)_2(Amine)Cl$ and $Ir(CO)_2(Amine)Br$ have been prepared and are described. (Contractor's abstract)

1253

Milan U. (Italy).

[STUDIES ON RHENIUM AND IRIDIUM COMPOUNDS] by L. Malatesta. Annual summary rept. no. 1, Apr. 1, 1958-Mar. 31, 1959 [2]p. (AFOSR-TN-59-642) (AF 61-(052)83) Unclassified

A brief report is made of the progress to date on the preparation and study of rhenium carbonyl compounds and derivatives of monovalent iridium which may or may not contain carbon monoxide.

1254

Milan U. (Italy).

RHENIUM COORDINATION COMPOUNDS, by L. Malatesta. Oct. 31, 1959, 15p. (Technical scientific note no. 2) (AFOSR-TN-59-1081) (AF 61(052)83) AD 232075; PB 145675 Unclassified

New coordination compounds of rhenium(I), rhenium(II), and rhenium(III) with halogens, triphenylphosphine (PR_3), and CO are described. From Re_2O_7, PR_3, and HCl the compound $ReCl_3(PR_3)_2$ is obtained, while HBr and HI give $ReBr_2(PR_3)_2$ and $ReI_2(PR_3)_2$. These latter are easily oxidized, by the corresponding halogen, to $ReBr_3(PR_3)_2$ and $ReI_3(PR_3)_2$. $ReCl_3$ and PR_3 gives instead $ReCl_3(PR_3)$. These compounds with CO at high pressure (200 atm) give derivatives of rhenium(I) containing both PR_3 and CO, i.e., $ReX(PR_3)_2(CO)_2$, $ReX(PR_3)_2(CO)_3$, where X is Cl or Br, and $ReI(PR_3)_2$ CO. (Contractor's abstract)

1255

Milan U Inst. of General Pathology (Italy).

PROTEIN SYNTHESIS IN VACUOLATED RAT LIVER CELLS, by A. Bernelli-Zazzera and G. Guidotti. [1958] [5]p. incl. illus. tables, refs. [AF 61(514)1026] Unclassified

Published in Exper. Cell Research, v. 14: 614-618, June 1958.

The incorporation of C-labeled glycine, leucine and phenylalanine into liver proteins has been studied on slices from normal and vacuolated rat liver. Vacuolated liver cells incorporate these amino acids at a rate significantly lowered as compared with normal controls. The release of protein-N and amino-N from the slices into the incubation medium is the same in normal and vacuolated cells. The synthesis of p-amino-hippuric acid from p-aminobenzoic acid and glycine, which has been chosen as an example of peptide bond synthesis, is impaired in vacuolated liver cells. The possible relationship of these observations to protein synthesis and general metabolism of vacuolated liver cells are discussed. (Contractor's abstract)

1256

Milan U. Inst. of General Pathology (Italy)

[CONTENT IN DIPHOSPHOPYRIDINE NUCLEOTIDE OF THE LIVER IN TURBID SWELLING AND OF THE VACUOLIZED LIVER] Contenuto in difosfopiridinnucleotide del fegato in rigonfiamento torbido e del fegato vacuolizzato, by C. Severi, A Fonnesu, and C. Agostini. [1957] [4]p. incl. table. (AFOSR-TN-59-833) (AF 61-(514)1026)   Unclassified

Also published in Atti Soc. Ital. Patol., v. 5: 513-516, June 1957.

Variations of the diphosphopyridine nucleotide (DPN) and the relationship between the oxidized and reduced forms of this coenzyme (DPN+/DPNH) in turbidly swollen liver and in vacuolized liver are studied. The tests were carried out on albino rats fed a standard diet. The turbid swelling of the liver was caused with 1 DML of endotoxin from endoperitoneal S. typhimurium and the vacuola degeneration of the liver was obtained keeping the animals for 2 hr in an atmosphere of 97% N_2-3%O_2.

The group of animals was separated into 2 groups, one for 45 min of fresh air and the other group was killed immediately after the treatment. The results are summarized in a table.

1257

Milan U. Inst. of General Pathology (Italy).

DIPHOSPHOPYRIDINENUCLEOTIDE CONTENT OI LIVERS AFFECTED BY CLOUDY SWELLING AND BY CELL VACUOLATION, by C. Severi-Fonnesu, A. Fonnesu, and C. Agostini. [1958] [8]p. incl. tables, refs. (AFOSR-TN-59-834) (AF 61(514)1026) AD 226152
                              Unclassified

Presented at Fifth Cong. of the Ital. Pathol. Soc. Milan-Como (Italy), June 9-11, 1957.

Also published in Ital. Jour. Biochem., v. 7: 226-233, July-Aug. 1958.

Oxidized (DPN+) and reduced (DPNH) diphosphopyridine-nucleotides were determined in normal rat liver, in the liver with cloudy swelling produced by salmonella typhi murium toxin, and in liver with cell vacuolation induced by hypoxia. DPN content as well as the ration DPN+/DPNH are unchanged in either liver showing cloudy swelling or in liver affected by cell vacuolation as compared with normal controls. The results are briefly discussed in the light of the most significant biochemical changes which have been previously found in cloudy swelling and in vacuolated liver. (Contractor's abstract)

1258

Milan U. Inst. of General Pathology (Italy).

COENZYME A CONTENT IN LIVERS AFFECTED BY VARIOUS DEGENERATIVE CHANGES, by C. Severi-Fonnesu, A. Fonnesu, and C. Agostini. [1958] [10]p. incl. tables, refs. (AFOSR-TN-59-835) (AF 61(514)1026) AD 226153   Unclassified

Also published in Ital. Jour. Biochem., v. 7: 215-225, July-Aug. 1958.

See item no. MIL.01:001, Vol. II for abstract.

1259

Milan U. Inst. of General Pathology (Italy).

[THE IN VITRO INCORPORATION OF 1-C^{14}-GLYCINE INTO THE PROTEINS OF NORMAL AND VACUOLATED RAT LIVERS] Incorporazione in "vitro" della glicina-1-^{14}C nelle proteine di fegato normale e vacuolizzato del ratto, by G. Guidotti and E. Bazzano. [1958] [3]p. incl. diagrs. tables, refs. (AFOSR-TN-59-836) (AF 61-(514)1026)   Unclassified

Presented at Internat'l. meeting of Nuclear Med., Turin (Italy), June 5-7, 1957.

Also published in Minerva Nucleare, v. 2: 22-24, Feb. 1958.

Liver vacuolation for the study involving glycine incorporation by keeping rats in an atmosphere of 97% nitrogen and 3% oxygen for 2 hr. Warburg vessels were used to carry out the incorporation. The results show that a first order relation between time and incorporation rate exists during the whole experiment in both normal and vacuolated livers. The incorporation rate is significantly decreased at each time in vacuolated livers. These results are discussed in connection with the energetic requirements of the liver cell.

1260

Milan U. Inst. of General Pathology (Italy).

THE METABOLISM OF ISOLATED CEREBRAL COR-
TEX FROM HYPOXIC RATS, by A. Bernelli-Zazzera,
M. Bassi, and E. Cassi. [1959] [6]p. incl. tables, refs.
(AF 61(514)1026)   Unclassified

Published in Exper. Cell Research, v. 18: 554-559,
Nov. 1959.

The oxidation of glucose, glutamate, pyruvate and lac-
tate, the respiratory quotient and aerobic and anaero-
bic glycolysis have been studied on brain cortex slices
from hypoxic rats. No difference has been found as
compared with normal rats. It seems therefore that
the brain is less affected than the liver by the same

hypoxia conditions. The incorporation of $1\text{-}C^{14}$-glycine
into the proteins of brain cortex slices has been studied
in vitro. No difference has been found between brain
cortex slices from normal and hypoxic rats. The in-
corporation of glycine into brain proteins is enhanced,
when the slices are incubated in oxygen, only if glucose
is present in the medium. The implications of this
fact are discussed in relation with the findings of ex-
periments with liver and kidney slices.

1261

Milan U. Lab. of Physiology (Italy).

CHANGES IN ELEMENTARY NEURON ACTIVITY PRO-
DUCED BY SOME NEUROTROPIC DRUGS, by R.
Margaria, T. Gualtierotti and others. [1959] [19]p. incl.
diagrs. tables, refs. (AFOSR-TN-59-637) (AF 61(514)-
637) AD 225173   Unclassified

Presented at Symposium on Aeronaut. Preventive Med.,
Washington, D. C., Nov. 1957.

Also published in Exper. Med. and Surg., v. 17: 46-64,
Mar. 1959.

A number of neurotropic drugs were tested in man, and
their effects on (a) the spinal delay in an oligosynaptic
reflex, (b) neuromuscular plate delay, (c) sensory and
motor fiber conduction speed, and (d) the activity of
Renshaw reverberating circuit, were studied. Conduc-
tion speed both in sensory and motor fibers is remarka-
bly constant and hardly influenced by most drugs. On
the contrary spinal delay is increased after administra-
tion of acetylcholine, adrenaline, curare-like substances,
ethanol and others: it is increased after atropine,
chlorpromazine and caffeine. End-plate delay changes
generally in the same direction as spinal delay.
Renshaw inhibition is increased by atropine, chlorpro-
mazine, ethanol, ritalin and diogenal: it is decreased
by adrenaline, acetylcholine, caffeine and probably by
curare-like substances. The changes induced by these

drugs in the elementary functional activities studied may
suggest their application in counteracting the effects of
some stress-inducing conditions. (Contractor's abstract)

1262

Milan U. Lab. of Physiology (Italy).

[REGULATION OF THE SPINAL MOTOR NEURON
DISCHARGE RHYTHM OF THE RENSHAW SUPPRES-
SION PHENOMENON] Regolazione del ritmo di scarica
del motoneurone spinale per mezzo dell'inibizione
antidromica di Renshaw, by T. Gualtierotti, D Spinelli,
and A. Firoentini. [1958] [5]p. incl. illus. diagr.
(AFOSR-TN-59-376) (AF 61(052)23)   Unclassified

Also published in Rend. Accad. Naz. Lincei, Series
VIII, v. 24: 744-748, June 1958.

The Renshaw phenomenon is considered to be explicable
from the bases of various experimental conditions,
such as in hypoglycemia. The action potential of a
single muscle fiber during a voluntary isometric con-
traction in man records the amplitude as a mono-
synaptic reflex response which is calculated from the
Renshaw suppression phenomenon obtained from the
same individual in normal and hypoglycemic conditions.
The hypothesis made predicts the dependence of the
discharge rhythm of the motor neuron upon the dura-
tion of the Renshaw inhibition, on the basis of a motor
neuron discharge rhythm variation due to the hypo-
glycemia of the same order of magnitude as the
Renshaw suppression phenomenon.

1263

Milan U. Lab. of Physiology (Italy).

[ROTATORY AND POSTROTATORY CEREBELLAR
RESPONSES AND NUCHAL NYSTAGMUS OF THE
PIGEON] Risposte rotatorie e postrotatorie cerebellari
e nistagmo nucale del piccione, by T. Gualtierotti and
D. Passerini. [1958] [5]p. incl. illus. (AFOSR-TN-59-
377) (AF 61(052)23)   Unclassified

Also published in Rend. Accad. Naz. Lincei, Series
VIII, v. 25: 219-223, Sept.-Oct. 1958.

The electric potentials of the cerebellum, of the neck
muscles, and the centripetal and tangential accelera-
tions are the three investigations made. The first
study records the rotatory and post-rotatory electrical
response of the cerebellum for an animal curarized
intravenously with succinylcholine, 1 mg/kg immediate-
ly after rotation. There is no muscular response, such
as could be expected after curarizing, and the agree-
ment of the rotatory and postrotatory responses with
the characteristics is found. The second study regis-
tered the rotatory and post-rotatory responses in a
normal pigeon subjected to a centripetal acceleration
so as to obtain a prolonged nystagmus. The rhythmic
muscular discharges are of large amplitude and are

formed of rhythmic potential sequences at a frequency of around 3-4/sec. It is found that the discharges of the nuchal muscles, expression of nystagmus, persists after ending the rotation although no posthumous cerebellar discharge is recorded. The third study records simultaneously the rotatory and post-rotatory cerebellar and muscular responses in the homing pigeon, while varying the rotational velocity. The purpose is to establish the identity or difference of the threshold between the nystagmus and the posthumous cerebellar responses. The results show the posthumous cerebellar discharges have a lower threshold than that for the nystagmus.

1264

Milan U. Lab. of Physiology (Italy).

[CEREBELLAR THRESHOLD AT ROTATORY ACCELERATIONS AND TEMPORAL SUMMATION IN THE HOMING PIGEON] Soglia cerebellare alle accelerazioni rotatorie e sommazione temporale nel piccione viaggiatore, by T. Gualtierotti and D. Passerini. [1958] [4]p. incl. illus. (AFOSR-TN-59-378) (AF 61(052)23)
Unclassified

Also published in Rend. Accad. Naz. Lincei, Series VIII, v. 25: 115-118, July-Aug. 1958.

A pigeon flying in a north-south direction, makes a lateral movement of the head through an extension of $7°$ to the velocity of 20 cm/sec, 2 cm being the distance between the labyrinth and the center of rotation of the head. The largest Coriolis acceleration is at the equator and is 3.21×10^{-6}g, at the forty-fifth parallel, the variation will only be 1×10^{-6}g. These data show that the hypothesis is unlikely that the sense of direction of migratory species is based on the physiological detail of such small differences in acceleration influencing the threshold. The data show that the sensibility to the rotatory solicitation is rather elevated in the homing pigeon and the duration of the rotation and the temporal summation increase such sensibility. The threshold values for the rotatory excitation are around 10^{-3}g, rather larger than the values necessary to raise the geodetic forces mentioned. Experiments are being conducted to determine the relative strengths of geodetic forces in comparison to temperature variations which also can cause excitations in the semicircular canals.

1265

Milan U. Lab. of Physiology (Italy).

[MODIFICATIONS INDUCED BY CURARE ON THE LOWER SPINAL NEURON ACTIVITY IN MAN] Modificazioni indotte dai curari sulla attivita dei bassi neuroni spinali nell'uomo, by D. Spinelli, T. Gualtierotti, and C. Morpurgo. [1958] 12p. incl. illus. refs. (AFOSR-TN-59-379) [AF 61(052)23] AD 219582
Unclassified

Presented at Simposio Internazionale su Curaro Curarosimili e Curarizzanti, Venice (Italy), Sept. 12-15, 1958.

Substances with curarizing action (Succinylcholine, d-Tubocurarine, Decamethonium) show a prompt effect on the spinal cord, even when introduced intravenously; therefore the hemato-liquoral and the perisynaptic barriers are not very efficient against these drugs. Any substance acting on the neuromuscular junction shows a similar effect on the synapsis between the recurrent fiber and the Renshaw cell, which belongs to the antidromic inhibitory circuit. The convulsive effects of the curarizing substances (muscle relaxants) directly introduced into the ventricles or in the spinal cord of the animal may be interpreted by supposing that they block the inhibitory circuit, leaving the facilitating circuits unbalanced. It is also possible that some other collateral effects attributed to these substances are partly due to a direct central action. The hypothesis is put forward that the effect of the curarizing drugs on the spinal motor neurone is not only localized on the cellular body, but may be transmitted along the nerve fiber to its termination. In fact, even in that portion of the nerve fiber, placed beyond the tourniquet applied to the limb, and therefore not affected by the drug, the same kind of alterations in the excitability occur, as seen in the cellular body. (Contractor's abstract)

1266

Milan U. Lab. of Physiology (Italy).

[CEREBELLAR ROTATORY AND POST ROTATORY RESPONSES AND ARTERIAL PRESSURE VARIATIONS IN THE CAT CURARIZED WITH D-TUBOCURARINE AND WITH SUCCINYLCHOLINE] Risposte rotatorie e post-rotatorie cerebellari e variazioni della pressione arteriosa nel gatto curarizzato con d-tubocurarina e con succinilcolina, by T. Gualtierotti and D. Passerini. [1958] [6]p. incl. illus. (AFOSR-TN-59-494) (AF 61-(052)23)
Unclassified

Also published in Rend. Accad. Naz. Lincei, Series VIII, v. 25: 584-589, Dec. 1958.

Experiments are carried out registering the electrocerebellogram from various points of the cerebellar cortex of the curarized cat, during and after rotatory solicitations of various entity. The animal was anaesthetized by ether and nitrogen peroxide through the exposure of that section of the cerebellar cortex and was heavily curarized. Graphs are shown giving the cerebellar electrical activity registered by the left flocculo-nodule, the posterior lobe and arterial pressure on the femur. Graphs show electromyograms of the dorsal muscles, electrocerebellograms and transversally registered tangential acceleration. The results confirm high cerebellar

sensitivity to acceleration. The rotatory and post-rotatory electrical result is limited to the region of the ilocculo-nodule. The cerebellar activity shows both amplitude increase and frequency diminution. The cerebral cortex responds typically to the afferent impulses, and with elevated strength when the stimuli stem from the labyrinth. The posthumous effect, constituted by 2 post-rotatory discharges is related to the receptor system of the semicircular canals.

1267

Milan U. Lab. of Physiology (Italy).

[THRESHOLD DETERMINATION OF THE CEREBELLAR ROTATORY RESPONSES OF THE FLOCCULO-NODULE OF THE CURARIZED CAT] Determinazione della soglia delle risposte rotatorie cerebellari dal flocculo-nodulo del gatto curarizzato, by T. Gualtierotti and D. Passerini. [1959] [4]p. incl. illus. (AFOSR-TN-59-654) (AF 61(052)23)   Unclassified

Also published in Rend. Accad. Naz. Lincei, Series VIII, v. 26: 79-82, Jan. 1959.

The registration of the cerebellar potential was made only in the region of the flocculo-nodule, at the same time as the electromyogram of the dorsal muscles. The centripetal and tangential accelerations due to the rotary motion were recorded, total paralysis was affected by d-tubocurarine (10 u/kg) but modal amplitude muscular discharges were registered during the rotation. The results confirmed the high sensitivity of the flocculo-nodule of the cerebellum to this stimuli elicited from this vestibule as a consequence of rotary stimuli. The cerebellar cortex appears to be subordinated to continuous stimuli, of labyrinthine origin relative to spontaneous spatial relationship movements. A continuous modulation of the amplitude of the cerebellar activity is noticeable, for example, in maintaining an erect position.

1268

Milan U. Lab. of Physiology (Italy).

[VARIABILITY OF SOME ELEMENTARY FUNCTIONAL CHARACTERS OF THE CENTRAL NERVOUS SYSTEM FOUND IN MAN] Variabilitá di alcuni caratteri funzionali elementari del sistema nervoso centrale rilevati nell'uomo, by L. Gallitelli and T. Gualtierotti. [1959] [4]p. incl. diagr. (AFOSR-TN-59-655) (AF 61(052)-23)   Unclassified

Also published in Rend. Accad. Naz. Lencei, Series VIII, v. 26: 83-86, Jan. 1959.

Experiments determine the normal variability of the conduction velocity of the sensitive fibers, of the spinal time, of the plate retardation, and of the antidromic inhibition of the motorneurons. Results show the standard deviation of this impulse velocity in the sensory (75

msec) or motor (64 msec) through stimuli having a duration of either 0.1 msec, or 1 msec, and of ± 0.01 msec, of the same magnitude of measurement error. The parameters of the monosynaptic reflex, determined with stimuli applied at the popliteal and gluteal fold levels of the sciatic nerve, show a very significant constant in the normal individual. The characteristic of antidromic inhibition confirm the importance of experimentally or pathologically induced elementary functional modifications of the spinal centers.

1269

Minnesota U, Minneapolis.

AN ANALYTIC PROBLEM WHOSE SOLUTION FOLLOWS FROM A SIMPLE ALGEBRAIC IDENTITY, by G. Baxter. June 1, 1959, 24p. (Technical rept. no. 8) (AFOSR-TN-59-592) (AF 18(603)30) AD 229241; PB 143956   Unclassified

Also published in Pacific Jour. Math., v. 10: 731-742, 1960.

The solution of a particular operator equation involving elements in a Banach algebra is shown to follow directly from an algebraic identity involving the operator. A combinatorial lemma of a rather general nature is proved and then used to show the result above. Applications to probability theory, etc. are considered. (Contractor's abstract)

1270

Minnesota U., Minneapolis.

A TWO-DIMENSIONAL OPERATOR IDENTITY WITH APPLICATION TO THE CHANGE OF SIGN IN SUMS OF RANDOM VARIABLES, by G. Baxter. July 1, 1959 [20]p. (Technical note no. 9) (AFOSR-TN-59-691) (AF 18-(603)30) AD 226551   Unclassified

Also published in Trans. Amer. Math. Soc., v. 96: 210-221, Aug. 1960.

Let $\{X_k\}$ be a sequence of independent, identically distributed random variables and let $S_0 = 0$; $S_1 = X_1, \ldots,$ $S_n = X_1 + \ldots + X_n$. A certain matrix factorization is shown to be related to the number of changes of sign among $S_0, S_1, \ldots, S_n$. The results are treated as statements about operators in Banach algebras. Two examples are considered; the symmetric exponential distribution and the Bernoulli variable case. (Contractor's abstract)

1271

Minnesota U., Minneapolis.

A FAMILY OF INTEGRALS SERVING TO CONNECT THE WIENER AND FEYNMAN INTEGRALS, by R. H. Cameron. Nov. 23, 1959 [24]p. (Technical note no. 12) (AFOSR-TN-59-1272) (AF 18(603)30) AD 232804; PB 146440   Unclassified

Also published in Jour. Math. Phys., v. 39: 126-140, July 1960.

A sequential definition is given of a family of integrals depending on a variance parameter σ^2. If σ^2 is real this reduces, under reasonable conditions, to the ordinary Wiener integral. If σ^2 is pure imaginary, the integral can be considered as a Feynman integral. For certain analytic functionals, the Feynman integral is shown to be reduced to an ordinary Wiener integral. (Contractor's abstract)

1272

Minnesota U., Minneapolis.

INITIAL-PERMEABILITY SPECTRA OF MICRO-SCOPIC IRON-OXIDE PARTICLES, by W. F. Brown, Jr., J. P. Hanton, and A. H. Morrish. Oct. 1959 [8]p. incl. diagr. table. (AFOSR-TN-59-759) (AF 18(603)-113) AD 227263; PB 143988   Unclassified

Presented at meeting on Magnetism and Magnetic Materials, Detroit, Mich., Nov. 16-19, 1959.

Also published in Jour. Appl. Phys., v. 31: 214S-215S, May 1960.

The magnetic resonance of single-domain ferromagnetic particles in zero applied steady magnetic field is studied theoretically and experimentally. The axial ratio of the powder particles deduced from the resonance measurements agrees reasonably well with optical data. This is strong evidence regarding the origin of the observed resonance. (Contractor's abstract)

1273

Minnesota U., Minneapolis.

NATURAL AND INDUCED SPECTRA OF SOME FERRITES, by D. B. Eonstrom, J. P. Hanton, and A. H. Morrish. Nov. 1959 [32]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1128) (AF 18(603)113) AD 229420; PB 144869   Unclassified

The natural magnetic spectra refers to the variation of the complex initial permeability ($\mu = \mu_1 - i\mu_2$) of some ferrites as a function of frequency. Two ferrite materials, magnetite (Fe_3O_4) and gamma ferric oxide

(γ-Fe_2O_3) were investigated over the frequency range 0 - 10 kmc/sec. Only 1 resonance in the μ_2 curves was observed; the frequency at which the maximum occurred was found to depend on the shape and size distribution of the particles in the powders. The induced magnetic spectra refers to the study of the permeability of a ferrite at a certain frequency, in this case 24 kmc/sec, in steady fields in the range 0 - 10 kilo-oersteds. Detailed investigations were made of some single crystals of magnetite at temperatures from 2-125°K. Magnetite undergoes a phase transition from a spinel to an orthorhombic structure at about 119°K. A magnetic field applied as the crystal is cooled through this temperature selects the orthorhombic c-axis. However, the a and b axes have 2 possible orientations, and, as a result, the crystal is twinned. This twinning was positively identified by a study of the magnetic resonances. The detwinning action of an applied field extinguishes certain resonances. (Contractor's abstract)

1274

Minnesota U. [Dept. of Aeronautical Engineering] Minneapolis.

INITIALLY WARPED SANDWICH PANEL UNDER COMBINED LOADINGS, by C. C. Chang and B. T. Fang. Aug. 16, 1959 [9]p. incl. diagrs. refs. (AF 18(603)112) AD 249009   Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 779-787, Oct. 1960.

Based on small deflection theory, differential equations for the elastic bending of an orthotropic weak-core sandwich panel with small initial warping are derived by the variational energy method. The applied loads consist of arbitrarily distributed transverse loads and eccentrically applied edge loads and/or edge moments. For the case of a simply supported rectangular panel, solutions of the differential equations are obtained in the form of double Fourier series. As a practical example, numerical values of the maximum stresses and deflections for a square sandwich panel are calculated and presented in the form of graphs. A simple design criterion is suggested for considering approximately the effect of initial warping and transverse pressure. The method is particularly useful for preliminary design. (Contractor's abstract)

1275

Minnesota U. [Dept. of Mathematics] Minneapolis.

CHANGE OF TIME SCALE FOR MARKOV PROCESSES, by S. Orey. Sept. 1, 1959 [21]p. (AFOSR-TN-59-1067) (AF 49(638)617) AD 243767; PB 144771

Unclassified

Also published in Trans. Amer. Math. Soc., v. 99: 384-397, June 1961.

Let $\{X_n\}$ be a recurrent Markov chain, n = 0, 1, ...
A new process $\{\bar{X}_t\}$, $0 \le t < \infty$ is obtained from the original process by requiring a wait of duration $\gamma(x)$ after reaching x, for every state x, where $\gamma(x) > 0$. Let $\tilde{X}_t =$ $(\bar{X}_t, Y_t)$, where Y_t is the elapsed time since the last transition. $\{\tilde{X}_t\}$ is a Markov process; Y_t is a generalized renewal process. Results are obtained about the structure of the $\tilde{X}_t$ - process and the asymptotic behavior of the transition probabilities. The case in which the waiting times are random variables is also treated. (Contractor's abstract)

1276

Minnesota U. [Heat Transfer Lab.] Minneapolis.

THE APPLICATION OF CONSTANT PROPERTY SOLUTIONS TO MASS TRANSFER COOLING CALCULATIONS, by C. J. Scott. Dec. 1958 [48]p. incl. diagrs. refs. (Engineering memo. no. 76) (AFOSR-TN-59-201) (AF 18(600)1226) AD 211527; PB 140425
Unclassified

Simple transformation relations are developed for applying the results of constant property laminar and turbulent boundary layer solutions to the calculation of mass transfer cooling problems using foreign gas effusion. The methods are similar to those developed by Eckert for solid surface predictions. Laminar constant pressure, laminar stagnation, and turbulent constant pressure flows are studied. A reference concentration of 4/10 of the wall concentration was used in evaluating the properties. Comparisons are made with currently available exact theoretical solutions in order to assess the value of the method as a means for extrapolating to conditions not covered by the available solutions. (Contractor's abstract, modified)

1277

Minnesota U. [Heat Transfer Lab.] Minneapolis.

INTEGRAL LAMINAR BOUNDARY LAYER SOLUTIONS USING THE CROCCO VARIABLES, by C. J. Scott. Aug. 1959 [19]p. incl. diagrs. table. refs. (Engineering memo. no. 86) (AFOSR-TN-59-1304) (AF 18(600)1226) AD 231973; PB 145775
Unclassified

An analysis is presented which predicts the skin friction and surface heat transfer characteristics of a compressible laminar boundary layer. The present formulation is restricted to constant specific heat and Prandtl number and a linear variation of fluid viscosity with temperature. Regions where the analysis may be extended are pointed out. For the injection cases considered, the coolant gas is considered to be identical

to the main stream fluid. Numerical examples are presented for constant pressure, impermeable and permeable surfaces, with upstream and downstream transpiration cooling and strip injection. Surface temperature distributions are presented for the case of constant surface injection with uniform reservoir temperature. In the cases where similarity exists, the method is tested by comparisons with exact solutions which are free from the limitations of the present analysis. (Contractor's abstract)

1278

Minnesota U. [Heat Transfer Lab.] Minneapolis.

LAMINAR, TRANSITIONAL AND TURBULENT MASS TRANSFER COOLING EXPERIMENTS AT MACH NUMBERS FROM 3 TO 5, by C. J. Scott, G. E. Anderson, and D. R. Elgin. Aug. 1959 [30]p. incl. illus. diagrs. (Research rept. no. 162) (AFOSR-TN-59-1305) (AF 18(600)1226) AD 231974; PB 145760
Unclassified

A summary is presented of the experimental research work on porous-wall mass transfer cooling effects. Two coolants, air and helium, were included in all of the investigations. Laminar, transitional, and turbulent boundary layers on constant pressure surfaces were investigated, using flat plates and cones. A porous hemisphere was used to examine the effect of nonuniform surface pressure. The experimental results covering relatively-low temperatures and low speed confirm analytical boundary layer predictions on the relative effectiveness of the 2 gases in reducing heat transfer although quantitative agreement does not exist. The available theories do not correctly indicate the general trends of experimental temperature recovery factors. Transition Reynolds number decreases, caused by injection, could be overcome by the cooling made possible by the injection process. Both laminar and turbulent boundary layers could be blown-off the bodies by excessive coolant injection. (Contractor's abstract)

1279

Minnesota U. [Heat Transfer Lab.] Minneapolis.

MASS TRANSFER COOLING EXPERIMENTS ON A HEMISPHERE AT M = 5, by G. E. Anderson, C. J. Scott, and D. R. Elgin. Aug. 1959 [20]p. incl. illus. diagrs. table, refs. (Research rept. no. 166) (AFOSR-TN-59-1306) (AF 18(600)1226) AD 231975; PB 145788
Unclassified

A segmented, porous hemisphere was designed and constructed to provide a constant temperature surface with helium mass transfer cooling. The variation of surface heat transfer with helium injection rate and with position on the hemisphere surface was measured. The data is presented along with available analytical results. (Contractor's abstract)

1280

Minnesota U. Hormel Inst., Austin.

SYNTHESES OF UNSATURATED FATTY ALDEHYDES, by H. K. Mangold. [1958] [3]p (AFOSR-TN-59-283) (AF 18(603)18) AD 234336　　　　Unclassified

Also published in Jour. Org. Chem., v. 24: 405-407, Mar. 1959.

Oleyl-, linoleyl-, and linolenyl-aldehydes were prepared by a modified Grundmann synthesis. The procedure can be used for the preparation of radioactive aldehydes on a mg scale. (Contractor's abstract)

1281

Minnesota U. Hormel Inst., Austin.

INCLUSION COMPLEXES IN SOLUTION, by H. Schlenk. Technical rept. Feb. 1, 1956-Dec. 31, 1957, 27p. incl. diagrs. tables, refs. (AFOSR-TR-59-30) (AF 18(603)-18) AD 212924; PB 140216　　　　Unclassified

Association of α- and β-cyclodextrin with several organic acids in aqueous solution has been studied by measuring solubilities. Molecule fitting into the dextrin rings are solubilized while bulky molecules are only slightly, if at all, affected by the presence of dextrins. The solubilization factors, the concentration of solubilized acids, and of dextrin, which have been found in systems saturated with both hydrated complex and fatty acid, indicate that the stabilities of complexes follow an irregular pattern. The different ring sizes of α- and β-cyclodextrin are reflected in the values obtained for the component ratios in solution and the solubilization factors. Unsaturated or rigid molecules associate strongly with cyclodextrins in solution, but they yield crystalline complexes only with difficulty. Cyclodextrins protect to some extent benzoic acid from the salting-out effect of halogen ions. The normal order of salting-out constants, Cl' > Br' > I', is reversed when related to complexes. I' has particular affinity for α-cyclodextrin, so diminishing its association with benzoic acid. The stoichiometry of dehydrated inclusion complexes of fatty acids follows the principle of preferential placing. The rate of the reaction of periodate with α-cyclodextrin is lowered when the latter is associated with guest molecules. The optical rotation of cyclodextrin in solution is increased by the presence of unsaturated molecules, while it is decreased when the cosolutes are saturated flexible molecules.

1282

Minnesota U. [Inst. of Tech.] Minneapolis.

ON THE STABILITY OF VISCOUS FLUID MOTIONS, by J. Serrin. [1959] 13p. incl. diagrs. refs. (AFOSR-TN-59-77) (AF 49(638)262) AD 210137

Unclassified

Also published in Arch. Rational Mech. and Anal., v. 3: 1-13, 1959.

Investigation is made of one aspect of the classical problem of hydrodynamical stability, i.e., the determination of sufficient conditions for a basic flow of an incompressible fluid to be stable under arbitrary disturbances. The method of energy was used to establish a Reynolds number criterion for the stability of an arbitrary fluid motion in a bounded region. Similar criteria were obtained for the stability of flows in unbounded regions and applied to the problem of uniqueness of steady flow. A general variation problem connected with the stability of an arbitrary motion is stated, as well as a particular example, the laminar Couette flow between rotating coaxial cylinder.

1283

Minnesota U [Inst. of Tech.] Minneapolis.

A NOTE ON THE EXISTENCE OF PERIODIC SOLUTIONS OF THE NAVIER-STOKES EQUATIONS, by J. Serrin. [1959] [3]p. (AFOSR-TN-59-78) (AF 49(538)-262) AD 210138　　　　Unclassified

Also published in Arch. Rational Mech. and Anal., v. 3: 120-122, 1959.

Proof is presented for the existence of stable periodic solutions of the Navier-Stokes equations. Let γ = γ(t) be a bounded region in space, and let a flow velocity be prescribed at each point of the boundary of γ. Assume furthermore that both γ and the assigned velocities depend periodically on the time t. Consider that (1) to every continuous initial distribution of velocities over γ there corresponds a solution of the Navier-Stokes equations satisfying the prescribed boundary conditions and (2) there is one solution whose Reynolds number Re = V d/v is less than 5.7, where V is the max speed of the flow during the whole time interval $0 \leq t < \infty$, d is the max diam of γ, and v is the kinematic viscosity (this solution is equicontinuous in $\chi = (x,y,z)$ for all t). Then, under conditions 1 and 2 there exists a unique, stable, periodic solution of the Navier-Stokes equations in γ which takes on the prescribed velocities on the boundary of γ.

1284

Minnesota U. [Inst. of Tech.] Minneapolis.

ON THE UNIQUENESS OF COMPRESSIBLE FLUID MOTIONS, by J. Serrin. [1959] [18]p. incl. diagr. (AFOSR-TN-59-205) [AF 49(638)262] AD 211659

Unclassified

Also published in Arch. Rational Mech. and Anal., v. 3: 271-288, 1959.

A study was made of the initial value problem for compressible fluid flow, with particular emphasis on the

uniqueness of its solutions. Proof is presented of theorems which assert that fluid motion in a bounded region $\Upsilon = \Upsilon$ (t) is uniquely determined by its initial velocity, temperature, and density distribution together with certain boundary conditions. The form of the boundary conditions is especially interesting for non-viscous, non-heat conducting fluids, it having been found that such conditions are superfluous at any point where the fluid is leaving Υ at a relatively supersonic speed. This result is closely associated with the existence of characteristic manifolds in the flow regions, and permits proof for spatial flows of a theorem of the type given by Courant and Friedrichs for 1-dimensional motions.

1285

Minnesota U. [Inst. of Tech.] Minneapolis.

THE EXTERIOR DIRICHLET PROBLEM FOR SECOND ORDER ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS, by N. Meyers and J. Serrin. [1959] [26]p. incl. diagrs. (AFOSR-TN-59-1251) (AF 49(638)262) AD 249929   Unclassified

Also published in Jour. Math. and Mech., v. 9: 513-538, July 1960.

This paper contains a careful and lucid analysis of the behavior of solutions of 2nd order elliptic equations, which are defined in a neighborhood $\mathcal{E}$ of infinity in $n \geq 2$ dimensions, and which assume prescribed boundary data on an inner boundary. The exterior Dirichlet problem is defined as follows: Let $\mathcal{E}$ be a given open region in the Euclidean number space E^n, containing a neighborhood of infinity and having a smooth internal boundary $F\mathcal{E}$. A continuous function $\varphi(x)$ is prescribed on F. The function $u = u(c)$ is sought, which is of class C^2 and satisfies Lu = f in $\mathcal{E}$, and which continuously takes on the values $\varphi(x)$ on the boundary $F\mathcal{E}$. Two different cases are considered: (1) the function u shall tend to an assigned limit 1 as x tends to infinity, and (2) the function u shall be bounded in $\mathcal{E}$. It is shown that problem 1 is well-set, (that is for any assigned data there exists exactly 1 corresponding solution) if and only if there exists a barrier at infinity. Problem 2 is found to be well-set for an equation of the form $\Lambda u = a_{ik} u_{ik} = 0$, if and only if the equation enjoys an extended maximum principle.

1286

Minnesota U [Inst. of Tech.] Minneapolis.

A NEW DEFINITION OF THE INTEGRAL FOR NONPARAMETRIC PROBLEMS IN THE CALCULUS OF VARIATIONS, by J. Serrin. [1959] [10]p. (AFOSR-3844) (AF 49(638)262)   Unclassified

Also published in Acta Math., v. 102: 23-32, 1959.

This study is largely concerned with the statement assuming that an extremal $u_0(x,y)$, taking the preassigned values on the boundary, gives the minimum for a double nonparametric integral of the calculus of variations $I[u] = (R) \int F(x, y, u, p, q)dxdy$ in a large class of admissible functions $u(x,y)$, if $u_0(x,y)$ can be imbedded in a field of extremals. R denotes an open bounded region of the xy-plane, and F a continuous function of x, y, u, p, q for $(x,y) \in R$, u, p, q real, $F(x, y, u, p, q) \geq 0$, satisfying the regularity condition $E(x, y, u, p, q, P, Q) \geq 0$, where E denotes the usual Weierstrass function. The following are proven: (1) For non-negative regular integrands $F(x, y, p, q)$ independent of u, if the class A, or A^*, is not empty, and $u(x,y)$ is an extremal satisfying the condition, $u(x,y)$ is continuous on $\bar{R} = R \cup R^*$ and takes on the boundary R^* of R preassigned in R, then $u \in A$, or $\in A^*$, and u gives the minimum of $I[u]$ in A or A^*. (2) For "tame" integrands $F(x, y, p, q)$ if $u(x,y)$ gives the minimum of $I[u]$ in the class A or A^*, then u is of class C^2 in R. (3) For non-negative regular integrands $F(x, y, u, p, q)$, if an extremal $u(x,y)$, $(x,y) \in R$, satisfying the condition in 1 above, and the condition, $I[u] < \infty$, and is an element of a field V of extremals over R, then u gives the minimum of $I[u]$ in the class A^*.

1287

Minnesota U. Rosemount Aeronautical Labs., Minneapolis.

BLUFF-BODY FLAME STABILIZATION AT LOW PRESSURES, by C. C. Chang, G. Engholm, and L. H Zacho. July 1959, 55p. incl. illus. diagrs. tables, refs. (Research rept. no. 161) (AFOSR-TR-59-111) (AF 18(600)-1553) AD 226869; PB 144346   Unclassified

Presented at Sixth Tech. Conf. of Rosemount Aeronaut. Labs., Minnesota U., Minneapolis, 1959.

Blowoff velocities of butane-air flames stabilized on a 3/16 in. diameter cylindrical flameholder were measured as a function of pressure (1/10 to 1 atm) and equivalence ratio for Reynolds numbers ranging from 1945 to 4685. Within this laminar range it was found that blowoff velocity was directly proportional to pressure for equivalence ratios from 0.9 to 1.5 and inversely proportional to pressure for equivalence ratios less than 0.9 or greater than 1.5. (Contractor's abstract)

1288

Minnesota U. School of Chemistry, Minneapolis.

SPIN RESONANCE STUDIES OF DEFECTS IN MAGNESIUM OXIDE, by J. E. Wertz, P. Auzins and others. [1959] [6]p. incl. diagr. refs. (AFOSR-3588) (In cooperation with Clarendon Lab., Oxford (Gt. Brit.)) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)479 and Atomic Energy Research Establishment) AD 612229   Unclassified

Also published in Faraday Soc. Discussions, No. 28: 136-141, 1959.

Excluding impurities, trapped holes are the most important defect centers which are observable by electron-spin resonance in presently-available magnesium oxide crystals. Models are suggested for 2 types of trapped hole centers. The 1st, involving 1 hole, is believed to involve the following linear array: hole trapped on an oxygen atom—positive ion vacancy—normal O^{-2} ion—trivalent impurity ion. The 2nd center, which is far less stable, involves 2 holes opposite another about a positive-ion vacancy. It is suggested that another defect is associated with this pair to cause localization of the axis of symmetry. These conclusions are drawn from electron-spin resonance spectra showing simple axial symmetry for single-hole centers lying along principal crystal axes. For hole-pair centers pairs of lines approximately centered upon the positions of the previously-mentioned axial lines are observed. More complex hole center spectra have also been observed. (Contractor's abstract)

1289

Minnesota U. School of Chemistry, Minneapolis.

ELECTRON TRANSFER AMONG TRANSITION ELEMENTS IN MAGNESIUM OXIDE, by J. E. Wertz, P. Auzins and others. [1958] [6]p. incl. diagr. tables, refs. (AFOSR-3589) (In cooperation with Clarendon Lab., Oxford (Gt. Brit.)) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)-479 and Atomic Energy Research Establishment) AD 612230 Unclassified

Also published in Faraday Soc. Discussions, No. 26: 66-71, 1958.

This study is largely devoted to interpretation of the qualitative displacement of the equilibria $M^{2+} = M^{3+} + e$ when MgO is heated in vacuum, in oxygen or in metal vapors, or subjected to 4.9 ev or x-irradiation. Heating in vacuum at temperatures of 1200°C or higher, molecular oxygen is lost from the surface of MgO when the partial pressure of oxygen is less than the decomposition. The electrons left behind by the oxide ions are trapped by trivalent iron group ions, principally Fe^{3+}, though V^{3+} may also do so if the treatment is prolonged. It is thought that a Fe^{3+} ion located near a positive ion vacancy may acquire an electron from a neighboring oxygen ion, leaving a hole. The hole as well as the positive-ion vacancy will tend to move toward the srface, with the hole combining with an electron from the surface oxygen which is lost. In oxygen heating, oxygen is taken up by MgO at temperatures above 1000°C in amounts exceeding that required to form a chemisorbed layer. It is noted that the divalent ions tend to lose an electron and become trivalent. It is presumed that the transfer of electrons from divalent ions to oxygen on the surface proceeds by way of hole movement. The effects of x-irradiation and ultra-violet irradiation are discussed also. Under the former the existing equilibrium is upset in favor of Fe^{2+}, Cr^{3+}, V^{3+}, and e.

1290

Minnesota U. [School] of Chemistry, Minneapolis.

A MODIFICATION OF THE METHOD OF FLASH PHOTOLYSIS AND ITS APPLICATION TO THE STUDY OF LABILE INTERMEDIATES IN REACTIONS SENSITIZED BY COMPLEX MOLECULES, by R. Livingston. Final rept. Sept. 1, 1955-Mar. 31, 1959. Aug. 12, 1959, 11p. incl. diagrs. (AFOSR-TR-59-114) (AF 18(600)-1485) AD 225663; PB 143630 Unclassified

A modification of the flash photolytic technique was used in the study of spectroscopic properties and reactions of photochemically produced labile states of polyatomic molecules. In the modified technique a device was developed in which a single flash served to photolyze the solution and to expose 2 absorption spectra. The 1st one was exposed after passing through the activated solution, and the other 1 after passing through a similar cuvette filled with the solvent. Measurements were made of the spontaneous rate of decay of chlorophyll a in pyridine and cyclohexanol. The quenching of the triplet by quinone, O, β-carotene, luteol, and zeaxanthophyll was also studied. Results indicated that m-dinitrobenzene was an efficient quencher and that all trans retinene, like carotene, was a quencher of the triplet state of chlorophyll. Measurements were made of the half life and the quenching of the triplet state of anthracene.

1291

Missouri U. Dept. of Mathematics, Columbia.

UNSTABLE HOMEOMORPHISMS AND THE CLOSED 2-CELL, by J. P. Jakobsen and W. R. Utz. Aug. 1959 [14]p. (Technical rept. no. 12) (AFOSR-TN-59-855) (AF 18(600)1108) AD 226230; PB 144308 Unclassified

If X is a metric space with metric ρ and $T(X) = X$ is a self-homeomorphism of X, then T is said to be unstable provided there exists a $\delta > 0$ depending only upon X and T such that corresponding to each distinct pair x, y $\in$ X there exists an integer n(x, y) for which $\rho(T^n(x), T^n(y)) > \delta$. Unstable homeomorphisms are shown not to exist for a closed 2-cell.

1292

Missouri U. Dept. of Mathematics, Columbia.

ON A THEOREM OF E. SPARRE ANDERSEN AND ITS

APPLICATION TO TESTS AGAINST TREND, by H. D. Brunk. Aug. 1959, 1v. incl. refs. (Technical rept. no. 13) (AFOSR-TN-59-856) (AF 18(600)1108) AD 225371; PB 144309   Unclassified

Let n be a positive integer, fixed throughout, and let $X_1,...,X_n$ be random variables. Let $S_c = 0$, and $S_r = \sum_{i=1}^{r} X_i$, $r = 1,2,...,n$. The lower part of the boundary of the convex hull of the set of points $\left\{ (r, S_r) \right\}_{r=0}^{r}$ in the Cartesian plane is the greatest convex minorant (gcm) of this set of points. An extension is presented of Andersen's theorem which finds the distribution of the random variable M, the number of sides of the gcm, when the random variables $X_1,...,X_n$ are symmetrically de-

pendent, and which observes that it is the same distribution as that of the number of cycles in a randomly chosen permutation of the integers 1,2,...,n. A class of random variables sharing a common distribution are exhibited for which M and the number of cycles of a randomly chosen permutation are instances. Events describable in terms of the gcm are presented. Conditions are

given under which the conditional probability $P(H|D^k)$ coincides with the probability $P[H(\alpha)]$. The likelihood ratio tests are described for H_0 against alternatives

subject to H_1, and of H_1 against all alternatives.

1293

Missouri U. [Dept. of Mathematics] Columbia.

BEST FIT TO A RANDOM VARIABLE BY A RANDOM VARIABLE MEASUREMENT WITH RESPECT TO A σ-LATTICE, by H. D. Brunk. [1959] [18]p. incl. refs. [Technical rept. no. 14] (AFOSR-TN-59-1134) (AF 18-(600)1108) AD 230193; PB 145489   Unclassified

Also published in Pacific Jour. Math., v. 2: 785-802, 1961.

Let (Ω,S,μ) be a probability space for f a random varia-ble, an S-measurable function from Ω into the space R of real numbers. Let S_0 be a sub-σ-algebra of S and

let f be integrable. Then the Radon-Nikodym theorem yields a S_0-measurable function g, which is the best

fit to f. A function with the same minimizing proper-ties is shown to correspond to f when an arbitrary sub-σ-lattice L takes the place of S_0. The problem for

square-integrable f is treated as a problem in Hilbert space. Results on the minimum problem for arbitrary classes of functions are obtained and used to yield the principal results for integrable f and for measurable f. Given a partial ordering on Ω, a σ-lattice L is shown to be introduced such that the L-measurable functions are precisely the order preserving functions. Applica-tion to the problem of maximum likelihood estimation of a multi-dimensional parameter is mentioned.

1294

Modena U. (Italy).

ELECTROCHEMICAL BEHAVIOR OF GRAPHITE ELECTRODES IN SOLUTIONS OF VARIOUS pH CON-TAINING OXYGEN AND HYDROGEN PEROXIDE, by G. Bianchi, G. Caprioglio and others. Apr. 30, 1959 [40]p. incl. diagrs. (Technical scientific note no. 3) (AFOSR-TN-59-708) (AF 61(052)85) AD 219263; PB 143596
Unclassified

Polarization measurements with graphite electrodes were effected in solutions of different pH by circulating O_2 and CO_2 and varying the H_2O_2 concentration of the solutions from 0 to 10^{-1} M. Variations of potential with time at the moment of opening and closing the polariza-tion circuit were also registered. The results were interpreted by considering the intervention of processes occurring on graphite, which, however, does not behave as an inert electrode with respect to O_2 and H_2O_2 proc-

esses. The intervention of the electrode is manifested under the form of processes presumably due to the presence of the superficial oxide C(O) and to adsorbed carbonates $(CO_3^{--})_{ads}$. Such processes can substitute

or superimpose those concerning H_2O_2 and O_2 particu-larly in the case of acid solutions.

1295

Modena U. (Italy).

INFLUENCE OF SURFACE PREPARATION OF PLATI-NUM ELECTRODES ON CATHODIC PROCESSES OF HYDROGEN PEROXIDE, by G Bianchi and G. Caprioglio. Apr. 30, 1959 [4]p. incl. diagrs. tables. (Technical scientific note no. 1) (AFOSR-TN-59-732) (AF 61(052)-85) AD 219364   Unclassified

Also published in Electrochim. Acta, v. 1: 18-21, 1959.

Values of static tensions have been measured, and cathodic polarization curves have been plotted for plat-inum electrodes in H_2O_2 solutions at various pH values.

The results depend upon the treatment of the platinum surface. Two different methods of surface preparation have been considered. With "bare" electrodes and with "oxidized" electrodes differences have been observed for static tensions and for slopes of polarization curves. (Contractor's abstract)

1296

Modena U. (Italy).

ANODIC BEHAVIOUR OF HYDROGEN PEROXIDE ON PLATINUM ELECTRODES, by G. Bianchi, G. Caprioglio

and others. Apr. 30, 1959 [36]p. incl. diagrs. refs.
(Technical scientific note no. 4) (AFOSR-TN-59-921)
(AF 61(052)85) AD 226591   Unclassified

The evolution of O_2 from the acid solutions of H_2O_2
begins on platinum at low anodic tensions (+ 800 mv)
due to probable intervention of the platinum oxides.
At greater current densities, the process occurs in
the same conditions as on other metals, e.g., gold,
and probably requires the intervention of the adsorbed
atomic O_2. The reaction between H_2O_2 and adsorbed
O_2 gives rise to the evolution of the O_2. The adsorp-
tion and the formation of platinum oxides can explain
the anodic phenomena of hysteresis. In alkaline solu-
tions the oxidation of H_2O_2 occurs on platinum with the
same mechanism as on other metals. At greater cur-
rent densities the discharge of the ions CH⁻ and the
formation on platinum of a film of adsorbed OH radicals
can intervene. The radicals can react with H_2O_2 to
give rise to the evolution of O_2. (Contractor's
abstract)

1297

Modena U. (Italy).

THE ELECTROCHEMICAL BEHAVIOR OF HYDROGEN
AND OXYGEN MIXTURES ON PLATINUM ELEC-
TRODES, by G. Bianchi and F. Mazza. Apr. 30, 1959
[7]p. incl. diagrs. (Technical scientific note no. 2)
(AFOSR-TN-59-1156) (AF 61(052)85) AD 232054
                                              Unclassified

Also published in Electrochim. Acta, v. 1: 198-204,
1959.

The electrochemical processes occurring when hydrogen
and oxygen, dissolved in aqueous solution, combine on a
platinum surface to give H_2O_2 and H_2O, and the anodic
and cathodic partial processes of hydrogen oxidation and
of oxygen reduction, have been investigated. The meas-
ured mixed potentials can be interpreted on the basis of
the polarization curves for these partial processes. Hy-
drogen reduces hydrogen peroxide solutions and mixed
potentials have been measured which can be interpreted
on the basis of polarization curves for the partial proc-
esses of hydrogen oxidation and hydrogen peroxide re-
duction. In more concentrated hydrogen peroxide solu-
tions (10^{-2}M) the mixed potentials always equal the po-
tential for the process of hydrogen peroxide reduction.
(Contractor's abstract)

1298

Modena U. (Italy).

BASIC RESEARCHES IN METAL CORROSION, by G.
Bianchi. Final technical rept. Apr. 30, 1959, 10p. incl.

tables. (AFOSR-TR-59-76) (AF 61(052)85)
AD 218368; PB 144122   Unclassified

The electrochemical processes of O_2 and H_2O_2 on
platinum, graphite and gold electrodes were studied, to
get a knowledge of the mechanism of oxygen corrosion.
The nature of the cathode affects the cathodic proces-
ses of oxygen and hydrogen peroxide reduction in acid
and neutral solutions; moreover the platinum, the graph-
ite and the gold are absolutely different also from the
point of view of their catalytic activity for the decom-
position of hydrogen peroxide in acid solutions. The
process of oxygen and hydrogen peroxide reduction in
alkaline solutions takes place, independently of the na-
ture of the cathode, at tensions very near the reversi-
ble one corresponding to the process: $O_2 + H^+ + 2e =$
HO_2^-. (Contractor's abstract)

1299

Mount Zion Hospital, San Francisco. Calif.

STUDIES OF THE RELATIONSHIPS BETWEEN
NEUROPHYSIOLOGICAL AND BEHAVIORAL PROC-
ESSES IN MAN, by B. Feinstein and M. Berke.
Final rept. Apr. 1, 1956-June 30, 1958. July 17, 1959
[47]p. incl. illus. diagrs. refs. appendices. (AFOSR-
TR-59-58) (AF 18(603)48) AD 216107; PB 143356
                                              Unclassified

A series of experiments on cerebral electrophysiology
are reported. A brief description of the laboratory ap-
paratus is given. The description of development of
both instrumentation and surgical techniques may be
found in the 4 technical reports which are included in
this report. A Stereotaxic Technique in Man Allowing
Multiple Spatial and Temporal Approaches to Intra-
cranial Targets, by B. Feinstein, W. W. Alberts and
others (Jour. Neurosurgery, v. 17: 708-720, 1960;
AFOSR-TN-60-1456) describes a method of intracranial
localization by precise stereotaxic means. This locali-
zation procedure includes radiographic positioning and
interpretation of this data for proper orientation of the
stereotaxic instrument on the target. A method which
allows return to this site without relocating is also de-
scribed. A Stimulus Pulse Polarity Reversal Unit, by
W. W. Alberts (MZH.02:001, Vol. II) describes a simple
means of obtaining a brain stimulus wavefront which
passes a current pulse, first in one direction and then
an equal pulse in the other, from a single laboratory
stimulator. Implanted Electrodes (unpublished) dis-
cusses the multi-lead electrodes which were designed
for this experiment. Preliminary results with stimula-
tion by these electrodes and the responses elicited are
presented. Sensory Perception by Direct Stimulation
of Human Cerebral Cortex: Stimulus Parameters, by
B. Libet, W. W. Alberts and others (Fed. Proc., v. 18:
92, Mar. 1959) presents an analysis of the adequacy of
electrical stimuli to the somatosensory area for elicit-
ing a sensation. Comparisons of stimuli and responses
are also discussed.

1300

Naples U. [Inst. of Aeronautics] (Italy).

LAMINAR MIXING OF STREAMS OF DIFFERENT
GASSES, by L. G. Napolitano and A. Pozzi. Apr. 1959
[70]p. incl. diagrs. tables, refs. (Technical note no. 1;
I.A. rept. no. 10) (AFOSR-TN-59-977) (AF 61(052)160)
AD 226469; PB 143911   Unclassified

Solutions of plane, isobaric, laminar mixing of 2
streams of different gases are presented. For the case
of isovel mixing an exact, closed form solution is de-
rived for the general case of Lewis number (Le) dif-
ferent from one. With the help of this exact solution it
is shown that the assumption Le = 1 may lead to sub-
stantial errors in the temperature profiles which are
already of the order of 10% when the Lewis numbers of
the 2 streams are around $1.10 + 1.20$. An approximate
method of solution, based on the integral method, is
presented for the general case without the limitations
of constant Schmidt number and constant $(\rho\mu)$. The solu-
tion by this method proves to be simple and immedi-
ate. The accuracy of the method is determined by com-
parison with the previously mentioned closed-form so-
lution and with numerical solutions obtained by means
of high-speed computing machine for a number of indi-
cative cases. The comparison shows that velocity pro-
files and concentration profiles are accurate to within
few percent throughout the ranges of practical interest
of the parameters entering the problem. (Contractor's
abstract)

1301

Naples U. [Inst. of Theoretical Physics] (Italy).

A SYSTEM OF COUPLED OSCILLATORS AS A FUNC-
TIONAL MODEL OF NEURONAL ASSEMBLIES, by V.
Braitenberg, E. R. Caianiello and others. Nov. 1958,
6p. (Scientific note no. 1) (AFOSR-TN-59-470)
(AF 61(052)96) AD 215229; PB 142142   Unclassified

Some points are presented in a purely qualitative and
non-mathematical form which are considered to be
relevant to the problems posed by the interpretation of
nervous functions. The basic principles are outlined
on which a theory can be founded and models are built
to imitate the functions of the nervous system. This
model promises to share with the living nervous sys-
tem the properties of economy, capacity to recognize
similarity, and character of wholeness (Gestalt).

1302

Naples U. [Inst. of Theoretical Physics] (Italy).

THE CEREBELLAR CORTEX AS A TIMING ORGAN.
DISCUSSION OF A HYPOTHESIS, by V. Braitenberg and
N. Onesto. Jan. 1959, 17p. incl. diagrs. refs. (Techni-
cal note no. 2) (AFOSR-TN-59-471) (AF 61(052)96)
AD 215230   Unclassified

Morphological evidence led to the assumption that the
cerebellar cortex is a timing organ, i.e. a nerve net
in which the precise timing of successions of impulses
plays an important role. A study of the histology of the
parallel fibers and the Purkinje cell system, translated
into physiological and neurologi~' language supporting
the importance of the cerebellar cortex in rapid volun-
tary movements, is presented. (ASTIA abstract)

1303

Naples U. Inst. for Theoretical Physics (Italy).

ON THE CONVERGENCE OF PERTURBATIVE EX-
PANSIONS, by A. Buccafurri and E. R. Caianiello.
[1958] [4]p. (AFOSR-J30) (AF 61(052)434)
                              Unclassified

Also published in Nuovo Cimento, v. 8: 170-173, Feb.
21, 1958.

It is shown that, when the space-time volume Ω of inte-
gration is taken finite and the free fermion and boson
propagators $S^F(x,y)$ and $D^F(x,y)$ are bounded, in modu-
lus, by finite quantities throug.i some cut-off proce-
dures, the perturbative expansions of the propagation
kernels $K_{NO}P_O$ of electrodynamics and similar theo-
ries are convergent, with a finite radius of convergence.
Further proof is offered in the particular case in which
the limitation of $S^F(x,y)$ is obtained by allowing only a
finite number of modes to the free fermion field. Such
perturbative expansions have an infinite radius of con-
vergence. The proof presented shows the mathemati-
cal reason of the holomorphy and is well suited for
deeper investigations on the subject.

1304

Naples U. Inst. of Theoretical Physics (Italy).

A SYSTEM OF COUPLED OSCILLATORS AS A FUNC-
TIONAL MODEL OF NEURONAL ASSEMBLIES, by V.
Braitenberg, E. R. Caianiello and others. [1959]
[5]p. (AF 61(052)434)   Unclassified

Published in Nuovo Cimento, Series X, v. 11: 278-282,
Jan. 16, 1959.

A theoretical approach for constructing an electronic
or mechanical model which would share with the living
nervous system the properties of economy, capacity
to recognize similarity, and the character of wholeness
is discussed. Attempt is made to provide the most
simple example of the process of signal transfer be-
tween input and output. It is found that since the coup-
ling constants could be varied within wide ranges of val-
ues, that practically any number of different frequency
spectra representing the output could be obtained to
correspond to a very large number of input patterns.
There exists good reason to believe that the model

would be able to recognize similarities between figures, and that a model with memory could be obtained if the coupling constants between any two oscillators we... taken as functions of all the past states of those two oscillators. The action of any oscillating unit on the oscillation of the whole array is dependent on the coupling and on the states of all other units.

1305

National Bureau of Standards, Washington, D. C.

MEASUREMENTS OF THERMAL DIFFUSIVITY IN SEMICONDUCTORS: InSb AND Mg_2Sn (Abstract), by I. I. Sochard and J. H. Becker. [1959] [1]p. [CSO-680-56-39]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 134, Mar. 30, 1959.

Accurate measurements of thermal diffusivity k in metals have been made from analysis of temperature waves due to periodically heating one end of an effectively semi-infinite rod. Generally low-frequency heat pulses (f ~ 1/100 cps) and large samples (~ 25 cm long) are employed. In contrast, with smaller semiconductor samples (~ 0.5 x 1 x 10 mm) we use higher frequency heat pulses (f ~ 10-1000 cps) obtained by chopping light which is strongly absorbed at a large area surface of the specimen; temperature waves are deduced from thermoelectric power, Nernst, or bolometric steady-state voltages produced by the sample. Sandblasting reduces undesired photosignals. To calculate k from the bolometric and Nernst effects the ambipolar diffusion constant is required, with thermoelectric power volt-

ages V, k is obtained from the slope of log $V(f)^{\frac{1}{2}}$ vs $(f)^{\frac{1}{2}}$. Results on intrinsic samples at 300 and 400°K agree with calculations from known thermal constants, however, for InSb an anomalous nonlinearity appears when measuring the magnetic field dependence of the Nernst effect.

1306

National Bureau of Standards, Washington, D. C.

ATTENUATION COEFFICIENTS OF HIGH ENERGY X-RAYS, by H. W. Koch and J. M. Wyckoff. Final rept. May 1, 1959, 1v. incl. diagrs. tables, refs. (NBS rept. no. 6313) (AFOSR-TR-59-25) (CSO-680-57-2) AD 211761   Unclassified

Direct measurements were made of the total attenuation coefficients for x-rays in the energy range from 5 to 180 mev. The research has resulted in detailed attenuation coefficients in hydrogen, carbon, water and

aluminum, which demonstrate specific areas requiring further theoretical and experimental investigations. (Contractor's abstract)

1307

National Bureau of Standards, Washington, D. C.

BREMSSTRAHLUNG CROSS SECTION FORMULAS AND RELATED DATA, by H. W. Koch and J. W. Motz [1959] [113]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TR-59-25; AD 211761) (Sponsored jointly by Air Force Office of Scientific Research and Atomic Energy Commission under [CSO-680-57-2])
                          Unclassified

Also published in Rev. Modern Phys. v. 31: 920-955, Oct. 1959.

Theoretical formulas and related data are given in a form convenient for practical calculations. For some cases comparisons are made with experimental results and the accuracy of the formulas estimated.

1308

National Bureau of Standards, Washington, D. C.

X-RAY ATTENUATION COEFFICIENTS FROM 15 TO 80 MEV FOR HYDROGEN, CARBON, WATER, AND ALUMINUM, by J. M. Wyckoff and H. W. Koch. [1959] [41]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TR-59-25; AD 211761) [CSO-680-57-2]
                          Unclassified

Also published in Phys. Rev., v. 117: 1261-1274, Mar. 1, 1960.

The x-ray attenuation coefficients for hydrogen, carbon, water, and aluminum have been measured in the energy range from 15 to 80 mev. Varying lengths of the attenuators were placed in a 90 mev bremsstrahlung beam in a good geometry experiment using a large sodium iodide total-absorption spectrometer as the detector. In the hydrogen case, a difference method employing cyclohexane (C_6H_{12}) and graphite was used.

The theoretical attenuation coefficients, due to electronic processes, were calculated using selected Compton and triplet cross sections in addition to the small quasi-deuteron cross sections. A pair cross section increase of 2.25% was required for carbon, water and aluminum to bring the total calculated coefficients into agreement with the measured coefficients in the 60 mev region. The difference between these calculated cross sections and the measured cross sections in the 15 to 50 mev region has been ascribed to the giant resonance nuclear absorption. A larger high energy tail to this absorption than predicted by (γ,p) and (γ,n) experiments is indicated. (Contractor's abstract)

1309

National Bureau of Standards, Washington, D. C.

THE RELATION BETWEEN THE ABSORPTION SPEC-
TRA AND THE CHEMICAL CONSTITUTION OF DYES,
by J. H. Gould and M. N. Inscoe. Final rept. Feb. 16,
1959 [19]p. incl. diagrs. (NBS rept. no. 6307) (AFOSR-
TR-59-15) (CSO-680-57-3) AD 210474
Unclassified

The principle areas of investigation were the associa-
tion and the phototropism of dyes. Spectral changes
produced in solutions of azo dyes as a result of as-
sociation were observed; the changes appeared to be
closely related to the forces involved in the binding of
dyes to fibers. The spectra of aqueous solutions of
certain trisazo dyes were observed to change with time
in the presence of inorganic salts, with the appearance
of a complex new band at wavelengths longer than those
of the normal absorption bands. The rate of change and
the maximum intensity observed for the new band were
influenced by the temperature, age of the stock dye solu-
tions, and the salt concentration. An apparently related
phenomenon was observed in the spectra of acidified
solutions of certain aminoazo compounds. In aqueous
solutions of Congo Red, the indicator change in spec-
trum was followed by another slower change character-
ized by a new complex band at longer wavelengths. For
phototropism studies, methoxyazo compounds were pre-
pared by methylation of hydroxyazo dyes. The methoxy-
azo compounds exhibited changes in spectra on illumina-
tion depending upon the wavelength of the light used for
illumination. The phototropism of indigo and thioindigo
dyes was examined on cellulose or celluose derivatives;
there was no evidence of phototropism.

1310

National Bureau of Standards, Washington, D. C.

ON STOKES FLOW ABOUT A TORUS, by W. H. Pell
and L. E. Payne. Sept. 22, 1959 [23]p. incl. diagrs.
refs. (NBS rept. no. 6546) (AFOSR-TR-59-151)
(CSO-680-57-16) AD 228853 Unclassified

A collection of m bodies (m ≥ 1) is considered each of
which has an axis of symmetry, and arranged collec-
tively in such a way that the aggregate also has an axis
of symmetry. Let this configuration be immersed in a
uniform flow of a viscous fluid, the axis of symmetry
of the configuration of bodies taken parallel to the di-
rection of the uniform flow. Assuming that U, the
speed of the uniform flow, is so small that inertial ef-
fects of the motion are negligible in comparison with
those of viscosity, a Stokes flow is obtained.

1311

National Bureau of Standards, Washington, D. C.

PHOTOCONDUCTIVE, PHOTOELECTROMAGNETIC,

BOLOMETRIC AND NERNST EFFECTS IN MAGNESI-
UM STANNIDE, by J. H. Becker and I. I. Sochard.
June 1, 1959, 77p. incl. diagrs. tables, refs. (NBS rept.
no. 6437) (AFOSR-TN-59-591) (CSO-680-58-15)
AD 217010 Unclassified

The photoeffects (photoconductivity and photoelectromag-
netic effects) as well as the analogous thermal effects
(bolometric and Nernst effects) have been studied in the
semiconductor Mg_2Sn. Experimental investigations were

made with monochromatic and filtered light interrupted
at audio frequencies. Included are the dependence upon
the temperature of the sample, the energy of the incident
photons, and the frequency at which the light is interrupt-
ed for samples with various impurity contents and sur-
face treatments. Theory and experiment are in reasona-
ble agreement. Particular attention is devoted to the rel-
ative amounts of the photo and thermal effects which are
measured in a given experiment; conditions which en-
hance the photo or thermal effects are verified. A new
method to determine the thermal diffusivity from the ra-
tio of the ac bolometric and Nernst effects is demonstrat-
ed. It is pointed out that experimental and theoretical
difficulties associated with this method can be circum-
vented by measurement of both the dc and ac bolometric
or Nernst effects. Optical absorption coefficients, sur-
face recombination velocities, and electron-hole pair
lifetimes are evaluated from the spectral dependence of
the photoeffects. Absorption due to indirect transitions
can account for the observed dependence of the absorption
coefficient upon photon energy at 146°K. Lifetimes at
200°K ranged from 0.2 to .03 usec. The temperature
dependence of the lifetimes between 140 and 250°K can
be interpreted in terms of a simple Shockley-Read-Hall
model. Below 140°K more complicated behavior is in-
dicated. (Contractor's abstract)

1312

National Bureau of Standards, Washington, D. C.

SUPERCONDUCTIVITY, by C. A. Shiffman. Oct. 30,
1959 [73]p. incl. diagrs. refs. (NBS rept. no. 6592)
(AFOSR-TR-59-182) [CSO-680-59-3] Unclassified

The distribution of normal and superconducting domains
in long circular cylinders of tin has been studied by
measuring the variation of the magnetic field along the
surfaces of suitably prepared specimens in a transverse
external field. The magnetic field sensor was a minute
bismuth resistor whose manufacture and properties are
described. Details of the scanning apparatus, cryogenic
equipment and electrical measuring system are also
given. The domain distributions have been measured as
a function of the external field, the temperature and the
metallurgical state of the specimens. It is found that at
a given temperature and field the domains are distrib-
uted periodically along the length of the specimen, with
periodicities of the order of a few tenths of a millimeter.
The relation between the periodicity and the surface en-
ergy at the normal-superconducting interfaces is dis-
cussed. It is shown that massive plastic deformation
tends to increase the periodicity. Prolonged annealing

reduces the periodicity up to a point, beyond which the principal result of further heat treatment is to reduce the fluctuations about the mean value. Histograms are presented to demonstrate this effect. In the case of most carefully treated samples the periodicity is shown to be proportional to the Gorter-Casimir value for the penetration depth over a wide range of temperatures. The field dependence, on the other hand, is shown to be in only rough agreement with the predictions of Landau's non-branching model. In addition the branching of domains to form sub-domains is demonstrated to occur under certain conditions. Preliminary results are presented to show that the domains may be either laminar or tubular, depending on the circumstances. The results are discussed in terms of the current theories of the intermediate state and of the surface energy. (Contractor's abstract)

1313

National Bureau of Standards, Washington, D. C.

A NEW METHOD OF SOLUTION FOR UNRETARDED SATELLITE ORBITS, by J. P. Vinti. July 1, 1959, 23p incl. diagr. tables, refs. (NBS rept. no. 6449) (AFOSR-TN-59-608) [CSO-680-59-4] AD 217395
Unclassified

An axially symmetric solution of Laplace's equation in oblate spheroidal coordinates is found, which may be used as the gravitational potential about an oblate planet. This potential, which makes the Hamilton-Jacobi equation for a satellite orbit separable, has an expansion in zonal harmonics in which the amplitudes of the zeroth and 2nd harmonics can be adjusted to agree exactly with the values for any axially symmetric planet and a 4th harmonic which then agrees approximately with the latest value for that of the earth. The net result is therefore a reduction of the problem of satellite motion to quadratures, with use of a potential field that is much closer to the empirically accepted one for the earth than any heretofore used as the starting point of a calculation. It may thus be possible to do the gravitational theory of a satellite orbit very accurately without use of perturbation theory. The method can take into account a first harmonic in the potential, in case observations are reduced to a center which does not coincide with the center of mass of the planet. (Contractor's abstract)

1314

National Bureau of Standards, Washington, D. C.

NEW APPROACH IN THE THEORY OF SATELLITE ORBITS, by J. P. Vinti. [1959] [1]p. [CSO-680-59-4]
Unclassified

Published in Phys. Rev. Ltrs., v. 3: 8, July 1, 1959.

If O is a center for the earth and if Oz points along the polar axis and Ox towards the vernal equinox, the oblate

spheroidal coordinates ξ, η, c, defined by

$$x = c[\xi^2 + 1)(1 - \eta^2)]^{\frac{1}{2}} \cos c, \ (0 < \xi < \infty)$$
$$y = c[\xi^2 + 1) (1 - \eta^2)]^{\frac{1}{2}} \sin c, \ (-1 < \eta < 1)$$
$$z = c\xi\eta,$$

turn out to be a useful system of coordinates for investigating the motion of an earth satellite. In this coordinate system any axially symmetric potential $V(\xi,\eta)$ that results in separability of the Hamilton-Jacobi equation must have the general form

$$V(\xi,\eta) = (\xi^2 + \eta^2)^{-1}[f(\xi) + g(\eta)].$$

The net result of the present work is a reduction of the problem of satellite motion to quadratures, for a potential whose even harmonics are exact through the 2nd, and whose 4th harmonic is comparable with empirical values.

1315

National Research Council. National Academy of Sciences, Washington, D. C.

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SCIENTIFIC INFORMATION. Washington, D. C. (Nov. 16-21, 1958), Washington, National Academy of Sciences, 1959, 2v. incl. illus. diagrs. tables, refs. [CSO-680-58-18]
Unclassified

This conference was jointly sponsored by the American Documentation Institute, the National Science Foundation, and the National Academy of Sciences—National Research Council. Its purpose was to bring together on an international level, scientists and information specialists for discussion of current research progress and problems concerned primarily with the storage and retrieval of scientific information. Approximately 75 papers were presented, covering the following topics: (1) Literature and reference needs of scientists; (2) Function and effectiveness of abstracting and indexing services; (3) Effectiveness of monographs, compendia, and specialized centers; (4) Organization of information for storage and search — Existing systems; (5) Organization of information for storage and retrospective search — Design of new systems; (6) Theories of information storage and retrieval; and (7) Responsibilities of government, professional societies, universities, and industry for better information services and research.

1316

National Research Council. National Academy of Sciences, Washington, D. C.

PROCEEDINGS OF AN INTERNATIONAL CONFERENCE ON THE ATOMIC MECHANISMS OF FRACTURE, Swampscott, Mass., Apr. 12-16, 1959, ed. by

B. L. Averback, D. K. Felbeck and others. Cambridge, MIT Technology Press, 1959, 646p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-213) (Sponsored jointly by Air Force Office of Scientific Research under [CSO-680-59-2], National Science Foundation, Office of Naval Research and Ship Structure Committee)
Unclassified

At a meeting designed to bring together both experimentalists and theorists working in the field of fracture mechanisms on an atomic scale, papers were presented dealing with theories, fatigue, and comparison of fractures. In all, 28 papers were presented on the history, work, and expectations in this field of study

1317

New Hampshire U. Dept. of Chemistry, Durham.

EVIDENCE FOR THE A-SE2 MECHANISM IN THE ACID-CATALYSED AROMATIC PHOTO-DEBORONA-TION, by H. G. Kuivila and K. V. Nahabedian. [1959] [2]p. incl. diagrs. (AFOSR-TN-59-667) (AF 49(638)-312) AD 246904 Unclassified

Also published in Chem. and Indus. (London), No. 36: 1120-1121, Sept. 5, 1959.

The acid-catalysed hydrolysis of p-methoxybenzeneboronic acid was studied spectrophotometrically and found to obey 1st order kinetics. The catalysis by molecular formic acid is thought to be the reason that the rate constant remains essentially constant through a unit change in the acidity function but then increases with increasing acidity. Two facts are revealed by the data: (1) the rate in protium solvent is 3.7 times greater than in a deuterium solvent; (2) the rates in isotopically mixed solvents are not predicted by the Grass-Butler theory.

1318

New Hampshire U. [Dept. of Physics] Durham.

CONDUCTIVITY OF A WARM PLASMA, by L. Mower. [1959] [3]p. (AFOSR-4289) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)-687] and Atomic Energy Commission) Unclassified

Also published in Phys. Rev., v. 116: 16-18, Oct. 1, 1959.

A theory for obtaining the conductivity of a uniform plasma as a function of frequency and temperature is presented and compared with a number of recent treatments. This research was stimulated by the different forms of the conductivity tensor reported by different investigators. It is shown that the parallel and transverse components of the electric field are mutually independent. The form of the components when propagation is parallel to or transverse to the direction of the dc field is also shown. However, in the case of propa-

gation of a plasma in a direction at an arbitrary angle to the dc magnetic field, even in the absence of thermal effects, the electric field of the independent modes posesses components both along and transverse to the direction of the dc magnetic field. For the general case of propagation at an angle to the direction of the dc magnetic field the elimination process is not valid.

1319

New Mexico U., Albuquerque.

FIRST INTERDISCIPLINARY CONFERENCE ON DECISIONS, VALUES AND GROUPS, New Mexico U., Albuquerque. (June 17-Aug. 10, 1957), ed. by D. Willner. New York, Pergamon Press, 1960, 348p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-66) (AF 49(638)-33) Unclassified

This conference sought to bring together young men with a potential for growth to discuss subjects related to the behavior sciences. It's participants included experts in philosophy, mathematics, economics, anthropology, sociology, and psychology. The broad title of Decisions, Values, and Groups was chosen to encompass the whole spectrum of research in which these investigators would have an interest. The program was divided into 5 parts, the 1st 3 of which were the various divisions suggested by the title, plus a section dealing with psychodynamic patterns of behavior and 1 concerned with special military problems.

1320

New Mexico U., Albuquerque.

RELATIONSHIPS AMONG THE TRAITS OF THE PERCEIVER AND THOSE OF THE PERCEIVED IN IMPRESSION FORMATION, by D. T. Benedetti, R. M. Morgan. and D. W. Bessemer. Final rept. Sept. 1959 [48]p. tables, refs. (AFOSR-TR-59-187) (AF 49(638)33) AD 228829; PB 144787 Unclassified

Two questions were experimentally investigated: To what extent are the impressions one forms of other persons contingent upon the extent to which one possesses the traits one perceives in the others? When one perceives another person, is the resulting impression an integrated or a piece-meal cognition? College students were given controlled information about a series of hypothetical persons. The impressions they formed were measured in a variety of ways. The correlations among certain personality trait scores of the subjects and the measures of their impressions were determined. The major conclusions were: (1) in general, one's personality traits are not potent, overall determiners of the impressions one forms of others, although there are certain selective relationships here; and (2) impressions formed of other people clearly tend to be integrated cognitions, in the sense that judgmental responses based upon them are typically intercorrelated. This study is predicated upon the assumption that since interpersonal

behavior is in part a function of personality impressions, the prediction and control of such behavior in military or other practical situations calls for grounding in knowledge gained by basic research.

1321

New Mexico U., Albuquerque.

INITIAL EXPECTATION, GROUP CLIMATE, AND THE ASSESSMENTS OF LEADERS AND MEMBERS, by E. F. Borgatta, L. S. Cottrell, Jr., and L. Wilker. [1959] [12]p. incl. tables. (In cooperation with New York U., N. Y.) (AF 49(638)33)   Unclassified

Published in Jour. Social Psychol., v. 49: 285-296, May 1959.

The problems of generalizing from small group laboratory research are discussed. The type of questions that must be answered are does the group climate influence individual attitudes, or what is the relationship of the group climate to the individual or what is this relationship in "natural" social situations. The findings suggest that there is a stability of individual scores from the time of expression of expectation to the time of expression of assessment of experience. There appears to be a tendency for initial level of the group to influence the assessment of the individual in the direction of the group mean. Analysis of the data suggest also, however, that shifts toward the mean may occur faster (or more frequently) for leaders than for members, although this appears to be visible only in the data derived from the question on ability to understand other people. There also appears to be some tendency for leaders to have greater change than members in their assessments in the low groups than in the high groups.

1322

New Mexico U., Albuquerque.

REDUNDANCY IN TASK ASSIGNMENTS AND GROUP PERFORMANCE, by R. B. Zajonc and W. H. Smoke. [1959] [9]p. incl. diagrs. refs. (In cooperation with Michigan U., Ann Arbor) (AF 49(638)33)
                                                          Unclassified

Published in Jour. Psychometrika, v. 24: 361-369, Dec. 1959.

The problem of combining abilities of group members to maximize the performance of the group as a whole is examined in terms of redundancy in task assignments. In particular, ways of distributing a given number of items of information among a given number of individuals to obtain the maximum probability of each item being recalled by at least one individual are studied. It is shown that there exists an optimal distribution scheme which is independent of the amount of material originally given, the size of the group, and individual differences in ability.

1323

New Mexico U. Dept. of Physics, Albuquerque.

ON THE RESPONSE OF A SINGLE LARGE SCINTILLATOR TO EXTENSIVE AIR SHOWERS, by J. R. Green. May 4, 1959 [25]p. incl. diagrs. tables, refs. (AFOSR-TN-59-490) (AF 49(638)34) AD 215843; PB 142021   Unclassified

Also published in Nuovo Cimento. Series X, v. 14: 1342-1355, Dec. 16, 1959. (Title varies)

The known properties of extensive cosmic ray air showers are applied to predict the response of single scintillator. Questions of particular interest are the relation of the number-spectrum of the particles traversing a single scintillator to the number spectrum of the extensive air showers, and the average size of the showers that result in a given number of particles traversing the scintillator. In cases where particular values are indicated, they are computed for the elevation of Albuquerque, N. M., namely, 1575 m s l, and for a scintillator whose diam is 10 ft and whose area is

7.3 m^2. (Contractor's abstract)

1324

New Mexico U. Dept. of Physics, Albuquerque.

SIZE-SPECTRUM OF EXTENSIVE AIR SHOWERS OF THE COSMIC RADIATION, by J. R. Green and J. R. Barcus. Oct. 7, 1959 [14]p. incl. diagrs. (AFOSR-TN-59-1068) (AF 49(638)34) AD 227953; PB 144342
                                                          Unclassified

Also published in Nuovo Cimento, Series X, v. 14: 1356-1365, Dec. 16, 1959. (Title varies)

The operation and calibration of a single scintillator of area 7.3 sq m are discussed. There are 2 basic calibrations. The 1st is the so-called single particle (the size of the pulse produced by a single, minimum-ionizing particle passing through the scintillator) and is obtained at a relatively high voltage for the photomultiplier. It leads to a 2nd calibration, i.e., the change in the photomultiplier amplification from that in high potential to the lower potential at which the photomultiplier is actually operated to detect events producing 10^2 to several times 10^3 particles in the scintillator. The photomultiplier is found to saturate for large pulses so that the range investigated is limited by this effect at the high end. The results of different analyzing circuits are combined to give the integral spectrum of pulses in the scintillator for a wide particle range. From about 30 particles to the upper limit of the apparatus, the spectrum is very regular and has a constant logarithmic slope of -1.51. From 10^5 to 10^8 particle range, it is deduced to have also a regular integral spectrum. As to spectrum of below 30 particles, there

is marked change of slope as a result of a different phenomenon, i.e., the local production of small nuclear events in the liquid of the scintillator.

New York State Coll. of Ceramics, N. Y. see
Alfred U. New York State Coll. of Ceramics, N. Y.

1325

New York U., N. Y.

CONFERENCE ON THE PHYSICS OF ELECTRONIC AND ATOMIC COLLISIONS, PROGRAM AND ABSTRACTS OF PAPERS, New York U., N. Y. (Jan. 27-28, 1958) [1958] 78p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and New York U.)
Unclassified

This conference brought together researchers investigating the phenomena and properties of electronic and atomic collisions. The papers are concerned with elastic and inelastic electron-atom scattering, atom-atom and atom-ion collisions, photon-atom collisions, and charge exchange.

1326

New York U., N. Y.

THE SCATTERING OF ELECTRONS BY FREE ELECTRONS, by A. Shadowitz, P. Nektaredes, and M. H. Shamos. Final rept. Jan. 1, 1959 [80]p. incl. diagrs. tables, refs. (AFOSR-TR-59-72) (AF 18(600)9[ ])
AD 218069; PB 142301   Unclassified

The scattering of electrons by free electrons was investigated experimentally by means of 2 intersecting electron beams. With a 30° angle between the beams the collisions produce higher and lower energy components in the forward cone. The higher energy component was detected with an electron multiplier preceded by a velocity gate; the latter rejected background scattering as well as the lower energy component. The scattered intensity was measured between 55° and 125° in the center-of-mass system. The energy in that system was 550 ev. The results, with statistics of about 3%, do not correspond either with the Rutherford or with the Mott scattering theories. Instead, the points lie on a curve which corresponds to a symmetric space wave function. The authors are unable to account for this unexpected result.

1327

New York U., N. Y.

SPONTANEOUS IGNITION PROPERTIES OF METAL ALKYLS, by J. Marsel and L. Kramer. [1959] [7]p. incl. illus. diagrs. tables. (AF 49(638)173)   Unclassified

Published in Seventh Symposium (Internat'l.) on Combustion, Oxford U., London (Gt. Brit.) (Aug. 28-Sept. 3, 1958), London, Butterworths Scientific Publications, 1959, p. 906-912.

Delays are reported for spontaneous ignition in air of Et_3Al, Me_3Al, a Et_3Al-Me_3Al mixture (1:3), and a Me_3Al-JP-5 mixture (9:1). The ease of spontaneous ignition of these materials suggests their use as igniters for jet engines at high altitudes.

1328

New York U. Coll. of Engineering, N. Y.

EFFECT OF GASEOUS IMPURITIES IN BF_3 PROPORTIONAL COUNTERS, by J. Davila-Aponte. Dec. 1958 [49]p. incl. diagrs. tables, refs. (AFOSR-TN-59-162) (AF 18(600)1555) AD 211141; PB 140619
Unclassified

The effects which SiF_4, SO_2, SF_6 have on the plateau and pulse size distribution of a proportional counter were investigated. SiF_4 was tested at 3 pressures; 30, 45, and 60 cm of BF_3 and its effect was found to be independent of the counter pressure for the range of values considered. From the variation in the plateau, the attachment probability for SiF_4 was calculated to be $h = 1.458 \times 10^{-5}$ and its cross section for attachment to be $\sigma_a = 5.12 \times 10^{-20}$ cm^2. The permissible amounts of these gases without the counter being affected beyond the limits of tolerance which are set up were found to be 0.04% for SiF_4, 0.01% for SO_2, and 2.0×10^{-6}% for SF_6. (Contractor's abstract)

1329

New York U. Coll. of Engineering, N. Y.

A STUDY OF DEAD TIME AND RESOLVING TIME IN A PROPORTIONAL COUNTER, by W. Reidy. Jan. 1959, 38p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-501) (AF 18(600)1555) AD 229385; PB 144492
Unclassified

Measurements were made on a helium isobutane counter, which determined the variation of dead time and resolving time with voltage and pulse amplitude. The purpose was to determine the dead time and resolving time of the counter when operated in the proportional region and contrast this with operation in the geiger region. Results were obtained from photographs and direct measurements of the counter pulse as displayed on an oscilloscope. The dead time in the proportional region was observed as less than 1 μsec, while in the geiger region, it is of the order of several hundred μsec. In

addition, measurements were made by the two-source method to determine the resolving time of a proportional counter and its associated electronic counting system. These measurements gave results of the order of 5 µsec.

1330

New York U. [Coll. of Engineering] N. Y.

PLATEAU SLOPES AND PULSE CHARACTERISTICS OF LARGE, HIGH PRESSURE BF_3 COUNTERS, by R.
B. Mendell. July 1959, 1v. incl. diagrs. refs. (AFOSR-TN-59-738) (AF 18(600)1555) AD 230018; PB 144936
Unclassified

Also published in part in Rev. Scient. Instr., v. 30:
442-444, June 1959.

Factors affecting the flatness in a plateau of large diameter, high pressure BF_3 counters were examined.

It was found that with gas and counter body free from contamination, counters up to 5 cm radius and filled with BF_3 gas at 64 cm Hg, had acceptably flat plateaus.

Desired gas purity was obtained by generating the gas from $C_2F_2BF_3$ complex, trapping residual impurities, and isolating and collecting BF_3 vapor that was in equilibrium with the liquid phase at a vapor pressure of 20 cm Hg. The resolution of counters of different pressures and cathode diameter for ionizing events with a known energy spectrum was compared. Pulse amplification characteristics of the different counters were determined, and results, including the effect of electron attachment on measured values for counters of large diameter and high pressure are discussed.

1331

New York U. [Coll. of Engineering] N. Y.

[RESEARCH IN THE FIELD OF RADIATION DETECTION EQUIPMENT, SPECIFICALLY COUNTERS], by S. A. Korff. Final rept. Nov. 1 1959, 4p. (AFOSR-TR-59-176) (AF 18(600)1555)   Unclassified

This project was set up to study the radius effect and the effects of impurities in BF_3 neutron counters.

The main difficulty to be overcome was to construct counters which are large size and still have good plateau characteristics. This problem is of great practical importance since the efficiency of a BF_3 counter for detecting neutrons depends on its size. Good counters with very flat plateaus were obtained by extending the purification of the gas. A study was also made of the impurities which arise owing to the normal method of preparing the counters and the filling gas. The impurities studied were sulfur dioxide, silicon tetrafluoride, and sulfur hexafluoride. A study

was also made of the dead times and resolving times of proportional and Geiger counters. In this study the electronic circuits necessary to determine these times are set up to trace the problem through the transition, from proportional counter operation to the Geiger region.

1332

New York U. [Coll. of Engineering] N. Y.

PROPORTIONAL AND GEIGER COUNTERS, by S. A. Korff. [1959] [20]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1555] and Office of Naval Research)
Unclassified

Published in Radiation Hygiene Handbook, New York, McGraw-Hill, 1959, p. 10-33—10-52.

A general discussion of proportional and geiger counters and their characteristics of operation are presented. The general makeup of proportional counters is discussed, and the effects of varying conditions under which they operate is analyzed such as increasing the voltage across the counter. Terms and definitions applicable to proportional counters are discussed also; and finally examples of typical problems and special uses of counters are discussed. Concerning geiger counters, the factors which differentiate them from proportional counters are shown. Effects of varying the voltage is also discussed in some detail. A list of terms and their definitions concerning geiger counters is followed by a detailed discussion of different-type geiger counters and their particular uses.

1333

New York U. Coll. of Engineering, N. Y

ATTEMPTS AT DERIVATION OF TRANSITION FROM LAMINAR INTO TURBULENT FLOW ALONG A FLAT PLATE, by H. B. Keller, D. F. De Santo, and R. Parthasarathy. Progress rept. June 1959, 26p. incl. diagr. (AFOSR-TN-59-686) (AF 18(603)25) AD 226270; PB 144324   Unclassified

Successful progress is reported on this research, in the following areas: (1) determination of initial-field and base-flow parameter values; (2) preparation of complete detailed instructions for programming the solution of the finite-difference equation for vorticity; (3) development of a numerical scheme for solving the linear equations associated with the solution of the vorticity equation; (4) carrying out a theoretical analysis of propagation of disturbances into the potential flow exterior to the boundary layer, so as to establish a permissible location for the upper horizontal boundary; (5) calculation of initial vorticity-propagation characteristics as given by the proposed finite-difference

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solution (in order to check the validity of the method
as well as the correctness of subsequent machine com-
putations; and (6) initiation of actual programming.

1334

New York U. Coll. of Engineering, N. Y.

EXPLORATORY RESEARCH ON THE THEORETICAL
CONSIDERATION OF WASTE WATER CYCLES IN A
CLOSED ECOLOGICAL SYSTEM, by W. T. Ingram, B.
Newman and others. [1958] 16p. incl. tables. (AFOSR-
TN-59-87) (AF 18(603)71) AD 210087; PB 142540
                                          Unclassified

Presented at Symposium on the Closed Ecological
System, AAAS meeting, Washington, D. C., Dec. 31,
1958.

The probable wastes in a closed ecological system
were classified to include feces, urine, sebaceous
gland excretions, perspiration, respiratory end prod-
ucts, washings containing soil from clothing, and wash-
ings containing food particles as a result of food prep-
aration and service. Problems concerning waste water
cycling were presented. It was found to be proble-
matical that the high treatment efficiencies required
to maintain water balance in the system could be
achieved without the development of techniques pecul-
iarly adapted to the conditions of space ecology. Urine
studies were summarized to determine the feasibility
of recovery of water from urine by distillation process
followed by adsorption on different materials.

1335

New York U. Coll. of Engineering, N. Y.

EXPLORATORY STUDIES IN THREE DIMENSIONAL
PHOTOTHERMOELASTICITY, by H. Tramposch and
G. Gerard. Sept. 1959 [59]p. incl. illus. diagrs. refs.
(Technical rept. no. SM-59-5) (AFOSR-TN-59-1069)
(AF 49(638)387) AD 229377   Unclassified

The exploratory application of the photo-thermoelastic
method is made to 3-dimensional thermal stress prob-
lems. Several of the existing 3-dimensional photo-
elastic techniques seemed applicable, but were found
undesirable. Rather, a completely new technique was
developed which utilizes an embedded polariscope con-
sisting of 2 sheets of polarizing material cemented with-
in the models. The technique has proved to be simple
to apply particularly to axisymmetric bodies and the re-
sulting fringe patterns are readily interpreted. The
systematic evaluation of the new technique starts with
strength tests of cemented joints. Then a simple bend-
ing model and a sphere are tested under mechanical
loading and the resulting fringe patterns are compared
with results obtained by other methods. The new tech-
nique is applied to thermal stress problems with sim-
ple 3-dimensional geometries for which theoretical so-
lutions are available. The investigations indicate the

general applicability of the new sandwich technique to
3-dimensional stress problems generated by mechanical
or thermal loads. The technique is particularly appli-
cable to thermal stress problems where other experi-
mental stress analysis methods are not highly developed.
(Contractor's abstract)

1336

New York U. Dept. of Chemistry, N. Y.

DEVIATION FROM THE KINETIC STEADY-STATE
APPROXIMATION IN A FREE-RADICAL FLAME, by
E. S. Campbell, J. O. Hirschfelder, and L. M. Schalit.
[1959] [7]p. incl. diagrs. tables, refs. (In cooperation
with Wisconsin U., Madison) (Sponsored jointly by
Air Force Office of Scientific Research under AF 49-
(638)169 and Bureau of Ordnance under NOrd-15884)
                                          Unclassified

Published in Seventh Symposium (Internat'l.) on Com-
bustion, Oxford U., London (Gt. Brit.) (Aug. 28-Sept.
3, 1958). London, Butterworths Scientific Publications,
1959, p. 332-338.

The flame equations are solved for a model free-radi-
cal flame in which a fuel A burns to a product C by
means of an intermediate reaction of A and a free-radi-
cal B. It is shown how deviations from the steady-state
approximation affect the distribution of A, B, and C in
the flame. The objective of the study is to test mathe-
matical methods applicable to more complex flames.

1337

New York U. Dept. of Electrical Engineering, N. Y.

OPTIMIZATION OF THE ADAPTIVE FUNCTION BY
Z-TRANSFORM METHOD, by S. S. L. Chang. Nov.
1959 [35]p. incl diagrs. tables, refs. (Technical rept.
no. 400-6) (AFOSR-TN-59-585) (AF 49(638)586)
AD 217032; PB 144276   Unclassified

Also published in Trans. Amer. Inst. Elec. Engineers,
v. 79(Pt. II): 223-231, July 1960.

A study is made on the optimization of the adjustment
process in a self-optimizing system under rather gen-
eral assumptions. The system is designed to keep a
performance parameter m either at a prescribed value
or at an unknown extremal value. A direct measure-
ment on m is made, and the adjustment is based on
measured m only. Factors considered are (1) the finite
measuring interval, (2) the necessity of looking ahead
one interval, (3) the probable error in measurement,
and (4) the changing situation. A set of weighting fac-
tors on present and past data, and the proper value of
test bias for extremal seeking systems, are determined
by a least square optimization process. The criterion
of optimization is least reduction in m for peak seeking
systems and least square error in m for systems with
prescribed value of m. Two types of extremal seeking

systems are studied. The alternate biasing systems
are found to be superior in performance compared to
the derivative sensing systems. (Contractor's abstract)

1338

New York U. Dept. of Electrical Engineering, N. Y.

TRANSIENT RESPONSE AS A DESIGN CRITERION
FOR STABILIZATION OF FEEDBACK AMPLIFIERS,
by J. H. Mulligan, Jr. Sept. 1959 [26]p. incl. diagrs.
tables. (Technical rept. no. 400-5) (AFOSR-TN-59-
1075) (AF 49(638)586) AD 229481; PB 144770
Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill.,
Oct. 12-14, 1959.

Also published in Proc. Nat'l Electronics Conf., v. 15:
1-14, 1959.

A design criterion for use in the stabilization of feed-
back amplifiers is discussed which is concerned direct-
ly with pole locations and with a feature of the transient
response. The criterion is the relative damping of the
amplifier step-function response, i.e., the ratio of the
deviations from unity in the normalized time response
at 2 successive extreme values. Use of the proposed
criterion in conjunction with a dominant term approxi-
mation to the transient response to formulate design
equations for representative transistor and vacuum
tube amplifier stages is demonstrated. Transient re-
sponse curves for a particular design using various
values of mid-band loop gain illustrate the effect of
parameter changes on the stabilization design parame-
ter. (Contractor's abstract)

1339

New York U. Dept. of Electrical Engineering. N. Y.

ON THE WIENER PREDICTION PROBLEM AND THE
PROBLEM OF THE OPTIMIZED NOISE FREE AUTO-
MATIC CONTROLLER, by N Aslund. Oct. 1959, 16p.
(Technical note no. 400-2) (AFOSR-TN-59-1100)
(AF 49(638)586) AD 229483; PB 144783
Unclassified

A solution is presented of the Wiener prediction prob-
lem in the sampled, non-stationary case. The deriva-
tion is simpler and more direct. The problem of min-
imizing a generalized loss-function defined for a sam-
pled, noisefree automatic controller is solved by using
a geometrical projection technique. The concept of
orthogonal projection is fundamental for the solution
of both problems and is shown to account for the struc-
tural resemblance of the final results. The princi-
pal difference between the 2 is also emphasized by the
methods used.

1340

New York U. Dept. of Electrical Engineering, N. Y.

INFORMATION FLOW CRITERIA FOR FEEDBACK
CONTROL SYSTEMS, by S. S. L. Chang. Jan. 1960
[29]p. incl. diagrs. (Technical rept. no. 400-8)
(AFOSR-TN-59-1328) (AF 49(638)586) AD 231893;
PB 146715 Unclassified

Presented at First Internat'l. Cong. of the Internat'l.
Federation of Automatic Control, Moscow (USSR), 1960.

Also published in Automatic and Remote Control, v. 2:
712-716, 1960.

Information capacity in Shannon's sense is suggested as
an additional criterion for control systems and compo-
nents. This criterion applies equally well to linear as
well as nonlinear systems, and enables a designer to de-
termine the tolerable amounts of small signal nonlinear-
ities in components. Equations are derived for calculat-
ing required system capacity from given signal proper-
ties and allowed error, loss of information rate in sys-
tem components, required capacities of system compo-
nents, and calculation of information capacities from the
characteristics of system components with either di-
rect or indirect limiting. (Contractor's abstract)

1341

New York U. Dept. of Sociology, N. Y.

THE STABILITY OF INTERPERSONAL JUDGMENTS
IN INDEPENDENT SITUATIONS, by E. F. Borgatta.
[1959] [16]p. incl. table, refs. (AFOSR-TN-59-42)
(AF 49(638)195) AD 209214; AD 238861
Unclassified

Also published in Jour. Abnorm. Social Psychol., v. 60:
188-194, Mar 1960.

The following aspects that have generally received at-
tention separately are discussed together: (1) the lim-
ited number of contents that will account for most of
the variance of interpersonal ratings; (2) data from
studies on the consistency of interpersonal rankings in
independent situations; and (3) the interrelationship of
self-ratings, self-rankings and peer rankings. Analy-
sis of 99 male subjects revealed that self-ratings may
be predictors of the self-rankings that are made after
5- and 3-person discussion situations, independent of
content. Examining the magnitude of predictions, it
appears that correlations to peer rankings are larger
for the 5- than for the 3-person self-rankings. Three
types of content that tend to be orthogonal were uti-
lized in the ratings and rankings and were demon-
strated to operate in parallel for the relationships
examined.

1342

New York U. [Dept. of Sociology] N. Y.

PERSONALITY AND BEHAVIOR CORRELATIONS OF
CHANGES PRODUCED BY ROLE PLAYING EXPERI-
ENCE, by J. H. Mann and E. F. Borgatta. [1959]
[22]p. incl. tables. (AFOSR-TN-59-500) (AF 49(638)-
195) AD 215925   Unclassified

Also published in Psychol. Repts., v. 5: 505-526,
Sept. 3, 1959.

The possibility of inducing change in personality and
behavior characteristics through short-term role play-
ing techniques is examined. The relationship that
exist between criterion variables, the relative prognos-
tic efficiencies of these variables and the dependencies
that exist between these variables when they are uti-
lized as measures of change are discussed. In gen-
eral, the findings on the change variables involve some
variation beyond that expected on a change basis, but
the amount and magnitude of relationships found require
caution in interpretation.

1343

New York U. [Dept. of Sociology] N. Y.

THE GENERAL ORIENTATIONS PROFILE (GOP), by
E. Francesco. [1959] [9]p. incl. tables. (AFOSR-TN-
59-619) (AF 49(638)195) AD 264386   Unclassified

Also published in Psychol. Repts., v. 5: 561-569, Sept.
3, 1959.

A presentation is made of the development of a new
brief inventory, factorially based, designed to tap in an
economical manner 7 dimensions of orientation and
5 interest clusters. The selection of dimensions and
clusters emphasized replication of the structure of re-
lationships among items and also among clusters in 183
male and 84 female college sophomores and juniors.
Examination of the GOP scores in their relation to
Guilford-Zimmerman (GZ) scores indicates that the
GOP taps some of the same content as the GZ. In part,
since the GOP scores tend to be defined in more spe-
cific terms, some interpretation of the GOP scores
through the GZ scores is possible. The relationships
found between the 2 tests are easily interpretable in
some cases, and in others may prove to be revealing of
particular connotations of the subscales involved. Sub-
sequent reports will present analyses of the GOP with
other personality inventories and with more direct
measures of behavior. (Contractor's abstract)

1344

New York U. [Dept. of Sociology] N. Y.

POWER STRUCTURE AND COALITIONS IN THREE

PERSON GROUPS, by M. L. Borgatta. [1959] [28]p.
incl. diagrs. refs. (AFOSR-TN-59-679) (AF 49-
(638)195)   Unclassified

Also published in Jour. Social Psychol., v. 5: 287-300,
Dec. 1961.

An investigation of 3-man groups is presented. The
study indicates that there are several ways in which the
members of 3-man groups may influence each other in
reaching a decision or taking action on a group task and
in developing a stable organization for control of the
group. In one type of problem solving situation involving
the 2 most active and aggressive persons, individuals
will usually work toward agreement, and ignore or carry
along the 3rd person. In other situations, such as that
of a 3-man bomber crew, the influence of each member
in working at a task problem is controlled by the as-
signed status structure of the team. The study concludes
that the problem of the composition and functioning of
3-person task groups merits further consideration in
view of the spotty and inconclusive results of past re-
search in this area. (Contractor's abstract, modified)

1345

New York U. [Dept. of Sociology] N Y.

THE GENERAL ORIENTATIONS PROFILE (GOP):
VALIDATION STUDIES, by E. Francesco. (AFOSR-
TN-59-809) (AF 49(638)195)   Unclassified

Also published in Psychol. Repts., v. 6: 255-265, Apr.
1960.

The GOP scores appear to be pervasively and intelligi-
bly related to data which include personality inventory
subtests, self-rankings, peer rankings, and a measure
of intelligence. The magnitudes of the correlation co-
efficients and the unique definitions in the patterns of
correlations of the GOP scores are in some cases
impressive, particularly when considered in the light
of the attenuation due to the unreliability of criterion
measures and also of the logical and empirical restric-
tions that occur when panels of orthogonal measures are
intercorrelated. While the GOP has all the shortcom-
ings of inventories and checklists that permit the re-
spondent to structure an image of himself, the findings
indicate that the responses made are coherent and in-
terpretable in terms of other measures. Since the GOP
is a relatively brief form with a broad substantive cov-
erage, this approach to assessing values and interests
should be efficient in many contexts. (Contractor's
abstract)

1346

New York U. Dept. of Sociology, N. Y.

STUDIES OF ROLE PERFORMANCE, by J. H. Mann.
[1959] [44]p. incl. tables. (AFOSR-TN-59-1296) (AF 49-
(638)195)   Unclassified

Also published in Genetic Psychol. Monographs, v. 64: 213-256, Nov. 1961.

The studies described in this monograph are concerned with establishing the relations between stable and efficient measures of role performance. Specifically these studies examine self-report descriptions of 5 role performances in order to determine the dimensions in terms of which each of these role performances ought to be measured; whether the same dimensions can be used to measure different role performances; whether persons act consistently in different role performances; and whether it is meaningful to attempt to derive a role performance typology.

1347

New York U. Dept. of Sociology, N. Y.

SOME RELIGIOUS-ETHNIC DIFFERENCES IN INTER-ACTION RATES, by J. Stimson. [1959] [12]p. incl. tables. (AFOSR-TN-59-1297) (AF 49(638)195)
Unclassified

Also published in Psychol. Repts., v. 7: 345-356, Oct. 1960.

College sophomores and juniors (N = 133) were divided into groups composed of Jewish, Catholic, Protestant, and No Religious Preference. The Jewish group was further divided into 3 subgroups; those of Slavic, Industrial European, or other ethnic origins. The Slavic group was large enough to be again divided into those of 2nd and 3rd generation of US residence. Using these subsamples the influence of background characteristics on action initiated and interpersonal judgments in group discussion situations was examined. The total interaction by each S was recorded using Interaction Process Scoring, Borgatta's revision of Bales' Interaction Process Analysis. Mean scores for each subsample were developed on these 19 types of behavior and on rankings of Behavioral Characteristics. Significant differences were found between the subsamples in the actual amounts of different types of behavior initiated and in the mean rankings by self and peers in the Behavioral Characteristic areas. (Contractor's abstract)

1348

New York U. [Dept. of Sociology] N. Y.

PERSONALITY CONCOMITANTS OF EXTREME RE-SPONSE SET (ERS), by E. F. Borgatta and D. C. Glass. [1959] [9]p. incl. tables, refs. (AFOSR-TN-59-1316) (AF 49(638)195)
Unclassified

Also published in Jour. Social Psychol., v. 55: 213-221, Dec. 1961.

Extreme response set and related concepts are considered in the framework of personality characteristics. ERS, defined on a panel of variables from a

test of values that is based on factor analytic study, is compared for 3-type of Ss. Correlation to the subsets of the Cattell Sixteen Personality Factor Questionnaire and the Edwards Personal Preference Schedule indicates that there is little relationship between ERS and the subsets. The lack of consistency raises serious questions about the psychological meaningfulness of ERS.

1349

New York U. [Inst. of Mathematical Sciences] N. Y.

NUMERICAL SOLUTION OF PROBLEMS WHICH ARE NOT WELL POSED IN THE SENSE OF HADAMARD, by F. John. [1959] [14]p. incl. refs. (AFOSR-TN-59-495) (AF 49(638)161)
Unclassified

Also published in Proc. Rome Symposium on Numerical Treatment of Partial Differential Equations with Real Characteristics, Rome (Italy) (Jan. 28-30, 1959). p. 103-116.

It is pointed out that most problems of physical interest are not well-posed in the sense of Hadamard, since the data are neither completely known nor perfectly accurate. The approximate solution of a large class of not-well-posed problems is formulated in a general setting. The error bound depends both upon the approximation scheme being used and upon the error in the data. The latter puts an inherent limitation on the accuracy of the approximation scheme. The problem is called well-behaved if the error due to an inaccuracy δ in the data is of the order of a positive power of δ. Examples are given of both well-behaved and not-well-behaved not-well-posed problems. It is pointed out that the error made in approximating the solution of a well-behaved not-well-posed problem by means of a fixed finite difference scheme with optionally chosen mesh h is of an order larger than any positive power of δ since such a scheme is unstable for small h. Thus in order to obtain an error of an order of δ one must let the finite difference scheme itself depend upon δ. (Math. Rev. abstract)

1349 a

New York U. [Inst. of Mathematical Sciences] N. Y

SPHERICAL CAP SNAPPING, by H. B Keller and E. L. Reiss. [1959] [10]p. incl. diagrs. refs. (AF 49-(638)161)
Unclassified

Published in Jour. Aero/Space Sci., v. 26: 643-652, Oct. 1959.

A nonlinear boundary value problem for the determination of the rotationally symmetric deformations of a clamped spherical cap under external pressure is solved by finite differences. The numerical solutions are obtained by employing a previously developed iteration procedure. A special case of the difference equations is solved explicitly and yields a justification of the

iteration method as well as insight into the properties
of the more accurate numerical solutions. Buckled
and unbuckled equilibrium states are obtained and the
shape of the pressure-deflection curve which is usually
assumed for these states is verified for a large class
of caps. Close estimates are given for the upper and
lower buckling loads and an intermediate buckling load-
i.e., the "dead-weight" load. The stresses and deflec-
tions in the buckled and unbuckled states are examined
and compared with an asymptotic solution valid in the
interior of very thin shells. Boundary layers are found
to develop in the buckled states both as the loading in-
creases and as the thickness of the shell decreases.

1350

New York U. Inst. of Mathematical Sciences, N. Y.

THE DISCRIMINANT OF HILL'S EQUATION, by W.
Magnus. May 1959, 40p. (Research rept. no. BR-28)
(AFOSR-TN-59-576) (AF 49(638)229) AD 217023
Unclassified

Explicit expressions for the discriminant of Hill's
equation up to terms of order 4 are being calculated.
It is shown that these formulas permit a new proof of
a theorem about the asymptotic distribution of the char-
acteristic values. They also permit the derivation of
certain summation formulas involving the lengths of
the intervals of instability and the Fourier coefficients
of the periodic function appearing in Hill's equation.
(Contractor's abstract)

1351

New York U. Inst. of Mathematical Sciences, N. Y.

THE INFLUENCE OF EDGES AND CORNERS ON PO-
TENTIAL FUNCTIONS OF SURFACE LAYERS, by R.
Leis. June 1959, 21p. (Research rept. no. BR-29)
(AFOSR-TN-59-943) (AF 49(638)229) AD 228551;
PB 144766 Unclassified

Also published in Arch. Rational Mech. and Anal., v. 7:
212-223, 1961.

The potential functions of multiple surface layers
behave singularly when approaching the boundary of
the surface. The degree of the singularities of these
functions and their derivatives are discussed. (Con-
tractor's abstract)

1352

New York U. Inst. of Mathematical Sciences, N. Y.

ON SOME FREDHOLM INTEGRAL EQUATIONS
ARISING IN DIFFRACTION THEORY, by C. H. Yang.
Aug. 1959, 18p. incl. diagrs. (Research rept. no. BR-
31) (AFOSR-TN-59-944) (AF 49(638)229) AD 229003;
PB 144765 Unclassified

Kernels of integral equations arising in diffraction
theory are investigated. These kernels depend on a
parameter α. Fredholm's theory shows that the re-
solvents of the kernels are meromorphic functions of
α and, hence, can be expanded into power series of α
which are convergent for certain regions. Regions of
convergence for α, in which the perturbation method
would work, are examined. (Contractor's abstract)

1353

New York U. Inst. of Mathematical Sciences, N. Y.

ON THE DIRICHLET PROBLEM FOR THE REDUCED
WAVE EQUATION, by R. Leis. June 1959, 23p. incl.
refs. (Research rept. no. BR-30) (AFOSR-TN-59-945)
(AF 49(638)229) AD 231668; PB 145743 Unclassified

An existence theorem for the exterior Dirichlet prob-
lem for the reduced wave equation is given for piece-
wise smooth surfaces.

1354

New York U. Inst. of Mathematical Sciences, N. Y.

A FORMAL SOLUTION OF THE EQUATIONS OF STA-
TISTICAL EQUILIBRIUM, by B. Zumino. Oct. 1958, 7p.
incl. refs. (Research rept. no. HT-1) (AFOSR-TN-59-
74) (AF 49(638)341) AD 209849; PB 140038
Unclassified

Also published in Phys. Fluids. v. 2: 20-22, Jan.-Feb.
1959.

A closed expression is given for the distribution func-
tions in the classical theory of statistical equilibrium.
This expression, when suitably expanded, permits one
to obtain the general term in the virial expansion of the
distribution functions and of the equation of state.
(Contractor's abstract)

1355

New York U. Inst. of Mathematical Sciences, N. Y.

MEASURE-THEORETIC FOUNDATIONS OF STATISTI-
CAL MECHANICS, by R. M. Lewis. Apr. 1959, 46p.
(Research rept. no. HT-2) (AFOSR-TN-59-307) (AF 49-
(638)341) AD 213091; PB 140588 Unclassified

The basic formulas of classical equilibrium statistical
mechanics are derived from well-known theorems in
measure theory and ergodic theory. The method used
is a generalization of the methods of Khinchin and Grad
and deals with a complete set of invariants or integrals
of the motion. Most of the results are simple corollaries
of Birkhoff's ergodic theorem, and since time-averages
are used, the whole approach is characterized by an ab-
sence of statistical ensembles and probability notions.
In the course of the development a generalized

temperature is introduced, and a generalization of the second law of thermodynamics is derived. Formulas for the microcanonical, canonical, and grand canonical distributions appear as special cases of the general theory. (Contractor's abstract)

1356

New York U. Inst. of Mathematical Sciences, N. Y.

A SOLUTION OF THE EQUATIONS OF STATISTICAL MECHANICS, by R. M. Lewis. Nov. 1959, 21p. (Research rept. no. HT-3) (AFOSR-TN-59-1216) (AF 49-(638)341) AD 230291　　　　Unclassified

The solution of the initial value problem for Bogoliubov's functional differential equation of non-equilibrium statistical mechanics is obtained. This solution is then expanded in an infinite power series in the density which has the advantage that the calculation of the lead terms requires the solution of s-body problems only for small values of s. A derivation of the equilibrium equation by reduction from the non-equilibrium equation is included. (Contractor's abstract)

1357

New York U. Inst. of Mathematical Sciences, N. Y.

CLASSICAL FLUCTUATION - RELAXATION THEOREM, by R. H. Kraichnan. [1959] [2]p. (AF 49-(638)341)　　　　Unclassified

Published in Phys. Rev., v. 113: 1181-1182, Mar. 1, 1959.

A general expression is derived for the average infinitesimal-impulse-response matrix of a conservative classical system in a canonical ensemble. The equations of motion are taken as $\dot{x}_n = X_n$, where the X's, as well as the energy E, are functions of the x's but not of their time derivatives. The Liouville equation $\Sigma \partial \dot{x}_n / \partial x_n = 0$ is assumed, but it is not required that the equations of motion be derivable for a Hamiltonian. If they are, the x's are the canonical coordinates and momenta. The result found in $g_{mn}(\tau) = \Phi_{mn}(\tau)/kT$, ($\tau \geq 0$), where $\epsilon g_{mn}(\tau)$ is the average increment in x_m at t resulting from an infinitesimal increment ϵ externally induced in x_n at time $t-\tau$, $\Phi_{mn}(\tau)$ is the covariance $\langle x_m(t)(\partial E/\partial x_n)' \rangle$, where the prime denotes argument $t-\tau$, k and T are Boltzmann's constant and absolute temperature. This relation is derived as a direct consequence of the fact that 2 initially isolated systems in equilibrium at identical temperatures remain in equilibrium when weakly coupled to each other. (Contractor's abstract)

1358

New York U. Inst. of Mathematical Sciences, N. Y.

CONDENSATION OF AN IMPERFECT BOSON GAS, by R. H. Kraichnan. [1959] [3]p. (AF 49(638)341)　　　　Unclassified

Published in Phys. Fluids, v. 2: 463-465, July-Aug. 1959.

The nature of the Einstein-Bose condensation in an imperfect boson gas is discussed. It is argued that no matter how low the temperature, provided it is not zero, macroscopic second-sound waves should be weakly excited as thermal fluctuations about equilibrium. This implies that the single-particle momentum distribution must be smeared so that the state of zero momentum cannot contain a finite fraction of the particles. A microscopic mechanism which independently leads to a momentum spread is discussed. It is suggested that the actual Einstein-Bose condensation of an imperfect gas takes place in energy rather than momentum but that even in terms of this variable it becomes perfectly sharp only at zero temperature. This hypothesis is formulated analytically in terms of correlation functions of the second-quantized boson field. (Contractor's abstract)

1359

New York U. Inst. of Mathematical Sciences, N. Y.

AN IMPROVED PERTURBATION THEORY FOR SHOCK WAVES PROPAGATING THROUGH NON-UNIFORM REGIONS, by M. P. Friedman. [1959] [17]p. incl. diagrs. (AFOSR-TN-59-603) (AF 49(638)446) AD 250043　　　　Unclassified

Also published in Jour. Fluid Mech., v. 8: 193-209, June 1960.

The problem is considered of the propagation of a shock wave down a non-uniform tube. Linearized solutions to the problem do not hold when the velocity behind the shock is near or at the sonic speed. By retaining appropriate non-linear terms of the flow equations, a solution is obtained which holds for all conditions behind the shock, and reduces to the linearized solution for conditions away from sonic. The behavior of supersonic or subsonic flow entering regions of expanding or contracting area changes is discussed. Subsidiary shocks may be formed; these can be located and described using the present solution. Explicit solutions are given for the cases of supersonic or subsonic flow entering a region of linearly expanding or contracting area. The point of shock formation as well as the path of the subsidiary shock is obtained for the case in which the area contracts. (Contractor's abstract)

1360

New York U. Inst. of Mathematical Sciences, N. Y.

MOTION OF A BORE OVER A SLOPING BEACH, by
H. B. Keller, D. A. Levine, and G. B. Whitham. [1959]
[39]p. incl. diagrs. tables. (AFOSR-TN-59-604)
(AF 49(638)446) AD 240786   Unclassified

Also published in Jour. Fluid Mech., v. 7: 302-316,
Feb. 1960.

The results of numerical calculations are presented for
the motion of a bore over a uniformly sloping beach.
The shallow water equations are solved in finite differ-
ence form, and a technique is developed for fitting in
the bore at each step. The results are compared with
the approximate formula given by Whitham (1958) and
close agreement is fo nd. The approximate theory is
considered further here; the main addition is a rigorous
proof that, within the shallow water theory, the height
of the bore always tends to zero at the shoreline. (Con-
tractor's abstract)

1361

New York U. [Physics Dept.] N. Y.

SUMMARY OF THE INVESTIGATION OF PERSISTENT
INTERNAL POLARIZATION, by [H. Kallman]. June 30,
1958, 15p. (AFOSR-TR-59-19) (AF 18(600)1004)
AD 211312   Unclassified

Persistent internal polarization (P.I.P.) is a new phe-
nomena. Before our first experiments, it was only
known that polarization fields occurred in photocon-
ductors, but neither their magnitude nor their per-
sistence has been realized. In the early experiments it
was established that P.I.P. is due to a displacement of
free charges and their freezing in after removal of ex-
citation. Many features of this phenomena were quali-
tatively determined. P.I.P. is a large macroscopic
effect since potentials larger than 1000 v can be stored
for long times and readily released thereafter. There-
fore, it was felt important to establish a quantitative
knowledge of the properties of this phenomena. This
has been done from a scientific viewpoint during the
last 4 yr.

Nobel Inst. for Neurophysiology, Stockholm (Sweden).
see Karolinska Inst. Nobel Inst.for Neurophysiology,
Stockholm (Sweden).

1362

North American Aviation, Inc. Rocketdyne Div..
Canoga Park, Calif.

THE MOTION AND SHATTERING OF BURNING AND
NONBURNING PROPELLANT DROPLETS, by E.

Rabin and R. [B.] Lawhead. Mar. 1959, 47p. incl. illus.
diagrs. tables, refs. (Rept. no. R-1503) (AFOSR-TN-
59-129) (AF 18(603)98) AD 210768; PB 140621
Unclassified

Studies have been conducted in a 1-in.-sq shock tube
to determine the effect of shock waves in the breaking
up of burning and non-burning liquid fuel droplets. Ex-
perimental data shows the existence of 2 main classes
of breakup; a bag-type and a shear-type occurs for both
burning and non-burning drops. The type of breakup
and the critical velocity required to cause breakup are
found to be significantly influenced by the duration of
the flow plateau following the shock front; however,
as yet, no generalized correlation has been established.
The critical velocity for burning drops was found to be
slightly lower than for non-burning drops of RP-1,
probably due to differences in surface tension. The
effect of test section pressure was examined briefly,
and it appears that the ratio of critical velocity varies
inversely as the $3/4$ power of the pressure ratios. Pos-
sible application to rocket combustion instability is
discussed. (Contractor's abstract)

1363

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

RESEARCH ON NITRIC ACID-SUPPORTED COMBUS-
TION, by G. Casaletto, G. Bauerle, and J. Colwell.
Final progress rept. Mar. 1959, 61p. incl. illus. diagrs.
tables, refs. (Rept. no. R-1157) (AFOSR-TR-59-1)
(AF 49(638)163) AD 208301; PB 143916   Unclassified

Details concerning an investigation of nitric acid flames
with methane, propane, hydrogen, and acetylene are pre-
sented. Flame stability limits, flame speeds, combus-
tion products and emission spectra were studied.
(Contractor's abstract)

1364

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

ACCELERATOR DESIGN TECHNIQUES FOR ION
THRUST DEVICES, by S. L. Eilenberg. Feb. 1959, 40p.
incl. diagrs. (Rept. no. R-1430) (AFOSR-TN-59-194)
(AF 49(638)344) AD 211471; PB 139229   Unclassified

The ion rocket engine can be divided, arbitrarily, into
2 major components: the power supply and the ion
thrust device. It is assumed that the power supply de-
livers the required voltage and current with a negligible
ripple factor for an unlimited period of time. This re-
port summarizes many of the problems associated with
the ion accelerating section of the ion thrust device.
Several methods for designing an ion accelerator are dis-
cussed, and a specific design calculation is performed.
A generalized description of a variety of ion accelerator
geometries is presented. (Contractor's abstract)

1365

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

INVESTIGATION OF DIRECT CONVERSION DEVICES
FOR APPLICATION TO ION PROPULSION, by A. L.
Huebner. May 1959, 40p. incl. diagrs. refs. (Rept. no.
R-1462) (AFOSR-TN-59-461) (AF 49(638)344)
AD 215266   Unclassified

The application of photovoltaic cells to ion propulsion
is discussed. The merit of the photovoltaic cell as a
propulsion device of extremely high reliability is ana-
lyzed. The theory of photovoltaic cells is developed
briefly, and the important parameters affecting the
operation of the cells are discussed, particularly with
respect to conversion efficiency, operating tempera-
ture, and specific weight.

1366

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

RADIATION ENVIRONMENT PROBLEM OF A NU-
CLEAR-POWERED ION ROCKET (Unclassified title),
by B. Kimura. June 1959, 37p. incl. diagrs. tables,
refs. (Rept. no. R-1496) (AFOSR-TN-59-594) (AF 49-
(638)344) AD 307801   Secret

A preliminary analysis of the effect of radiation on a
nuclear powered ion rocket is given. The expected ra-
diation intensities due to reactor radiation leakage and
reactor coolant activation are calculated. The conse-
quences of these intensities are to create (1) a severe
heating problem for materials located near the reactor,
and (2) radiation-induced damage problems. Data are
presented illustrating the severity of these problems.
Some idea of the required radiation shielding for pro-
tection of sensitive components located at different po-
sitions relative to the reactor and radiator is given.
(U) (Contractor's abstract)

1367

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

ION ROCKET STUDY PROGRAM (Unclassified title).
(n.a.) Final rept. [1959] 97p. incl. diagrs. tables, refs.
(AFOSR-TR-59-99) (AF 49(638)344)   Secret

1368

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

RECENT DEVELOPMENTS AND DESIGNS OF THE ION
ROCKET ENGINE, by R. H. Boden. [1959] [20]p. incl.

illus. diagrs. table. refs. (Sponsored jointly by Air
Force Office of Scientific Research under [AF 49(638)-
344] and WADC Aeronautical Research Labs.)
                                            Unclassified

Published in Proc. Tenth Internat'l. Astronaut. Con-
gress, London (Gt. Brit.) (Aug. 30-Sept. 5, 1959),
Vienna, Springer-Verlag, v. 1: 463-482, 1960.

A brief summary of the basic relationships governing
the operation of electrical propulsion systems is given.
Fundamental design parameters of ion rocket engines
are tabulated for both English and metric systems. The
cross-sectional area of the engine is estimated by con-
sidering a flat-plate electrode configuration and the
modifications imposed on this idealized situation by the
presence of an aperture through which ions are emitted.
The relationship of engine design, vehicle design, and
the mission results from the characteristic velocity re-
quired to accomplish the objective. Methods of mission
analysis are referenced, but not discussed in detail.
The maximum payload for a mission accomplished with
an electrically powered vehicle is estimated from the
data. The limiting thrust-to-weight ratio has been sum-
marized graphically for several types of vehicles in-
cluding ion, plasma, and chemical rockets and modern
aircraft. Comparative maximum payloads of chemical
and ion rockets are presented in terms of the mission
characteristic velocity. The experimental program and
techniques for verifying these analyses on a specific
type of ion rocket engine conceived at Rocketdyne are
presented.

1369

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

SECOND AFOSR CONTRACTORS MEETING ON ION
AND PLASMA PROPULSION, Canoga Park, Calif.,
July 8-9, 1959. [1959] 1v. (AFOSR-TN-59-770)
[AF 49(638)351] AD 241053   Unclassified

This report contains 28 abstracts of papers presented
at the meeting. The topics discussed include: (1) cesi-
um ion motor development; (2) analytical studies of ion
propulsion at Rocketdyne; (3) ion propulsion systems;
(4) positive ion surface emission; (5) advanced space
propulsion systems; (6) compact charge exchange ion-
ization; (7) investigation of a charged-colloid propul-
sion system; (8) heavy particle propulsion research;
(9) non-uniform R.F. field acceleration methods for
plasma rockets, (10) ions in rocket combustion prod-
ucts; (11) high pressure plasma production technique;
(12) properties of ions in flames; (13) low temperature
plasma jet as free radical source; (14) heat transfer
from an ionized gas to a gaseous coolant; (15) gasdy-
namics of plasmas; (16) basic studies in magnetohy-
drodynamics; (17) magnetohydrodynamic waves; (8)
heat transfer from high temperature gases using an
electric arc; (19) plasma propulsion with the electro-
magnetic pinch; (20) electromagnetically induced chem-
ical reactions; (21) power generation using a plasma as

the working fluid; (22) initial breakdown process of gaseous conductors; (23) research on high intensity ionic jets; (24) study of the acceleration and channeling of plasma by magnetic fields; (25) physical properties of high intensity arcs; (26) plasma propulsion; (27) pulsed plasma propulsion; and (28) electromagnetic acceleration of plasma.

1370

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

SUMMARY OF EXPERIMENTAL ION ROCKET PROGRAM FOR THE PERIOD MAY 1, 1958 TO APRIL 30, 1959, by A. T. Forrester and R. C. Speiser. May 1959, 28p. incl. illus. diagrs. (Rept. no. R-1763) (AFOSR-TN-59-878) (AF 49(638)351)   Unclassified

The purpose of this program is to gain an understanding of basic electrical propulsion principles, propellant properties, and ionization and acceleration techniques. Experimental studies were performed on contact ionization ion sources, ion acceleration, and ion beam neutralization. Small research-type devices were successfully operated in ion motor configurations to verify theoretical analysis and to integrate experimental tests on components. The report discusses 2 types of vacuum systems: a bell jar, and a small steel tank. The tank operation proved more versatile, and 2 working variations of the device were built and tested. Instrumentation, fabrication, and neutralization techniques are described, and future work is outlined. (Contractor's abstract)

1371

North American Aviation Inc. Rocketdyne Div., Canoga Park, Calif.

CESIUM ION MOTOR RESEARCH, by R. C. Speiser and C. R. Dulgeroff. [1959] [9]p. incl. illus. diagrs. (AFOSR TN-59-1336) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)351 and Wright Air Development Center under AF 33(616)5927) AD 240986   Unclassified

Also published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass., (O   1959), Boston, v. 1: 179-184, 1959. (AFOSR-63·,

The electrostatic acceleration of ions for the purpose of propulsion is discussed. Small scale experiments with cesium surface ionization devices operated as miniature ion motors are reported. These experiments cover many of the phenomena of significance to the development of practical size ion motors.

1372

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

THE ION ROCKET ENGINE, by R. H. Boden. [1959] [11]p. incl. diagrs. [AF 49(638)351]   Unclassified

Presented at SAE Nat'l. Aeronautic Meeting, New York, Apr. 9, 1958.

Published in SAE Trans., v. 67: 227-237, 1959.

The significant design parameters of an ion-propellant rocket engine are developed in terms of 3 independent parameters. These are: the ratio of the acceleration voltage to atomic or molecular weight of the propellant, gross weight of the vehicle, and thrust-to-weight ratio. Engineering trends are presented which will lead toward advanced study of ion thrust chambers, power generation systems, and propellants. (Contractor's abstract)

1373

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

ION ROCKET ENGINE SYSTEMS - A SUMMARY, by R. H. Boden. [1959] [20]p. incl diagrs. tables. (AF 49(638)351)   Unclassified

Published in Aero/Space Engineering, v. 18: 67-71, Apr. 1959.

The concept of the ion rocket engine which has evolved at Rocketdyne, is 1 of a system which includes 3 major sub-systems - the energy source, the power converter, and the ion thrust chamber. One concept of an ion rocket engine system (electrostatic engine) is summarized. The heart of its thrust producing system is the thrust chamber, which includes an ion source, an array of electrodes to focus and accelerate them, and an electron emitter. This concept, it is believed, will result in an engine of minimum weight and simplicity. Many other concepts which include heat sources other than nuclear, direct power conversion systems, thrust chambers with electromagnetic accelerators in which crossed electromagnetic fields apply the forces to accelerate the ions and electrons, etc., have been conceived and proposed. But after evaluation of design and performance problems associated with these concepts, the most favorable system for development within the next few years appears to be the electrostatic engine. An extensive examination is presented of the 4 major problem areas of the ion rocket engine: (1) the heat source, (2) the power conversion system, (3) the ion thrust chamber, and (4) the propellants.

1374

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

CESIUM ION MOTOR DEVELOPMENT (Abstract), by
A. T. Forrester, R. C. Speiser, and D. J. Kerrisk.
[1959] [1]p. (Bound with its AFOSR-TN-59-770;
AD 241053) (AF 49(638)351)   Unclassified

Presented at Second AFOSR Contractors meeting on
Ion and Plasma Propulsion, North American Aviation,
Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9,
1959.

In a cesium ion motor the cesium must be transmitted
through a porous aggregate of a material with appropri-
ate physical properties. Some attempts have been made
to use nickel and graphite in this application, but neither
proved as satisfactory as tungsten. With a porous tung-
sten ionizer current densities of 30 ma/cm^2 were ob-
tained from a surface approx 3/16" in diam at an ionizer
temperature of approx 1500°K. The beam current is
measured to a collector approx 1 ft away from the ion
source and current measurements are supplemented by
2 other measurements on the beam. The beam power is
measured calorimetrically and the thrust is measured
as the steady state displacement of a collector mounted
as a pendulum. Oscillations in the beam current have
been observed at frequencies of approx 100 kc. Neutral-
ization of the ion beam was accomplished by a thermi-
onic electron emitter placed very close to the exit aper-
ture of the ion source. It was observed that the cur-
rent reaching the collector dropped to 0 when the ther-
mionic emitter was heated. At the same time the calor-
imetric collector indicated that the ion beam was un-
changed by the heating of the emitter. While there re-
main several important problems which have not yet
been attacked, e.g. neutral atom efflux and accelerating
electrode erosion, the ion motor continues to appear to
be very promising as a highly efficient propulsion de-
vice for space missions for which high specific im-
pulses are appropriate.

1375

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

ANALYTICAL STUDIES OF ION PROPULSION AT
ROCKETDYNE (Abstract). [1959] [2]p. (Bound with its
AFOSR-TN-59-770; AD 241053) (AF 49(638)649)
                                     Unclassified

Presented at Second AFOSR Contractors meeting on
Ion and Plasma Propulsion, North American Aviation,
Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9,
1959.

Rocketdyne has been engaged in a formal study program
on ion rocket engines under Air Force support since
February 1957. Analytical investigations are currently
being carried out in the areas of power sources, power

converters, electrical generators, ion accelerating
electrode design and mission analysis. In order to study
the influence of electrode geometry on such factors as
the space charge current limitation, sputtering, beam
focusing and beam spreading, an electrolytic tank was
designed and constructed. The tank is modified to simu-
late space charge and uses an analog computer to furnish
ion and electron trajectories. A comprehensive study of
the flight mechanics of low thrust devices in strong grav-
itational fields has recently been completed. Numerous
space flights have been simulated on an IBM-704 com-
puter using an 8-body, 3-dimensional precision integra-
tion program. Work is also being conducted to develop
analytical expressions for low thrust trajectories. A
generalized parametric study of mission analyses has
resulted in the evaluation of a technique whereby, given
a mission and a payload, a relationship may be derived
relating the significant mission parameters to each other.
System components evaluations and turboelectric cycle
studies are being made.

1376

North Carolina U. [Dept. of Chemistry] Chapel Hill.

SELECTIVE POTENTIOMETRIC TITRATION OF MET-
AL IONS WITH TRIETHYLENETETRAMINE, by C. N.
Reilley and M. V. Sheldon. Feb. 1959 [19]p. incl. diagrs.
tables, refs. (Rept. no. UNC-Chem no. 21-CNR)
(AFOSR-TN-59-170) (AF 18(600)1160) AD 211040
                                     Unclassified

Presented at Fifteenth Cong. of the Internat'l. Union
of Pure and Appl. Chem., Lisbon (Portugal), 1956.

Also published in Talanta, v. 1: 127-137, July 1958.

See item no. NCU.01:020, Vol. II for abstract.

1377

North Carolina U. [Dept. of Chemistry] Chapel Hill.

TETRAETHYLENEPENTAMINE, 'TETREN,' A SELEC-
TIVE TITRANT FOR METAL IONS, by C. N. Reilley
and A. Vavoulis. Feb. 1959 [19]p. incl. diagrs. tables,
refs. (Rept. no. UNC-Chem. no. 20-CNR) (AFOSR-
TN-59-171) (AF 18(600)1160) AD 211104
                                     Unclassified

Also published in Anal. Chem., v. 31: 243-248, Feb.
1959.

Theoretical and practical considerations demonstrate
that tetraethylenepentamine, as a selective titrant for
metal ions, is superior to triethylenetetramine. The
extent of reaction of tetraethylenepentamine with Hg,
Cu, Ni, Zn, and Cd is discussed quantitatively in rela-
tion to the effect of pH, complex formation, and hydro-
lysis. Potential-pH diagrams obtained using a Hg
electrode offer a simple means of predicting desirable
titration conditions and for detecting the relative

effect of the various competitive equilibria involved. Titrations of Hg, Cu, Ni, Zn, and Cd alone and in various mixtures were effected using the Hg electrode for potentiometric end point detection. The alkaline earths, rare earths, Al, Bi, Pb, and Sc do not interfere. Hg and Cu can be titrated at low pH in the presence of Ni, Zn, or Cd. In combination with EDTA, a large number of metal ions in multicomponent mixtures may be readily estimated. (Contractor's abstract)

1378

North Carolina U. [Dept. of Chemistry] Chapel Hill.

NEW CHELONS BASED ON PYRIDINE, by D. C. Priest, F. S. Sadek and others. Feb. 1959 [5]p. incl. diagr. (Rept. no.UNC-Chem. no. 22-CNR) (AFOSR-TN-59-172) (AF 18(600)1160) AD 211112   Unclassified

Also published in Talanta, v. 2: 275-277, 1959.

Recently the proposal of new chelons (other than the classical EDTA) has permitted many selective titrations. Thus, for example, the polyamines permit selective titrations of the latter transition metals and EGTA (the titration of Ca in the presence of Mg). Another class, derivatives of 2-aminoethyl pyridine-N-N-diacetic acid (PADA) have been synthesized, and the results of the 6-methyl derivative are described in this study. Unlike EDTA, the 6-methyl PADA does not form stable complexes with the alkaline earths and rare earths, that is otherwise similar. Unlike the polyamines, the 6-methyl PADA reacts with Pb and Bi in acid solution. (Contractor's abstract)

1379

North Carolina U. Dept. of Chemistry. Chapel Hill.

ELECTRICAL METHODS OF ANALYSIS, by C. N. Reilley. Final rept. June 1, 1954-June 30, 1958. Aug. 29, 1959, 8p. incl. refs. (AFOSR-TR-59-128) (AF 18-(600)1160) AD 227954; PB 144349   Unclassified

A summary is presented of the 4 years of research under this contract in which important progress was made toward understanding of the mechanism of electrode processes and a number of electrochemical methods -- especially those involving chelate reactions -- were developed. Also, several new procedures of analytical value have been discovered. Some of the more important achievements of this research are the following: (1) Proof of the general equation of chronopotentiometry. (2) Recognition of ion pairs as important factors governing reactivity at electrode surfaces. (3) Development of a new principle (via the mercury electrode) for the determination of metal-chelon stability constants. (4) Recognition of the enormous importance of adsorption of surfactants in determining the rates of chemical reactions at electrodes, especially the rates of dissociating metal-complexes. Also important was the recognition of the numerous factors giving rise to

these effects. (5) Development of new high precision colorimetric methods and new methods of indirect spectrophotometry. (6) Discovery of the value of chelons other than EDTA as reagents in analytical chemistry (especially the polyamines and EGTA); also the development of the new indicator "calcon" - now widely used in the U. S. and in Europe. In addition to these major developments, a great deal of solid progress was made in the description of various reactions and in the accumulation of significant data.

1380

North Carolina U. Dept. of Chemistry, Chapel Hill.

METAL CHELATE STABILITY CONSTANTS OF AMINOPOLYCARBOXYLATE LIGANDS, by J. H. Holloway and C. N. Reilley. Sept. 11, 1959 [28]p. incl. diagrs. tables, refs. (Rept. no. UNC-Chem. no. 2-CNR) (AFOSR-TN-59-748) (AF 49(638)333) AD 226874; PB 144499   Unclassified

Also published in Anal. Chem., v. 32: 249-256, Feb. 1960

The stability constants for the reaction between a series of divalent metal ions with cyclohexanediaminetetraacetic acid (CyDTA), diethylenetriaminepentaacetic acid (DTPA), ethyleneglycol bis-(β-aminoethyl ether)-N,N'-tetraacetic acid (EGTA), ethyletherdiaminetetraacetic acid (EEDTA), and N-hydroxethylethylenediaminetriacetic acid (HEDTA) were determined potentiometrically with a mercury electrode. The stability constants for the reaction between lanthanum and diethylenetriaminepentaacetic acid was also determined by the same method. The reported log K values were obtained at 25.00 ± 0.02°C. and at an ionic strength of 0.10. (Contractor's abstract)

1381

North Carolina U. Dept. of Chemistry, Chapel Hill.

THE CHELON APPROACH TO ANALYSIS, by C. N. Reilley, R. W. Schmid, and F. S. Sadek. Aug. 29, 1959, 54p. incl. diagrs. tables, refs. (Rept. no. UNC-Chem. no. 1-CNR) (AFOSR-TN-59-896) (AF 49(638)333) AD 227955; PB 144879   Unclassified

Also published in Jour. Chem. Education, v. 36: 555-564, Nov. 1959; v. 36: 619-626, Dec. 1959.

The stability constants for the reaction between a series of divalent metal ions with cyclohexanediamine-tetraacetic acid (CyDTA), diethylenetriaminepentaacetic acid (DTPA), ethyleneglycol bis-(β-aminoethyl ether)-N,N'-tetraacetic acid (EGTA), ethyletherdiaminetetraacetic acid (EEDTA), and N-hydroxethylethylenediaminetriacetic acid (HEDTA) have been determined potentiometrically with a mercury electrode. The stability constants for the reaction between lanthanum and diethylenetriaminepentaacetic acid have also been determined by the same method. The complexes studied were

those of $Hg\text{-}CyDTA^{-2}$ (log K = 24.4), $Ni\text{-}CyDTA^{-2}$ (19.4), $Zn\text{-}CyDTA^{-2}$ (18.6), $Ca\text{-}CyDTA^{-2}$ (12.3), $Sr\text{-}CyDTA^{-2}$ 10.0), $Hg\text{-}DTPA^{-3}$ (27.0), $Zn\text{-}DTPA^{-3}$ (18.8), $Cd\text{-}DTPA^{-3}$ (19.0), $Mn\text{-}DTPA^{-3}$ (15.5), $Pb\text{-}DTPA^{-3}$ (18.6), $Ca\text{-}DTPA^{-3}$ (10.7), $La\text{-}DTPA^{-2}$ (19.1), $Hg\text{-}EGTA^{-2}$ (23.8), $Cu\text{-}EGTA^{-2}$ (17.8), $Ni\text{-}EGTA^{-2}$ (13.6), $Co\text{-}EGTA^{-2}$ (12.3), $Zn\text{-}EGTA^{-2}$ (14.5), $Cd\text{-}EGTA^{-2}$ (16.7), $Mn\text{-}EGTA^{-2}$ (12.3), $Pb\text{-}EGTA^{-2}$ (14.6), $Ca\text{-}EGTA^{-2}$ (10.9), $Hg\text{-}EEDTA^{-2}$ (23.1), $Ni\text{-}EEDTA^{-2}$ (14.7), $Co\text{-}EEDTA^{-2}$ 14.7) $Zn\text{-}EEDTA^{-2}$ (15.3), $Pb\text{-}EEDTA^{-2}$ (14.4), $Sr\text{-}EEDTA^{-2}$ (8.6), $Hg\text{-}HEDTA^{-1}$ (20.1), $Zn\text{-}HEDTA^{-1}$ (14.5), $Pb\text{-}HEDTA^{-1}$ (15.5), $Mg\text{-}HEDTA^{-1}$ (7.0), $Sr\text{-}HEDTA^{-1}$ (6.8), $Ba\text{-}HEDTA^{-1}$ (6.2). The reported log K values were obtained at $25.00 \pm 0.02°C$ and at an ionic strength of 0.10.

1382

North Carolina U. Dept. of Chemistry, Chapel Hill.

ADSORPTION IN POLAROGRAPHY, by C. N. Reilley and W. Stumm. Oct. 19, 1959 [42]p. incl. diagrs. (Rept. no. UNC-Chem. no. 3-CNR) (AFOSR-TN-59-113) (AF 49(638)333) AD 228463; PB 144383   Unclassified

Surface active substances, even in trace quantities, can exert a marked and often insidious effect on electrode processes. In polarography, adsorption of such substances at the electrode may decrease the limiting current, shift the half wave potential and in some cases obliterate the entire wave. In addition, they can cause minima or deceiving split waves. The characterization of the mode by which these effects arise and how one may detect their origin constitutes the purpose of this discussion. (Contractor's abstract)

1383

North Carolina U. [Dept. of Mathematics] Chapel Hill.

ON THE GREATEST DISTANCE BETWEEN TWO CHARACTERISTIC ROOTS OF A MATRIX, by A. Brauer and A. C. Mewborn. Apr. 1959, 14p. (Technical rept. no. 11) (AFOSR-TN-59-29) (AF 18(603)38) AD 208874; PB 142598   Unclassified

Also published in Duke Math. Jour., v. 26: 653-661, Dec. 1959.

Results for obtaining upper and lower bounds for the greatest distance between 2 characteristic roots of matrices with only real roots and normal matrices are improved and extended to arbitrary matrices. Let $A = (a_{ij})$ be a square matrix of order n with only real roots. Let $f(x) = x^n - c_1 x^{n-1} \dots + (-1)^n c_n = 0$ be its

characteristic equation and $\omega_1 \geq \omega_2 \geq \dots \geq \omega_r$ its characteristic roots. Let K_2 be defined by $K_2 = \{2(1-1/n)c_1^2 - 4c_2\}^{\frac{1}{2}}$. Then, for n even, $K_2 \geq Max / \omega_i - \omega_j \mid \geq (2/n)^{\frac{1}{2}} K_2$; and, for n odd, $K_2 \geq Max \mid \omega_i - \omega_j \mid \geq \{2n/(n^2-1)\}^{\frac{1}{2}} K_2$.

1384

North Carolina U. Dept. of Mathematics, Chapel Hill.

ON STOCHASTIC MATRICES WITH A NON-TRIVIAL GREATEST POSITIVE ROOT, by A. Brauer. Nov. 1959, 8p. (Technical rept. no. 12) (AFOSR-TN-59-933) (AF 18(603)38) AD 237483; PB 148024   Unclassified

Also published in Duke Math. Jour., v. 27: 291-295, Sept. 1960.

The greatest positive characteristic root of an unreduced stochastic matrix A is the trivial root 1. A study is presented of the matrices A which have a non-trivial greatest positive root which is less than the trivial root 1, but greater than or equal to the absolute value of all the other characteristic roots. (Contractor's abstract)

1385

North Carolina U. Dept. of Physics, Chapel Hill.

COVARIANT COMMUTATORS FOR THE QUANTIZED GRAVITATIONAL FIELD, by B. S. DeWitt. Oct. 1959, 7p. (Publication no. 4) (AFOSR-TN-59-1080) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)563 and Institute of Field Physics) AD 226875; PB 144487   Unclassified

The derivation of covariant commutators for the quantized gravitational field provides an important application of the theory of bi-tensor Green's functions. Because of the coordinate invariance of general relativity, well defined commutators can be obtained only if (1) some form of invariant coordinates are introduced, and (2) an explicit expression (can be used to define an arbitrary external source) is found. The 2 requirements are shown to be related.

1386

North Carolina U. [Inst. of Statistics, Chapel Hill].

COMPLEX REPRESENTATION IN THE CONSTRUCTION OF ROTATABLE DESIGNS, by R. C. Bose and R. L. Carter. [1959] [10]p. (AF 18(600)83)
                                               Unclassified

Published in Ann. Math. Stat., v. 30: 771-780, Sept. 1959.

Response surface techniques are discussed as a generalization of factorial designs, emphasizing the concept of rotatability. It is shown that the necessary and sufficient conditions for a configuration of sample points to be a rotatable arrangement of a specified order are greatly simplified if, in the case of 2 factors, the factor space is considered as the complex plane. A theorem giving these conditions is proved, with an application to the conditions governing the combination of circular rotatable arrangements into configurations possessing a higher order of rotatability. This is done by showing that certain coefficients must vanish in the "design equation" whose roots are the (complex) values of the various sample points. A method is presented by which any configuration of sample points (for example, some configuration fixed by extra-statistical conditions) may be completed into a rotatable design of the first order by the addition of only 2 properly chosen further sample points. (Contractor's abstract)

1387

North Carolina U. [Inst. of Statistics] Chapel Hill.

SECOND ORDER ROTATABLE DESIGNS IN THREE DIMENSIONS, by R. C. Bose and N. R. Draper. [1959] [16]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)83 and Office of Naval Research)   Unclassified

Published in Ann. Math. Stat., v. 30: 1097-1112, Dec. 1959.

The technique of fitting a response surface is one widely used (especially in the chemical industry) to aid in the statistical analysis of experimental work in which the "yield" of a product depends, in some unknown fashion, on 1 or more controllable variables. Before the details of such an analysis can be carried out, experiments must be performed at predetermined levels of the controllable factors, i.e., an experimental design must be selected prior to experimentation. Methods were needed which would provide both 2nd and 3rd order designs in 3 and more factors. The present work represents an attempt to meet, in part, this need. New construction methods for obtaining rotatable designs of second order in 3 dimensions are here presented. By use of these methods various infinite classes of designs are obtained, and it may be shown that all the rotatable designs previously known can be derived as special cases of these infinite classes. Also derived is an infinite class of 2nd order rotatable designs which contain only 16 points; only 2 particular designs contain fewer points. (Contractor's abstract)

1388

[North Carolina U. Inst. of Statistics, Chapel Hill.]

ASYMPTOTICALLY EFFICIENT TESTS BASED ON THE SUMS OF OBSERVATIONS, by J. H. MacKay. [1959] [8]p. incl. diagrs. [AF 18(600)458]   Unclassified

Published in Ann. Math. Stat., v. 30: 806-813, Sept. 1959.

For tests, $\Phi = \{\Phi_k\}$, of composite hypotheses, ω_1 and ω_2 asymptotic efficiency is defined in terms of the behavior as $\alpha \to 0$ of the sample size N_φ required to reduce the maximum risk to α. For problems where the ω_i contain elements θ_i whose densities satisfy

$$\sup_{\omega_1} \inf_{t>0} E_\theta(f_2/f_1)^t = \inf_t E_i(f_2/f_1)^t = \sup_{\omega_2} \inf_{t<0} E_\theta(f_2/f_1)^t,$$

Chernoff's Theorem 1 is applied to the non-randomized test Φ^*, with $\omega_k^* = 1$ or 0 according as $\Sigma \log (f_2/f_1) > 0$ or not and proves Φ^* asymptotically efficient. The principal results of the paper are applications of a Theorem to tests of the difference $(\xi - \eta)$ of binomial probabilities with samples of relative size m/n. For $\omega_1 = \{\xi - \eta \leq -\delta\}$, $\omega_2 = \{\xi - \eta \geq \delta\}$, certain tests of the form $\Phi_k^* = 1$ if and only if $\lambda(\xi - \frac{1}{2}) > (\hat{\eta} - \frac{1}{2})$, with λ increasing in m/n, turn out to be asymptotically efficient, while all tests of the form $\psi_k = 1$, a_k, 0 according as $(\hat{\xi} - \hat{\eta})$ is greater than, equal to, or less than c_k are asymptotically inefficient when $m \neq n$. For given relative sampling costs, the ratio m/n may be chosen so that the asymptotic cost of observations is minimized. (Contractor's abstract)

1389

North Carolina U. Inst. of Statistics, Chapel Hill.

MULTI-DIMENSIONAL INCOMPLETE BLOCK DESIGNS, by S. N. Roy and R. F. Potthoff. Nov. 1958, 257p. incl. refs. (Mimeograph series no. 211) (AFOSR-TN-59-68) (AF 49(638)213) AD 209843; PB 140622   Unclassified

The following topics are discussed in detail: analysis of multi-dimensional incomplete block (MDIB) designs for models with no interaction terms; analysis of MDIB designs for models with interaction terms; some examples of MDIB designs and methods of constructing them; and some extensions of the theory of MDIB designs.

1390

North Carolina U. Inst. of Statistics, Chapel Hill.

A NOTE ON J. ROY'S "STEP-DOWN PROCEDURE IN MULTIVARIATE ANALYSIS," by V. P. Bhapkar. Dec. 1958, 7p. (Mimeograph series no. 212) (AFOSR-TN-59-69) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)213 and Office of Naval Research under Nonr-85506) AD 209844; PB 140544
Unclassified

The step-down procedure is applied to the multiple independence of normal variates under a general linear model. This procedure was applied to multivariate analysis of variance by Roy in deriving new tests of significance and simultaneous confidence-bounds on a number of deviation-parameters.

1391

North Carolina U. Inst. of Statistics, Chapel Hill.

SOME NONPARAMETRIC ANALOGUES OF "NORMAL" ANOVA, MANOVA, AND OF STUDIES IN "NORMAL" ASSOCIATION, by S. N. Roy and V. P. Bhapkar. Jan. 1959, 33p. (Mimeograph series no. 215) (AFOSR-TN-59-70) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)213 and Office of Naval Research under Nonr-85506) AD 209845
Unclassified

Also published in Contributions to Probability and Statistics, Stanford, Stanford U. Press, 1960, p. 371-387.

Hypotheses are proposed which are generalizations appropriate to the set-up of the usual hypotheses in classical normal univariate fixed effects analysis of variance (ANOVA), normal multivariate fixed effects analysis of variance (MANOVA), and in analysis of various kinds of normal indepen4vce. Sample tests are offered for such hypotheses. For each (kind of) response or factor, a distinction is made between the structure and the unstructured case, but even for structured factors, the pre-Box treatment is given which avoids the realistic problem of exploring the nature of the dependence of response on the structured factor or factors. Point estimation and confidence bounds on meaningful parametric functions are not discussed separately, nor are the general decision procedures (e.g., ranking, choosing the best, etc.) discussed.

1392

North Carolina U. Inst. of Statistics, Chapel Hill.

A NOTE ON CONFIDENCE BOUNDS CONNECTED WITH ANOVA AND MANOVA FOR BALANCED AND PARTIALLY BALANCED INCOMPLETE BLOCK DESIGNS, by V. P. Bhapkar. Jan. 1959, 12p. (Mimeograph series no. 216) (AFOSR-TN-59-88) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)213 and Office of Naval Research under Nonr-85506) AD 210088; PB 140546 Unclassified

Explicit algebraic expressions are obtained for the total and partial parametric functions that go with the simultaneous confidence statements in the case of both ANOVA and MANOVA and for balanced and partially balanced designs. How to obtain the algebraic expression in a convenient form is considered for the confidence bounds on each such parametric function, without a derivation of these expressions in an explicit form. (Contractor's abstract)

1393

North Carolina U. Inst. of Statistics, Chapel Hill.

A NOTE ON A RESULT IN THE THEORY OF CODE CONSTRUCTION, by R. C. Bose and S. S. Shrikhande. Jan. 1959, 16p. incl. refs. (Mimeograph series no. 217) (AFOSR-TN-59-213) (AF 49(638)213) AD 211772; PB 140418 Unclassified

Also published in Inform. and Control, v. 2: 183-194, June 1959.

A connection is established between Hadamard matrices and a problem in the theory of code construction. A square matrix H of order h is called Hadamard matrix H_h, if all its elements are $+1$ or -1 and if any 2 rows (columns) of H are orthogonal. A theorem is proved asserting the co-existence of the maximal codes M(4t, 2t; 8t), M(4t-1, 2t; 4t), where t is any positive integer; the balanced incomplete block design with parameters $v = b = 4t-1$, $r = k = 2t-1$, $\gamma = t-1$; and the Hadamard matrix H_{4t} of order 4t. The results known up to date are stated regarding the existence of Hadamard matrices and the corresponding balanced incomplete block designs. The structure is studied of the maximal codes M(4t-2, 2t; 2t), M(4t-1, 2t; 4t), and M(4t, 2t; 8t). (ASTIA abstract)

1394

North Carolina U. Inst. of Statistics, Chapel Hill.

CONTRIBUTIONS TO UNIVARIATE OR MULTIVARIATE ANALYSIS OF VARIANCE WITH FIXED EFFECTS, NORMAL OR NONNORMAL RANDOM EFFECTS, AND NORMAL ERROR, by S. N. Roy and W. Cobb. Jan. 1959, 133p. incl. diagr. refs. (Mimeograph series no. 214) (AFOSR-TN-59-217) (AF 49(638)213) AD 211779; PB 140355 Unclassified

The theory of variance components analysis is extended to include univariate models with nonnormal random components and multivariate models with fixed, normal, or nonnormal random components. In the multivariate model, confidence bounds are obtained on some functions (characteristic roots) of the variance matrices when the block effects are normal, but without the restriction that the variance matrices of these block effects are proportional to the variance matrix of the normal error. An investigation is made to remove from the model (univariate or multivariate) the stipulation that the random components are normally distributed and still obtain confidence bounds on some measure of the dispersion of these random components, e.g., the interquartile difference if not the variance. The study aims to remove from the model, restrictive assumptions, including its designation as an ANOVA (analysis of variance) model or a variance components model. For each unobservable of the model, a statistic is obtained which can be used in the analysis of variance,

or in components of va iance analysis, regardless of whether other unobservables of the model are fixed or random. (ASTIA abstract)

1395

North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE FALSITY OF EULER'S CONJECTURE ABOUT THE NON-EXISTENCE OF TWO ORTHOGONAL LATIN SQUARES OF ORDER 4t+2, by R. C. Bose and S. S. Shrikhande. Preliminary rept. Mar. 1959 [6]p. incl. tables. (Mimeograph series no. 220) (AFOSR-TN-59-277) (AF 49(638)213) AD 212711; PB 140629 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 734-737, May 1959.

A general theorem is proved on the existence of pairwise orthogonal Latin squares (p. o. l. s.) of a given order. A counter example is given to Euler's conjecture that there do not exist 2 p. o. l. s. of order 4t+2. (Contractor's abstract)

1396

North Carolina U. Inst. of Statistics, Chapel Hill.

A NOTE ON TESTING VARIOUS KINDS OF ASSOCIATION UNDER A MULTIVARIATE NORMAL LINEAR MODEL, by S. N. Roy. Mar. 1959, 5p. (Mimeograph series no. 221) (AFOSR-TN-59-384) (AF 49(638)213) AD 214191 Unclassified

Assume the following model: $\frac{X}{p \times m} = \frac{\xi}{p \times m} \frac{A}{m \times n} + \frac{\epsilon}{p \times n}$,

where $\frac{\epsilon}{p \times n} = \left[\epsilon_1, \epsilon_2 \cdots, \epsilon_n\right]$, the ϵ_i's (i = 1,2,...,n) are

supposed to be a set of n independent p-dimensional

stochastic vectors, each being $N\left[\frac{0}{p \times 1}, \frac{\Sigma}{p \times p}\right]$, $\underline{A}$ is the

structure matrix determined from the design of the experiment and the model, and $\underline{\xi}$ at this stage is assumed to be a set of unknown parameters associated with fixed effects. Assume, without any loss of generality, that rank $\left[\underline{A}\right] = r \leq m < n-p$. Under this model, procedures are set up for testing various types of hypothesis on Σ that one poses and tests under a model

in which $\frac{X}{p \times n}$ is supposed to be a set of n independent

and identically distributed stochastic p-vectors, each

being an $N\left[\frac{\xi}{p \times 1}, \frac{\Sigma}{p \times p}\right]$. (Contractor's abstract)

1397

North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE CONSTRUCTION OF SETS OF PAIRWISE OR-

THOGONAL LATIN SQUARES AND THE FALSITY OF A CONJECTURE OF EULER, by R. C. Bose and S. S. Shrikhande. Apr. 1959, 31p. incl. diagrs. refs. (Mimeograph series no. 222) (AFOSR-TN-59-401) (AF 49-(638)213) AD 214521; PB 142723 Unclassified

Also published in Trans. Amer. Math. Soc., v. 95: 191-225, May 1960.

Methods are generalized for constructing pairwise orthogonal Latin squares (p.o.l.s.) by showing that a general class of designs, called pairwise balanced designs of index unity, can be used for the construction of sets of p.o.l.s. Various applications of this method are made. Euler's conjecture, the non-existence of 2 orthogonal Latin squares of order v when v = 2 (mod 4), is shown to be false for an infinity of values of v, including all values of the form 36 m + 22. A table is given for all values of v ≤ 150, for which the method shows that N(v) > n(v); N(v) being the max possible number of Latin squares of order v and n(v) the max possible number of p.o.l.s. The smallest number which demonstrates the falsity of Euler's conjecture is 22. The appendix contains 2 orthogonal squares of order 22 constructed by this method.

1398

North Carolina U. Inst. of Statistics, Chapel Fill.

ON THE CONSTRUCTION OF PAIRWISE ORTHOGONAL SETS OF LATIN SQUARES AND THE FALSITY OF A CONJECTURE OF EULER, II, by R. C. Bose and S. S. Shrikhande. May 1959, 13p. incl. table. (Mimeograph series no. 225) (AFOSR-TN-59-518) (AF 49(638)213) AD 216239; PB 143028 Unclassified

The study is continued on the construction of pairwise orthogonal sets of Latin squares and the falsity of a conjecture of Euler previously reported (item no. 1397 Vol. III). Under satisfying conditions, the proof of the theorem on the existence of a pairwise balanced design of index unity is augmented. Improvements on the lower bounds for (N(v) are obtained. A demonstration shows that at least 2 orthogonal Latin squares of order v exist for v > 6 except for v = 14 and 26.

1399

North Carolina U. Inst. of Statistics, Chapel Hill.

INCOMPLETE BLOCK DESIGNS IN WHICH THE NUMBER OF REPLICATES IS NOT THE SAME FOR ALL TREATMENTS, by L. C. A. Corsten. May 1959, 20p. incl. tables. (Mimeograph series no. 226) (AFOSR-TN-59-580) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)213, Institute for Research on Varieties of Field Crops in the Netherlands, and Netherlands Organization for Pure Research) AD 217027 Unclassified

Construction is considered of incomplete block designs

in which the treatments have not all the same number of replicates, but which still have a certain degree of symmetry, usually indicated with the term balance. Considered are the case in which the treatments have either r_1 or r_2 replicates $(r_1 < r_2)$, which are called rare and frequent treatments respectively. (Contractor's abstract)

1400

North Carolina U. Inst. of Statistics, Chapel Hill.

CONTRIBUTIONS TO THE STATISTICAL ANALYSIS OF EXPERIMENTS WITH ONE OR MORE RESPONSES (NOT NECESSARILY NORMAL), by V. P. Bhapkar. July 1959, 123p. incl. refs. (Mimeograph series no. 229) (AFOSR-TN-59-795) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)213 and Office of Naval Research under Nonr-85506) AD 219882
Unclassified

Experimental data are considered which are given in the form of frequencies in cells determined by a finitely multi-way cross-classification, with predefined categories, finite in number, along each way of classification. Hypotheses are imposed which are considered to be generalizations appropriated in (1) classical normal univariate fixed effects analysis of variance (ANOVA), (2) normal multivariate fixed effects analysis of variance (MANOVA), and (3) analysis of various kinds of normal independence. Sample tests are given for these hypotheses. Two theorems on minimum χ_1^2 are proved, and the univariate 2-factor problems are studied. The 2-way classification test is extended to cover incomplete block situations. An extension of the U-statistics theorem is stated and proved, and a new test-criterion for the problem of c samples is given. Some regression problems and some bifariate problems in the non-parametric set-up are studied. Most of the test-criteria developed are asymptotic in nature. (ASTIA abstract)

1401

North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE APPLICATION OF THE GEOMETRY OF QUADRICS TO THE CONSTRUCTION OF PARTIALLY BALANCED INCOMPLETE BLOCK DESIGNS AND ERROR CORRECTING BINARY CODES, by D. K. Ray-Chaudhuri. June 1959, 125p. incl. diagrs. tables, refs. (Mimeograph series no. 230) (AFOSR-TN-59-796) (AF 49(638)213) AD 235092 Unclassified

A brief systematic treatment of the theory of quadrics in finite projective geometry is presented, and some new results in the theory of quadrics are derived. Several properties of the polar spaces are proved. The explicit formulas for the number of p-flats contained in nondegenerate quadrics in PG(n,s), the finite projective geometry of n dimensions based on a Galois field GF(s),

are obtained. The canonical forms for the elliptic and hyperbolic nondegenerate quadric and several properties of the nucleus of polarity of a nondegenerate quadric in PG(2k, 2^m) are given. A general method of constructing Partially Balanced Incomplete Block Designs is developed. Several new PBIB designs with r and k not greater than 10 are contained in 1 section. A theorem is proved about PBIB designs with 3 associate classes which gives a much less demanding definition of PBIB design with 3 associate classes. Two series of such designs are obtained. A set of points in PG(m,2) to be a R_t-set if no t points of the set lie in a (t-2)-flat. It is proved that there exists a t-error correcting binary (n,k)-group codes with n places and k information places if, and only if, $N_{2t}(n-k-1) \geq n$.

1402

North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE COMPOSITION OF BALANCED INCOMPLETE BLOCK DESIGNS, by R. C. Bose and S. S. Shrikhande. [1959] [12]p. [AFOSR-TN-59-940] (AF 49(638)213)
Unclassified

Also published in Canad. Jour. Math., v. 12: 177-188, 1960.

An orthogonal array (N, k, s, t) of size N, k constraints, s levels, strength t and index λ is a k x N matrix whose elements are taken from the integers 1,...,s such that every t rowed submatrix contains every t-plet exactly λ times as a column. The authors first derive by construction lower bounds on the number k of constraints if $t = 2$. The construction depends on the existence of another configuration termed pairwise balanced designs of index λ. The authors then confine a composition procedure for balanced incomplete block designs by which a BIB $(v_1 v_2, k, \lambda_1 \lambda_2)$ under certain conditions also a $(v_1(v_2 - 1) + 1, k, \lambda_1 \lambda_2)$ can be obtained from a (v_1, k, λ_1) and a (v_2, k, λ_2). Various refinements and modifications of this method are given by which resolvable designs and BIB designs with other specified properties can be obtained. Finally BIB designs with $k = 5$, $\lambda = 1$ and $k = 4$, $\lambda = 1$ are constructed when v satisfies certain arithmetical conditions. The results are very numerous and interesting. It is however impossible to cram into a review all the definitions needed for a precise formulation of the results. (Math. Rev. abstract)

1403

North Carolina U. Inst. of Statistics, Chapel Hill.

ON A CLASS OF ERROR CORRECTING BINARY GROUP CODES, by R. C. Bose and D. K. Ray-Chaudhuri. Sept. 1959, 14p. incl. tables. (Mimeograph series no. 240) (AFOSR-TN-59-1240) (AF 49(638)213) AD 235094
Unclassified

Also publtshed tn Inform. and Control, v. 3: 68-79, Mar. 1960.

A general method of constructing error correcttng binary group codes ts obtained. A btnary group code wtth k information places and n places is called an (n,k) code. Explicit methods of constructing t-error correcting (n,k) codes are given for n = 2^m-1 and k = 2^m-1-mt for general t. An example is worked out to illustrate the method of construction. (Contractor's abstract)

1404

North Carolina U. [Inst. of Statistics] Chapel Hill.

ORTHOGONAL LATIN SQUARES AND EULER'S CON-JECTURE, by R. C. Bose, S. S. Shrikhande, and E. T. Parker. [1959] 34p. incl. diagrs. tables, refs. [Mimeograph series no. 245] (AFOSR-TN-59-1241) (AF 49-(638)213) AD 235095   Unclasstfted

A Latin square of order n is defined as an nxn square, the n^2 cells of which are occupied by n distinct symbols such that each symbol occurs exactly once in each row and once in each column. Two Latin squares are said to be orthogonal tf, on superposition, each symbol of the 1st square occurs exactly once with each symbol of the 2nd square. Euler conjectured that there does not exist a pair of orthogonal Latin squares of order n = 4t + 2, for any postttve tnteger t. Successive steps are traced for which a complete solution of the problem of constructing a pair of orthogonal Latin squares of any order 4t + 2, t>1, was achieved. Counterexamples to Euler's conjecture are also given.

1405

North Carolina U. [Inst. of Statistics, Chapel Htll].

EQUALITY OF MORE THAN TWO VARIANCES AND OF MORE THAN TWO DISPERSION MATRICES AGAINST CERTAIN ALTERNATIVES, by R. Gnanadesikan. [1959] [8]p. [AF 49(638)213]   Unclassified

Publtshed tn Ann. Math. Stat., v. 30: 177-184, Mar. 1959.

In thts paper, using the heurtstic unicn-intersection principle, 2 tests are proposed, and the associated simultaneous confidence bounds on parametric tuncttons which are measures of a certain type of departure from the respective null hypotheses are obtained. The 1st test ts for the equality of (k + 1) variances (k ≥ 2) of (k + 1) univariate normal popu'ations, wherein one ot the vartances as a standard (of course, unknown), ts chosen and compared wtth the other k variances. The alternattve to the hypothests ts that not all the k variances are equal to the standard one. The proposed test may be called the simultaneous variance ratios test. The well-known Hartley's F_{max} test for the case of equal sample stzes is not equivalent to the present test

even when all samples are of the same size since the alternatives in the 2 cases are different. In the alternative in Hartley's test, aside from the inequality of the k variances to the standard one, the mutual inequality of the k variances also plays an important role. The 2nd test proposed in thts paper, ts a multivartate extension of the 1st. This paper also considers the distribution problems that arise in connection wtth both the tests. The nonavailabili ty of tables at the moment makes the immediate practical application of the tests and the associated confidence bounds not possible. (Contractor's abstract)

1406

North Carolina U. [Inst. of Statistics, Chapel Hill].

A SIMPLE MINIMUM-AVERAGE-RISK PROCEDURE FOR THE MULTIPLE COMPARISONS PROBLEM (Abstract), by D. B. Duncan. [1959] [2]p. (Sponsored jotntly by Air Force Office of Scientific Research under [AF 49(638)213] and Public Health Service)
                                        Unclassified

Presented at meeting of the Inst. of Math. Stat., Pittsburgh, Pa., Mar. 19-21, 1959.

Published in Ann. Math. Stat., v. 30: 621-622, June 1959.

Let $[y_1,...,y_n,s]$ be a sufficient estimator for $[\mu_1,...,\mu_n, \sigma]$ such that, to take a typical simple case, $[y_1,...,y_n]$ is normally distributed with mean $[\mu_1,...,\mu_n]$ and variance $I\sigma^2$, and s^2 is the usual form of independent estimate (with ν degrees of freedom) for σ^2. Let T represent the class of n(n − 1) differences $T = \{\tau : \tau = (\mu_j)/\sqrt{2}\sigma; i,j = 1,...,n; i \neq j\}$. The sub-set system of the multiple comparisons problem considered ts that formed as the restricted product of the 2-decision component-problem subset pairs $\tau > 0$, $\tau \lessgtr 0$ for all $\tau \in T$. A Bayes solution ts developed for each component problem. Their simultaneous application, all $\tau \in T$, ts shown to be the Bayes solution to the given multiple compartsons problem with respect to a loss function formed as the sum of the component loss functions and to a Bayes function having the component Bayes functtons at its margins. A table of t is used for each component solution, the test statistte now also being a function of the restdual variance among the y's and having $\nu + n − 2$ tnstead of ν degrees of freedom.

1407

North Carolina U. [Inst. of Statistics, Chapel Htll].

SOME CONTRIBUTIONS TO ANOVA IN ONE OR MORE DIMENSIONS: I, by S. N. Roy and R Gnanadesikan. [1959] [14]p. incl. refs. [AF 49(638)213] Unclassified

Two models are considered in detail which are the Models I and II of ANOVA in the terminology of Eisenhart. The present paper, which deals with the 1 dimensional or univariate case, and its sequel, which will deal with the multidimensional or multivariate case, seek to give a unified general treatment, using matrix methods, of certain problems under the 2 models of ANOVA. Section 1 of each paper, which deals with Model I, is of the nature of a résumé giving the main results of a general treatment. Section 2 of each paper, which deals with Model II or variance components model, is self-contained, and presents a natural tie-up between the analyses under the 2 models for a k-way classification. Results in estimation, testing of hypotheses and confidence bounds are presented, although the main emphasis is on the results in confidence bounds (simultaneous and/or separate) on meaningful parametric functions which are physically natural and mathematically convenient measures of departure from customary null hypotheses. It is shown that a mixed model, which would include both Models I and II as special cases, can be defined, and the associated problems can be studied by using methods which are, essentially, a combination of the methods given for the separate models in Sections 1 and 2, respectively, of this paper. (Contractor's abstract)

1408

North Carolina U. [Inst. of Statistics, Chapel Hill].

SOME CONTRIBUTIONS TO ANOVA IN ONE OR MORE DIMENSIONS: II, by S. N. Roy and R. Gnanadesikan. [1959] [23]p. incl. refs. [AF 49(638)213]
Unclassified

This paper presents certain natural extensions, to the multi-dimensional or multivariate situation, of the results contained in another paper (item no. 1407, Vol. III). The same notation as before is used and, in addition, the following notation is added: $c(A)$ will denote all the characteristic roots of the matrix A, and if A is at least positive semi-definite, then $c_{min}(A)$ and $c_{max}(A)$ will denote, respectively, the smallest and the largest of these roots; $D_a(p \times p)$ will denote a diagonal matrix whose elements are $a_1, a_2, ..., a_p$; $\tilde{T}(p \times p)$ will denote a triangular matrix whose non-zero elements are along and below the diagonal; $|A|$ will denote the determinant of a square matrix A; and, $A(p \times p) \times B(q \times q)$ will denote the Kronecker product or right direct product of the matrices A and B. Also $min(p, q)$ will denote the lesser of the two real numbers p and q. (Contractor's abstract)

1409

North Carolina U. [Inst. of Statistics] Chapel Hill.

MOMENTS OF ORDER STATISTICS FROM A NORMAL POPULATION, by R. C. Bose and S. S. Gupta. [1959] [8]p. incl. tables, refs. [AF 49(638)213]
Unclassified

This paper deals with the problem of obtaining the moments of $X_{(k)}$, the kth order statistic for a sample of size n from a normal population $N(0, 1)$. It has been shown that $\mu'_t(n,k)$, the tth moment of $X_{(k)}$, can be expressed in terms of lower moments of order $t - 2i$ ($i = 1, 2, ..., \frac{1}{2}t$ or $\frac{1}{2}(t - 1)$) and the integral

$$(1) \quad \int_{-\infty}^{+\infty} P_{t+1}(x) e^{-\frac{1}{2}(t+1)x^2} dx,$$

where $P_{t+1}(x)$ for $t > 0$, is defined by

$$(2) \quad P_{t+1}(x) = k \binom{n}{k} \frac{dt}{d\Phi}[\Phi^{k-1}(1 - \Phi)^{n-k}],$$

it being understood that in (2), Φ is replaced after differentiation by $\Phi(x)$, the cumulative distribution function (c.d.f.) of $N(0, 1)$. $P_t(x)$ is thus a polynomial of degree $(n-t)$ in $\Phi(x)$ if $t \le n$ and is zero if $t > n$. Exact values of all odd order moments can be derived when $n < 5$, and the exact values of all even order moments can be derived when $n < 6$. The exact moment tables for $t = 3$ and 4 are provided in this paper. In general the numerical evaluation of the integral (1) can be expeditiously done by using the Gauss method of numerical integration based on the zeros and the weight factors of the Hermite polynomials.

1410

North Carolina U. Inst. of Statistics, Chapel Hill).

MINIMUM BIAS ESTIMATION, by W. J. Hall. Dec. 1958, 21p. incl. refs. (Mimeograph series no. 213) (AFOSR-TN-59-215) (AF 49(638)261) AD 211777; PB 142677
Unclassified

This is an expository paper on the theory and application of minimum bias estimation, an approach to estimation theory which characterizes an estimator primarily according to its bias. Minimum risk theory leads to estimators which minimize the average risk or the maximum risk. The place of bias in the risk theory is reinterpreted, and an alternative theory is developed with the risk function replaced by a bias function. When the unbiased estimators do not exist, the average or the maximum of the bias function is minimized by choosing an unbiased estimator of a suitable approximation to the function to be estimated.

Relevant aspects of the theory of approximation are reviewed. Estimators which minimize the maximum absolute bias are shown to minimize also the average squared bias, the average being taken with respect to a least favorable prior distribution. The problem of estimating a root of the binomial parameter, arising in certain biological and military applications, is used to exemplify various aspects of the minimum bias theory.

1411

North Carolina U. Inst. of Statistics, Chapel Hill.

AN OPTIMUM PROPERTY OF SOME BECHHOFER AND SOBEL NON-SEQUENTIAL MULTIPLE-DECISION RULES, by W. J. Hall. Nov. 1958, 8p. (Mimeograph series no. 210) (AFOSR-TN-59-216) (AF 49-(638)261) AD 211778; PB 140590   Unclassified

Presented at meeting of the Inst. Math. Stat., Ames, Iowa, Apr. 3-5, 1958.

Abstract published in Ann. Math. Stat., v. 29: 621, June 1958.

Proof is presented of the following theorem: Let $\{f_\Theta\}$, $\Theta \in \Omega \subset R_1$, be a homogeneous class of density functions w.r.t. a fixed measure. Let $\{X_{ij}\}$ ($i = 1, 2, ...,$ m; $j = 1, 2, ..., n$) denote mn independent random variables where X_{ij} has the density function $f_{\Theta i}$, $\Theta_i \in \Omega$, $i = 1,$ ..., m, and let $\Theta_{(1)} \leq ... \leq \Theta_{(m)}$ be the ordered values of the Θ_i's. Denote $\underline{\Theta} = (\Theta_1, ..., \Theta_m)$. Suppose $t_i = t_i(x_{i1}, ..,$ $x_{in})$ is a numerical sufficient statistic for Θ_i, that t_i has a monotone likelihood ratio, and that Θ_i is a location parameter in the induced distribution of t_i ($i = 1,$ ..., m). Le D_n denote any decision rule for choosing which Θ_i is $\Theta_{(m)}$ based on an observation on the mn random variables $\{X_{ij}\}$, and let D_n^o denote that D_n which chooses as the largest of the m Θ_i's the one corresponding to the largest of the t_i's. Suppose N is the least n for which $\int F_n^{m-1}(t + \delta)dF_n(t) \geq \gamma$ ($\delta > 0$, $0 < \gamma < 1$) where $F_{\Theta,n}(t) = F_n(t - \Theta)$ is the c.d.f. of t with parameters Θ and n. Then D_N^o satisfies the following: (a) Pr { correct decision using $D_n | \underline{\Theta}$ } $\geq \lambda$ for all $\underline{\Theta}$ for which $\Theta_{(m)} - \Theta_{(m-1)} > \delta$ and (b) there does not exist decision rule D_n satisfying (a) with n < N. (ASTIA abstract)

1412

North Carolina U. Inst. of Statistics, Chapel Hill.

A SIMPLE BAYES SOLUTION TO A COMMON MULTIPLE COMPARISONS PROBLEM, by D. B. Duncan. Apr. 1959, 38p. incl. diagrs. table, refs. (Mimeograph series no. 223) (AFOSR-TN-59-492) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-(638)261, Office of Naval Research under Nonr-85506, and Public Health Service) AD 215396   Unclassified

The problem is discussed of making the $n(n-1)/2$ simultaneous 2-sided symmetric t tests of the $n(n-1)/2$ hypotheses H:$\mu_i = \mu_j$;i,j = 1,...,n; i < j. The more mathematical aspects of a comprehensive Bayes analysis of the problem is presented. The closeness of a seemingly useful adaptation of the Bayes rule and the least-significant-difference rule of Fischer is demonstrated.

1413

North Carolina U. Inst. of Statistics, Chapel Hill.

TWO-STAGE EXPERIMENTS FOR ESTIMATING A COMMON MEAN, by D. L Richter. June 1959, 15p. (Mimeograph series no. 231) (AFOSR-TN-59-793) (AF 49(638)261) AD 225090   Unclassified

Also published in Ann. Math. Stat., v. 31: 1164-1173, Dec. 1960.

Let π_1, π_2 be 2 normal populations with common mean μ and variances σ_1^2, σ_2^2, where the parameter values are unknown. Suppose that it is desired to estimate μ, and that the experimental procedure is to take m observations from each population, compute variance estimates, and then take n — 2m observations from that population with the smaller observed variance, where n has been fixed beforehand. Let $R_n(\theta, m) = V_0^{-1} E(\hat\mu - \mu)^2$ be the risk of the estimator $\hat\mu$, where $V_0 = n^{-1} \min (\sigma_1^2, \sigma_2^2)$ and where $\theta = \sigma_2^2/\sigma_1^2$. For a class of "best" estimators, it is shown in this paper that $\sup_\theta R_n(\theta, m) \to 1$ as $n \to \infty$ if and only if m/n → 0 and $n \to \infty$ as $n \to \infty$; that $\min_m \sup_\theta R_n(\theta, m) \sim 1 + Cn^{-1/3}$ as $n \to \infty$; and that the minimax sample size is $m \sim Cn^{2/3}$ as $n \to \infty$. (Contractor's abstract)

1414

North Carolina U. Inst. of Statistics, Chapel Hill.

ON SUFFICIENCY AND INVARIANCE WITH APPLICATIONS IN SEQUENTIAL ANALYSIS, by W. J. Hall. June 1959, 21p. incl. diagr. refs. (Mimeograph series no. 228) (AFOSR-TN-59-794) (AF 49(638)261) AD 235091; PB 148239   Unclassified

An investigation is made to determine in what sense sufficiency properties are preserved under the invariance principle. Thus an interpretation is obtained of the sufficiency of a statistic in the presence of nuisance parameters. It is shown that if a statistic, s, contains all relevant information about a parameter, then the maximal invariant function of s contains all the relevant information about the function of that parameter that is available in any invariant function. It is also shown that knowing the mean parameter and variance, the magnitude of the sample mean as an invariantly sufficient statistic can be obtained by invoking invariance under changes in sign. Similarly, with normal mean and variance unknown, the sample variance is invariantly sufficient for the population variance under changes in location, and the t-statistic is invariantly sufficient for the mean in standard deviation units under changes in scale; with 2 normal populations with equal and known variances, the difference between the sample means is invariantly sufficient for the difference between population means under changes in location.

1415

North Carolina U. Inst. of Statistics, Chapel Hill.

LOWER BOUNDS FOR THE EXPECTED SAMPLED SIZE AND THE AVERAGE RISK OF A SEQUENTIAL PROCEDURE, by W. Hoeffding. June 1959, 29p. incl. table, refs. (Mimeograph series no. 227) (AFOSR-TN-59-600) (AF 49(638)261) AD 235093 Unclassified

Also published in Ann. Math. Stat., v. 31: 352-368, June 1960.

Also published in Information and Decision Processes, N. Y., McGraw-Hill, 1960, p. 53-61.

Lower bounds are considered for the expected sample size $E_0(N)$ of an arbitrary sequential test whose error probabilities at 2 parameter points, θ_1 and θ_2, do not exceed given numbers α_1 and α_2, where $E_0(N)$ is evaluated at a 3rd parameter point θ_0. The bounds are shown to be attainable or nearly attainable in certain cases where θ_0 lies between θ_1 and θ_2. Lower bounds for the average risk of a general sequential procedure are obtained. (Contractor's abstract)

1416

North Carolina U. [Inst. of Statistics, Chapel Hill].

THE MOST-ECONOMICAL CHARACTER OF SOME BECHHOFER AND SOBEL DECISION RULES, by W. J. Hall. [1959] [6]p. (AF 49(638)261) Unclassified

Published in Ann. Math. Stat., v. 30: 964-969, Dec. 1959.

Justification is given for the use of a wide range of procedures for choosing particular populations. These choices guarantee a correct decision with prescribed probability when the extreme population parameter is sufficiently distinct from the others. This paper proves that no other rules can meet this guarantee with a smaller (fixed) sample size. Proof of this most-economical character of these rules is achieved by proving their minimax character when a suitable loss function is introduced.

1417

North Carolina U. Psychometric Lab., Chapel Hill, N. C.

BAYES ESTIMATION OF PROPORTIONS: THE EFFECT OF STIMULUS DISTRIBUTION AND EXPOSURE TIME, by E. H. Shuford and R. A. Wiesen. Dec. 1959, 16p. incl. tables. refs. (AFOSR-TN-59-1311) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)729 and National Institutes of Health) AD 232826 Unclassified

Twenty-three undergraduate students estimated the percentage of 1's in random matrices composed of 1's and 0's in varying proportions. The 2 types of information were experimentally varied by using different stimulus distributions and exposure times. The subjects were not told what the stimulus distribution would be and, thus, had to learn the stimulus probabilities during the course of the experiment. The decision-theoretic model, fitted to the data of each subject, yields estimates of 3 parameters -- 2 pertaining to the subjective stimulus probabilities, the other reflecting the effect of changes in exposure time. The estimates of the majority of the subjects were affected by changes in stimulus distribution and exposure time and were in agreement with the Bayes strategy interpretation. The ability of the model to predict subsequent behavior was quite dependent upon the way a subject interpreted the situation, e.g., some subjects, instead of learning the new stimulus distribution, assumed that the previous distribution was being presented and their subjective stimulus probabilities displayed a "gambler's fallacy" effect. Most subjects used an all-or-none, rather than a squared error, performance criterion. (Contractor's abstract)

1418

Northwestern U. Dept. of Chemistry, Evanston, Ill.

BRIDGED MECHANISM FOR THE PLATINUM (II) CATALYSIS OF CHLORIDE EXCHANGE IN CHLOROAMMINE PLATINUM (IV) COMPLEXES, by M. L. Morris, F. Basolo, and R. G. Pearson. Nov. 20, 1959 [26]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1225) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)315 and Atomic Energy Commission under AT(11-1)89) AD 232954; PB 145844 Unclassified

A kinetic study was made of the platinum (II) catalyzed chloride ion exchange of various chloroammineplatinum (IV) complexes. The exchange was observed to follow the rate law $R = k[Pt (IV)][Pt (II)][Cl^-]$ and to be essentially the same as the rate of platinum exchange.

The rate of chloride exchange with $\underline{trans}\text{-}Pt(NH_3)_4Cl_2^{2+}$ is about 2,000 times faster than with the cis isomer and about 10,000 times faster than with $\overline{Pt(NH_3)}_5$ Cl^{3+}. There is no chloride exchange in the system $\underline{trans}\text{-}Pt(tetrameen)_2Cl_2^{2+}$ - $Pt(tetrameen)_2^{2+}$ - $*Cl^-$.

All of these observations are explained on the basis of a 2 electron change redox reaction involving a bridged activated complex. (Contractor's abstract)

1419

Northwestern U. Dept. of Chemistry, Evanston, Ill.

LINKAGE ISOMERISM. SYNTHESIS AND ISOMERIZA-TION OF NITRITOPENTAMMINE COMPLEXES OF RHODIUM (III) AND IRIDIUM (III), by F. Basolo and G. S. Hammaker. Nov. 20, 1959, 3p. (Bound with its AFOSR-TN-59-1225; AD 232954) (AF 49(638)315)
Unclassified

Published in Jour. Amer. Chem. Soc., v. 82: 1001-1002, Feb. 20, 1960.

The successful synthesis of $Rh(NH_3)_5ONO^{2+}$ and $Ir(NH_3)_5ONO^{2+}$ salts and their isomerization complexes is reported. Their acquisition is a good example of the use of reaction mechanisms to prepare new compounds. It was thought that a low energy reaction path should be available to form the compounds similar to that of the N_2O_3 or NO^+ on the oxygen of $Co(NH_3)_5OH^{2+}$ to form $Co(NH_3)_5ONO^{2+}$. It was found that the stable nitro compound is sufficiently slow that the reaction at mild conditions yields the kinetic nitrito product. It is reported that at elevated temperatures the reactions of $Rh(NH_3)_5OH^{2+}$ and $Ir(NH_3)_5OH^{2+}$ with NO_2^- produce salts of $Rh(NH_3)_5NO_2^{2+}$ and $Ir(NH_3)_5NO_2^{2+}$, but at ice-bath temperatures similar mixtures produced salts of $Rh(NH_3)_5ONO^{2+}$ and $Ir(NH_3)_5ONO^{2+}$ instead. The presence of M-ONO linkage was verified and its rate of isomerization to $M\text{-}NO_2$ followed by an examination of the infrared spectra of the solid compounds.

1420

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

THE DISTRIBUTION OF A GENERALIZED D_n^+ STA-

TISTIC, by M. Dwass. [1959] 7p. (AFOSR-TN-59-38) (AF 49(638)151) AD 209210   Unclassified

Also published in Ann. Math. Stat., v. 30: 1024-1028, Dec. 1959.

Let $F_n(x)$ be the sample c.d.f. for a sample of size n from the continuous population c.d.f. $F(x)$. Elementary derivations are given of the exact distribution of $\sup_{-\infty \leq x \leq \infty}[F_n(x) - cF(x)]$, where $c > 0$.

1421

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

AVERAGES OF FOURIER COEFFICIENTS, by R. R. Goldberg. [1959] [5]p. (AFOSR-TN-59-647) (AF 49-(638)383) AD 230020   Unclassified

Also published in Pacific Jour. Math., v. 9: 695-699, 1959.

The author proves that if $\psi(x)$ is of bounded variation in the interval $0 \leq x \leq 1$, and (a_n) is the sequence of Fourier coefficients of L^p function, then the sequence $(1/n$ $\Sigma_{m=1}^n \psi(m/n)a_m)$ $(n = 1,2,...)$ is also. The case $\psi(x = 1)$ was proved by G. H. Hardy (Messenger of Math., v. 58: 50-52, 1929). (Math Rev. abstract)

1422

Northwestern U. Dept. of Mathematics, Evanston, Ill.

THE ISOPERIMETRIC INEQUALITY AND ASSOCIATED BOUNDARY PROBLEMS, by W. T. Reid. Dec. 1958, 11p. (Technical rept. no. 1) (AFOSR-TN-59-2) (AF 49(638)400) AD 208182   Unclassified

Also published in Jour. Math. and Mech., v. 8: 897-905, Nov. 1959.

The extremal property of the smallest proper value of the boundary problem $\eta'' + \lambda\eta = 0$, $\eta(0) = 0$, $\eta(L) = 0$, is used to present an elementary proof of the isoperimetric inequality $4\pi A \leq L^2$ for a simple closed plane curve of length L and enclosed area A. With the aid of this extremal property there is established also an integral inequality for simply connected rectifiable pieces of regular surfaces, which in turn provides an elementary proof of the result of Carleman [Math. Zeitschr., 9: 154-160, 1921] that the isoperimetric inequality persists for such pieces of minimal surfaces. The extremal property of the smallest proper value of a related boundary problem is shown to afford a similar proof of the modified isoperimetric inequality for the simplest instance of a plane variational problem of Dido type. (Contractor's abstract)

1423

Northwestern U. Dept. of Mathematics, Evanston, Ill.

EXISTENCE THEOREMS FOR CERTAIN CLASSES OF
TWO-POINT BOUNDARY PROBLEMS BY VARIA-
TIONAL METHODS, by R. J. Driscoll. Mar. 1959, 37p.
(Technical rept. no. 2) (AFOSR-TN-59-254) (AF 49-
(638)400) AD 212254; PB 142297   Unclassified

Also published in Pacific Jour. Math., v. 10: 91-115,
1960.

Existence theorems are established for the solutions of
2 classes of differential systems by the variational
methods. The 1st system considered is of the form:
$y''(x) = f[x, y(x), y'(x)]$ for $a \le x \le b$, and $y(a) = y_1$ and
$y(b) = y_2$, where $f(x,y,z)$ is a real vector function of the
real scalar x and the real n-dimensional vectors $y \equiv$
(y_j and $z \equiv (z_j)$, $(j = 1, 2, ..., n)$. In conjunction with this
system, a functional $l(y,z)$ is considered which is de-
fined over a suitable class of pairs of vector functions
$[y(x), z(x)]$ satisfying $y(a) = y_1$ and $y(b) = y_2$. The 2nd
system considered is of the form: $y''(x) = g_y [x, y(x)]$
for $0 < x < \infty$, and $y(0) = y_0$ for $y(x)$ bounded on $0 < x < \infty$
where $g(x,y)$ is a real scalar function of the real scalar
x and the n-dimensional vector y, and $g_y(x,y)$ denotes
the vector $g_{y_j}(x,y)$. The functional $l(y)$ is considered in
conjunction with the 2nd system for which y'' is the re-
lated Euler equation. $l(y,z)$ is shown to have the abso-
lute minimum zero, so that if $y_0(x), z_0(x)$ minimizes
$l(y,z)$, then $y = y_0(x)$ is a solution of the 1st system.

Under suitable hypotheses, $l(y)$ is shown to have a
minimizing function which is the unique solution of the
2nd system.

1424

Northwestern U. Dept. of Mathematics, Evanston, Ill.

ON THE APPROXIMATION OF INTEGRABLE FUNC-
TIONS BY FUNCTIONS OF BOUNDED VARIATION, by
W. T. Reid. Aug. 1959, 8p. (Technical rept. no. 4)
(AFOSR-TN-59-825) (AF 49(638)400) AD 227581;
PB 144375   Unclassified

Also published in Ann. Scuola Norm. Super. Pisa Sci.
Fis. e Mat., Series III, v. 14: 133-140, 1960.

Proof is presented of the following theorem: suppose
that $y(x) \equiv (y_\alpha(x))$, $(\alpha = 1, ..., n)$, is (Lebesgue) integra-
ble on the closed interval (a,b), and of bounded variation
on an extension closed interval (b,d). If L is the infimum
$\Lambda(a,b;z) \equiv L(a,b;z) + |z(b) - y(b^+)|$ for $z \in E(y)$, then:
(1) $L < \infty$ if and only if $E_{bv}(y)$ is non-empty; (2) h^{-1}

$\int_a^b |y(x^+ h) - y(x)| dx \to L$ as $h \to 0^+$; and (3) if $L < \infty$
then $z_+(x) = \lim_{h \to 0} h^{-1} \int_0^h y(x^+s) ds$ exists on (a,b) and:
(i) $z_+ \in E_{bv}(y)$; (ii) z_+ is right-hand continuous on (a,b)
and $z_+(b) = y(b^+)$; (iii) $\Lambda(a,b;z_+) = L(a,b;z_+) = L$; and
(iv) if $z \in E_{bv}(y)$ and $\Lambda(a,b;z) = L$, then $z(a) = z_+(a)$ and
for $a < x < b$ there is a $\Theta(x)$ such that $0 < \Theta(x) < 1$ and
$z(x) = (1 - \varepsilon(x))z_+(x^-) + \Theta(x)z_+(x)$.

1425

Northwestern U. Dept. of Mathematics, Evanston, Ill.

PROPERTIES OF SOLUTIONS OF A RICCATI MATRIX
DIFFERENTIAL EQUATION, by W. T. Reid. Aug. 1959,
28p. incl. refs. (Technical rept. no. 3) (AFOSR-TN-59-
826) (AF 49(638)400) AD 227560; PB 144497
                                    Unclassified

Also published in Jour. Math. and Mech., v. 9: 749-770,
Sept. 1960.

The study of the properties of the solutions of Riccati
matrix differential equations is continuing. The analytic
methods of a previous article (item no. 1422) are shown
to yield properties presented by Redheffer (Jour. Ratio-
nal Mech. and Anal., v. 5: 835-848, 1956; Math. Ann.
v. 133: 235-250, 1957). Certain of the results presented
are formed to establish the existence of solutions, rather
than to postulate their existence. The improved result
involves an extension of a quadratic form problem. Spe-
cial attention is given to Riccati equations arising as the
Legendre equation for a variational problem. The meth-
ods are shown to provide the main theorem on the
Mycielski-Paszowski diffusion problem.

1426

Northwestern U. Dept. of Metallurgy and Materials
Science, Evanston, Ill.

FURTHER STUDIES OF GP1 ZONE FORMATION IN
Al-2 AT.% Cu, by C. Chiou, H. Herman, and M. E.
Fine. June 2, 1959 [34]p. incl. diagrs. tables, refs.
(AFOSR-TN-59-509) (AF 18(600)1468) AD 216274;
PB 142038   Unclassified

Presented at meeting of the Amer. Inst. Metall. Engi-
neers, Chicago Ill., Nov. 2-5, 1959.

Also published in Trans. Metall. Soc. AIME, v. 218:
299-306, Apr. 1960.

The effects were investigated of varying the solution
treating procedure and the concentration of quenched-
in vacancies on the growth kinetics of Guinier-Preston
zones of the first kind (GP1). Dynamic Young's modu-
lus was studied in single crystal specimens. The dy-
namic method for measuring Young's modulus

incorporated longitudinal vibrations that were excited and detected electrostatically. As aging proceeded, the specimen's fundamental and natural frequency of longitudinal vibration (resonant frequency) increased. The variables that were investigated for direct aging were solution temperature (515° and 550°C) and quenching speed (oil and water quenching). Data indicated that grain boundaries do not appear to have a significant effect on the kinetics of formation of zones occurring at room temperature. The kinetics was also about the same for specimens with a circular cross-section of 0.18 in. diameter and rectangular cross-section of 0.21 by 0.055 in. The magnitude of the change in Young's modulus varied with crystallographic direction. The hardness change during aging was not orientation dependent over the range that was studied. The initial rate of aging was slower after oil quenching, but this was reversed at later times. The rate of aging was greater for oil quenching at longer times. Final hardness was considerably less for the oil quench. (Contractor's abstract)

1427

Northwestern U. Dept. of Metallurgy and Materials Science, Evanston, Ill.

THE PLASTIC DEFORMATION OF SINGLE CRYSTALS OF AN ALUMINUM-SILVER ALLOY, by A. Kelly, A. Lassila, and S. Sato. [1959] [18]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-719) (AF 18(600)1468) AD 239913   Unclassified

Also published in Philos. Mag., v. 4: 1260-1277, Nov. 1959.

Tensile tests have been carried out at a variety of temperatures between 77°K and 373°K on single crystals of an aluminum-20 wt % silver alloy. The crystals were aged either at room temperature, or at 160°C, within the cold-hardening range. Single crystals of this material are very ductile. Stress-strain curves have been obtained, and the change of flow stress with temperature (during deformation) has been measured and compared with the change of modulus over the same temperature range. Observations have been made with the optical microscope of the appearance of slip lines on polished surfaces of the specimens. The stress-strain curves are approximately linear showing a rate of work hardening about the same as that of pure aluminum in stage II of the stress-strain curve. The temperature dependence of the flow stress is small, varying less than does the elastic modulus over the temperature range investigated. The temperature dependence of the flow stress is compared with new measurements of the same quantity in pure aluminum single crystals. The crystals deform by a < 100 > {111} slip mechanism but cross slip is profuse at all stages of the deformation and at all temperatures. This is attributed to the very high flow stress of these single crystals which is 2 orders of magnitude greater than that shown by pure aluminum. (Contractor's abstract)

1428

Northwestern U. Dept. of Metallurgy and Materials Science, Evanston, Ill.

AN INVESTIGATION OF PHASE TRANSFORMATIONS AND OTHER STRUCTURAL CHANGES IN METALS BY MEASUREMENT OF ELASTICITY AND INTERNAL FRICTION, by M. E. Fine and A. Kelly. Final rept. June 1, 1955-Aug. 31, 1959. Sept. 30, 1959 [50]p. incl. diagrs. tables, refs. (AFOSR-TR-59-141) (AF 18-(600)1468) AD 227686; PB 144008   Unclassified

Dynamic elasticity and internal friction apparatus were built for ranges of 77° to 1075°K and 20 to 200 kc. The high temperature apparatus using electrostatic excitation and detection embodied a number of improvements. In addition, apparatus using piezoelectric quartz crystals was set up. Measurement of dynamic Young's modulus was used to study the kinetics and mechanism of formation of Guinier-Preston (GP) zones from supersaturated solid solution in Al-base Cu alloys, and Al-base Ag alloys; atomic arrangements in $AuCu_3$, and α-brass; and the hexagonal-to-cubic transformation in Co. In addition, the Young's modulus and internal friction of a number of metals were measured at elevated temperatures, and an acoustic relaxation effect in Mn_3O_4 was studied. A theoretical and experimental study of the strength and plasticity of age-hardened Al alloys was undertaken. Since theory seems to indicate that GP zones are sheared during deformation, an x-ray study of the effect of deformation on size and shape of zones in Al-base Ag alloys using low-angle scattering was made. Much of the research involved use of single crystals, and various methods were developed for growing these from Al-base Ag, Cu, and Zn alloys.

1429

Northwestern U. Dept. of Metallurgy and Materials Science, Evanston, Ill.

ELECTRICAL RESISTIVITY CHANGE FROM FORMATION OF ZONES IN ALUMINUM ALLOYS, by M. E. Fine. [1959] 3p. (AFOSR-4025) (AF 18(600)1468)
Unclassified

Also published in Acta Metall., v. 7: 228-229, Mar. 1959.

An analysis of the processes taking place during zone aging of aluminum alloys is presented. It can be concluded that 2 main resistivity effects are occurring in Al-Cu alloys: (1) a decrease in resistivity due to a reduction in Cu concentration in the solid solution, and (2) an increase due to the presence of zones. In these alloys the atomic diameters are 2.856A and 2.551A, respectively. The mismatch, created by the 12% difference in diameter size, must be taken up by some means. It is suggested that the zones contain extra rows of copper atoms, of which each row could be

thought of as a pair of edge dislocations of opposite sign in the matrix. The increase in resistivity would be due to scattering of electrons by the extra rows of atoms as well as the lattice strains in the matrix. Calculations are presented which tend to substantiate this hypothesis.

1430

Northwestern U. Dept. of Metallurgy and Materials Science, Evanston, Ill.

TEMPERATURE DEPENDENCE OF THE STRENGTH OF ZONE HARDENED ALUMINUM-SILVER ALLOYS, by M. E. Fine. [1959] 4p. incl. table. (AFOSR-4026) (AF 18(600)1468)   Unclassified

Also published in Philos. Mag., v. 4: 1375-1377, Dec. 1959.

The principal source of the strength of aluminum-rich silver alloys containing Guinier-Preston zones has been attributed to chemical changes associated with shearing of zones during plastic deformation. The purpose of this note is to point out that there is also an increase in entropy resulting from shearing of zones and to discuss the temperature dependence of the flow stress due to the entropy term. The configurational entropy per atom in a zone is very small and negligible compared to the configurational entropy of an atom in the matrix solid solution. The entropy of mixing of the zones in the matrix solid solution may also be neglected. The average change in free energy due to removing an atom from a zone and placing it into solution can be calculated, and from that the free energy change may be put on the per atom of silver basis. The results are presented in table form and show that the computed temperature variation is only qualitative. It is concluded that the entropy consideration may be important in determining the temperature variation of the flow stress in this alloy.

1431

Northwestern U. Dept. of Metallurgy and Materials Science, Evanston, Ill.

THE STRENGTHENING BY PRECIPITATES IN Al-Cu ALLOYS (Abstract), by J. G. Byrne, A. Kelly, and M. E. Fine. [1959] [1]p [AF 18(600)1468]
                                    Unclassified

Presented at meeting of the Amer. Inst. Metall. Engineers, Chicago, Ill., Nov. 2-5, 1959.

Single crystals of Al-3.85% Cu were water quenched from the solid solution range and aged at various times and temperatures to produce the various known precipitates GPI, GPII, θ' and θ. Measurements were made of the critical resolved shear stress and the temperature dependence of the flow stress at a variety of temperatures between 77°K and 373°K. Stress-

strain curves were obtained and the temperature dependence of the rigidity modulus of this alloy in various aged states were measured. Crystals containing GPI zones and crystals containing θ' and θ precipitates respectively show a temperature dependence of the strength greater than that shown by crystals containing GPII zones. The effect of long aging times on the critical resolved shear stress at 77°K and 273°K was investigated. Tensile testing of single crystals containing the various precipitates, a liquid helium temperatures, is underway. Comparison of the temperature dependence of the flow stress of these crystals with that of the elastic constants enables a critical appraisal of theories of age hardening to be made.

1432

Northwestern U. [Dept. of Metallurgy and Materials Science] Evanston, Ill.

CONTRIBUTION OF DISLOCATION LINE TENSION AND THE DENSITY OF THE SOLUTE ATMOSPHERE TO THE YIELD POINT IN STRAIN AGED INGOT IRON, by J. O. Brittain and T. Mura. Aug. 7, 1959 [23]p. incl. diagrs. refs. (AFOSR-TN-59-760) (AF 18(600)1598) AD 225736; PB 143620   Unclassified

Also published in Acta Metall., v. 8: 767-772, Nov. 1960.

An investigation was made of the 77°K yielding behavior of ingot iron specimens that had been prestrained and aged while under stress at 303°K. It was observed that the presence of a yield point at 303°K after a strain aging treatment does not result in a yield point at 77°K until the strain aging treatment is prolonged so as to result in an increase in the 303°K yield point on about 20%. The sharpness and magnitude of the yield point at about 303° and 77°K increased with an increase in the aging time and/or an increase in the stress which was maintained upon the specimen during the aging treatment. The observations of the effect of the aging time and aging stress are discussed in terms of the contribution of the dislocation line tension and solute atmosphere density along the dislocation. (Contractor's abstract)

1433

Northwestern U. Dept. of Metallurgy and Materials Science, Evanston, Ill

KINETICS OF SINTERING OF SODIUM CHLORIDE IN THE PRESENCE OF AN INERT GAS, by D. H. Whitmore and J. B. Moser. Nov. 19, 1959 [24]p. incl. diagrs. table, refs. (AFOSR-TN-59-1256) (AF 49(638)436) AD 231157; PB 145644   Unclassified

Also published in Jour. Appl. Phys., v. 31: 488-496, Mar. 1960.

Direct observations of interfacial growth and the approach of centers between spheres of NaCl were made

in an Ar atm and over a temperature range of 700-900°C The rate law governing the increase of the contact area between spheres, the effect of changing size scale on this rate and the absence of a change in the center-to-center distance during sintering all indicate that the rate-determining mechanism of material transport in this sintering process is evaporation-condensation. A model is presented which considers Stefan flow to occur within a thin boundary layer in the gaseous phase adjacent to the condensing surface, the sintering rate being predominantly governed by the rate at which sodium chloride vapor diffuses through this boundary layer. The marked pressure-dependence of the empirical relationship between contact area and sintering time for fixed temperature and sphere size is consistent with the proposed model. (Contractor's abstract)

1434

Norway Technical U. Inst. for Theoretical Chemistry, Trondheim.

AN ELECTRON DIFFRACTION INVESTIGATION OF THE MOLECULAR STRUCTURE OF ALLENE, by A. Almenningen, O. Bastiansen, and M. Traetteberg. Aug. 31, 1959, 9p. incl. diagrs. tables. (AFOSR-TN-59-704) (Also bound with its AFOSR-TN-59-905; AD 226434) (AF 61(052)72) AD 230376; PB 145611   Unclassified

Also published in Acta Chem. Scand., v. 13: 1699-1702, 1959.

The electron diffraction sector method was used to determine the structure of allene vapor. The observed molecular parameters are the following: C-H: 1.081_6A (u = 0.0795A), C=H: 1.311_6A (u = 0.0390A), C_1C_3: 2.617A (u = 0.0519A) and < H-C=C:

120.8°. The C_1C_3 distance was found to be shorter than twice the C=C distance. This can be explained by out-of-linearity vibrations. (Contractor's abstract)

1435

Norway Technical U. Inst. for Theoretical Chemistry, Trondheim.

PART I. AN ELECTRON DIFFRACTION INVESTIGATION OF THE MOLECULAR STRUCTURE OF ALLENE. PART II. ELECTRON DIFFRACTION STUDIES OF THE MOLECULAR STRUCTURE OF NAPHTHALENE AND CORONENE IN THE VAPOR STATE. PART III. PRELIMINARY ELECTRON DIFFRACTION STUDIES OF BUTATRIENE, by A. Almenningen, O. Bastiansen and others. Annual Technical rept. Apr. 1, 1958-June 30, 1959. July 24, 1959, 1v.incl. diagrs. tables, refs. (AFOSR-TN-59-905) (AF 61(052)72) AD 226434; PB 146183   Unclassified

Part I also published in Acta Chem. Scand., v. 13: 1699-1702, 1959.

Part I. See item no. 1434, Vol. III for abstract. Part II. A least-squares refinement procedure was applied to the data obtained from the radial distribution curve. A least-squares refinement of naphthalene was applied to the intensity curve. Observed structural models of coronene and naphthalene were compared with those from x-ray studies. Part III. Electron diffraction diagrams of butatriene were taken at 3 distances between diffraction point and the photographic plate. The 1st experimental molecular intensity curve was obtained from these diagrams. The 1st radial-distribution curve was obtained by using intensity values up to s = 45 A^{-1}; the 1st structural model was made from the radial distribution curve. (Contractor's abstract)

1436

Ohio State U., Columbus.

INPUT DISTORTION AND OBSERVER OVERLAP IN
DECISION-MAKING, by J. S. Kidd and F. Boyer. [1959]
[9]p. incl. diagr. tables. (AFOSR-TN-59-161) (AF 49-
(638)236) AD 264401   Unclassified

Also published in Management Sci., v. 6: 123-131, Oct.
1959.

A realistic decision-making situation was developed
based on the simulation of a tactical military operation.
A 3-man team comprised the work unit; 2 acted in an
information-processing role and 1 was assigned an in-
formation-integration and decision-making function.
Differential levels of information input distortion and
observer overlap were compared. It was found that
input distortion degrades decision-making speed and
accuracy and that the increased intensity of coverage
provided by observer-overlap did not moderate this ef-
fect. Detailed analysis of the activities associated with
the information-processing function were also made.
The findings were interpreted in terms of both theoreti-
cal and methodological issues. (Contractor's abstract)

1437

Ohio State U. Research Foundation. Dept. of Chemistry,
Columbus.

AN INVESTIGATION OF THE TRANSFORMATION
AND STRUCTURE OF SILVER MERCURIC IODIDE, by
C. E. Olsen and P. M. Harris. Aug. 1959, 61p. incl.
diagrs. tables, refs. (Technical rept. no. 2) (AFOSR-
TN-59-756) (AF 18(500)769) AD 229755; PB 156106
                              Unclassified

Single crystals of Ag_2HgI_4 were grown from solution.
They undergo transformation at ~51°C without shatter-
ing. The transformation at 51° clearly shows that the
initial phase obtained from solution is not again ob-
tained. Transitions are shown from β' phase at less
than 51°C, α phase from 51°C to 157°C, and β phase
back to less than 51°C. The unit cell of the β'-phase
contains 2 molecules Ag_2HgI_4 ideally and is tetragonal
with a = 6.32A, c = 12.64A, c/a = 2 exactly. It is body-
centered with I4̄ symmetry. Evidence is adduced sup-
porting the hypothesis that the β' crystals are non-
stoichiometric and exhibit iodine vacancies with a por-
tion of the silver ions in interstitial sites. The β-phase
obtainable from the α-phase appears to have a cubic,
primitive cell, a = 12.64A. (Contractor's abstract)

1438

Ohio State U. Research Foundation. Dept. of Chemistry,
Columbus.

LAUE-BRAGG SCATTERING AND CHARGE DISTRIBU-

TION IN LITHIUM HYDRIDE, by T. J. Phillips and P.
M. Harris. Sept. 1959, 39p. incl. diagrs tables, refs.
(Technical rept. no. 3) (AFOSR-TN-59-757) (AF18-
(600)769) AD229758; PB 156107   Unclassified

Intensities of Laue-Bragg scattering from single crys-
tals of LiH were obtained at room temperature and
at approximately 100°K, using an x-ray spectrometer
equipped with either a Geiger-Müeller counter or pro-
portional counter detector. Values of relative crystal
structure factors, F_{hkl}, and relative atomic form fac-
tors were derived from the measured intensities. Ab-
solute crystal structure factors were determined by 2
different experimental methods: the use of a crystal
monochromator in conjunction with a Geiger-Müeller
counter detector, and the use of a proportional counter
detector with energy discrimination. Electron density
distributions were computed for LiH from the absolute
structure factors. Radial charge distributions were
computed from the electron density distributions. The
experimental crystal structure factors were found to
be in better agreement with an ionic model with overlap
than with either a neutral atom model or a separated
ion model. (Contractor's abstract)

1439

Ohio State U. Research Foundation. Dept. of Chemistry,
Columbus.

RESEARCH ON SOLID-STATE PROPERTIES OF ME-
TALLIC CERAMIC AND ELECTRONIC MATERIALS, by
P. M. Harris. Final rept. Sept. 1959, 7p. (AFOSR-TR-
59-109) (AF 18(600)769) AD 228575; PB 152014
                              Unclassified

The work covered and reported in Technical Reports
No. 1: (OSU.05: 003, Vol. I), No. 2: (item no. 1437, Vol
III) and No. 3: (item no. 1438, Vol. III) is briefly sum-
marized. Additional work initiated but not yet com-
pleted and being presently prosecuted is also reviewed.

1440

Ohio State U. [Research Foundation] Dept. of Chemistry,
Columbus.

GAS-LIQUID CHROMATOGRAPHIC ANALYSIS OF
SOME OXYGENATED PRODUCTIONS OF COOL-FLAME
COMBUSTION, by G Kyryacos, H. R. Menapace, and C.
E. Boord. [1959] [4]p. incl. diagrs (AF 18(600)787)
                              Unclassified

Published in Anal. Chem., v. 31: 222-225, Feb. 1959.

This work was carried out to understand better the
mechanism of hydrocarbon combustion through separa-
tion and identification of the intermediates formed in
cool-flame oxidation by means of gas chromatography.
Compounds hitherto unidentifiable have been separated
and identified: ethylene oxide, propionaldehyde, acetone,

acrolein, cis- and trans-2,5-dimethyltetrahydrofuran, n-butyraldehyde, methyl ethyl ketone, methyl vinyl ketone, 2-ethyl tetrahydrofuran, methanol, and croton-aldehyde. (Contractor's abstract)

1441

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

STRUCTURES OF TRINITRO-AROMATIC CRYSTALS AND RELATED SUBSTANCES, by P. M. Harris. Final rept. Sept. 1959 [63]p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-165) (AF 18(600)1371) AD 228781; PB 156104   Unclassified

Determinations were made of the molecular and crystal structures of trinitro-derivatives of benzene and related explosives, including sym-trinitrobenzene, RDX, TNT, picryl chloride, and lead styphnate.

1442

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

THE VAPORIZATION OF RARE EARTH OXIDES, by P. N. Walsh, H. W. Goldstein, and D. White. [1959] [19]p. incl. diagr. tables, refs. (AFOSR-TN-59-706) (AF 18(600)1545)   Unclassified

Presented at 61st annual meeting of the Amer. Ceramic Soc., Chicago, Ill., May 19, 1959.

Also published in Jour. Amer. Ceram. Soc., v. 43: 229-233, May 1, 1960.

A study of the vaporization of La_2O_3, Nd_2O_3, and Y_2O_3 at high temperatures has been carried out by the Knudsen effusion technique. The methods employed, the results of these measurements, and the low temperature heat capacities of these materials, which were determined for the purpose of calculating thermal functions of the oxides, are discussed. All the above oxides react with tantalum, forming gaseous tantalum monoxide as a principal product. Cubic tantalates of lanthanum and neodymium are also formed in these reactions. Dissociation energies of the monoxides of tantalum and the rare earth metals are given. Based on this information some generalizations about the vaporization behavior to be expected of other rare earth oxides are formulated. (Contractor's abstract)

1443

Ohio State U. [Research Foundation] [Dept. of Chemistry] Columbus.

NEW REACTIONS ON DECOMPOSITION OF A

HINDERED α-DIAZOKETONE, by M. S. Newman and A. Arkell. [1959] [3]p. incl. diagrs. refs. (AFOSR-190) (AF 33(616)3412)   Unclassified

Also published in Jour. Org. Chem., v. 24: 385-387, Mar. 1959.

A new procedure for the conversion of monohydrazones of α-diketones to α-diazoketones by oxidation of the hydrazone with mercuric trifluoroacetate in acetonitrile in the presence of triethylamine is described. The rearrangements of 4-diazo-2,2,5,5-tetramethyl-3-hexanone under several conditions are described. The main product of these rearrangements is 2,2,4,5-tetramethyl-4-hexen-3-one, a product in which a methyl migration has occurred. (Contractor's abstract)

1444

Ohio State U. [Research Foundation. Dept. of Chemistry] Columbus.

REARRANGEMENT OF 4-METHYL-4-TRICHLORO-METHYL-2,5-CYCLOHEXADIENOLS, by M. S. Newman, J. Eberwein, and L. L. Wood, Jr. [1959] [3]p. incl. refs. (AFOSR-TN-59-1077) (AF 49(638)-277)   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 6454-6456, Dec. 20, 1959.

It is shown that in 2 cases in which a trimethyl group was reported to undergo a 1:2-shift, errors in identification of products were made. 4-Methyl-1-phenyl-4-trichloromethyl-2,5-cyclohexadienol (I) yields 4-methylbiphenyl (II) on treatment with cold formic acid, and 2,6-dichloro-4-methyl-4-trichloromethyl-2,5-cyclohexadienol (VIII), yields 3,5-dichloro-2-methyl-benzoic acid (X) on treatment with a solution of sulfuric acid in acetic acid at reflux. (Contractor's abstract)

1445

Ohio State U. [Research Foundation. Dept. of Chemistry] Columbus.

REACTIONS OF 2,5-CYCLOHEXADIENONES CONTAINING THE TRICHLOROMETHYL GROUP, by M. S. Newman and L. L. Wood, Jr. [1959] [5]p. incl. refs. (AFOSR-TN-59-1078) (AF 49(638)277)   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 6450-6454, Dec. 20, 1959.

The synthesis of 3,4-dimethyl-4-trichloromethyl-2,5-cyclohexadienone (III) is described. On treatment with phosphorus pentachloride, III yields 4-methyl-3-(β,β,β-trichloroethyl)-chlorobenzene (IV). On treatment of III with polyphosphoric acid, 2-chloro-4,5-dimethylbenzoic acid (V) and 2-chloro-5,6-dimethyl-benzoic acid (VI) are formed in addition to a small amount of 3,4-dimethylchlorobenzene (VII). Treatment

of 4-methyl-4-trichloromethyl-2,5-cyclohexadienone (I) with the same reagents yields 3-methyl-4-trichloro-methylchlorobenzene and 4-chloro-2-methylbenzoic acid (VII) (plus a little *p*-chlorotoluene (IX)), respectively. Mechanisms are proposed to account for these facts. (Contractor's abstract)

1446

Ohio State U. Research Foundation. Dept. of Electrical Engineering, Columbus.

ANALYTICAL STUDY ON THE TRANSVERSE FIELD TRAVELING-WAVE TUBES, by F.-S. Chen. July 1959, 114p. incl. diagrs. tables, refs. (Technical note no. 5) (AFOSR-TN-59-985) (AF 18(600)982) AD 228321; PB 156108   Unclassified

It is known that transverse-field traveling-wave tubes have a low noise figure when the beam is well collimated. The present analysis shows in detail the properties of the slow-wave structure, the electronic motion, and the mechanism of energy exchange between the electron beam and the traveling wave from which gain, noise figure, and frequency response are evaluated. The proposed tube has a slow-wave structure composed of 2 flat helices, each of them wound on a conducting metal plate but insulated from it. By properly exciting the 2 helices, a transverse field is obtained between them. Direct potential is applied between the helices and the metal plates for periodic electrostatic focusing of the electron beam. The analysis of the slow-wave structure shows that 2 fundamental slow-wave modes can be excited. The propagation constants and the interaction impedances of the 2 modes are calculated. Also the field configuration in the various regions of the slow-wave structure is shown. (Contractor's abstract, modified)

1447

Ohio State U. [Research Foundation]. Dept. of Physics [and Astronomy] Columbus.

COMPUTATION OF ASYMMETRIC ROTATOR CON-STANTS FROM ENERGY MOMENTS. III. FIRST-OR-DER CENTRIFUGAL STRETCHING EFFECTS, by P. M. Parker and L. C. Brown. [1959] [4]p. incl. diagr. table. (AFOSR-TN-59-259) [AF 18(600)772] AD 251670   Unclassified

Also published in Jour. Chem. Phys.. v. 31: 1227-1230, Nov. 1959.

Further expressions are developed which relate the parameters of the asymmetric rotator to experimental data through moments of the energy levels. The expressions developed here apply to an asymmetric rotator system described by a Hamiltonian which includes terms allowing for 1st-order centrifugal stretching effects. A criterion for the applicability of the 1st-order theory is given. (Contractor's abstract)

1448

Ohio State U. [Research Foundation] Dept. of Physics and Astronomy, Columbus.

COMPUTATION OF RIGID ASYMMETRIC ROTATOR CONSTANTS FROM ENERGY MOMENTS, II. by P. M. Parker and L. C. Brown. [1959] [4]p. incl. tables, refs. [AF 18(600)772]   Unclassified

Published in Jour. Chem. Phys., v. 30: 900-912, Apr. 1959.

Further expressions are given which relate the rotational constants of the rigid asymmetric rotator to experimental data through moments of the energy levels. These expressions remove the requirement that all energy levels for given J be known. Instead, the energy levels associated with one symmetry group of the rotational wave functions for given J are required. (Contractor's abstract)

1449

Ohio State U. [Research Foundation. Dept. of Physics and Astronomy] Columbus.

ELECTRON BANDS OF A ONE-DIMENSIONAL RAN-DOM ALLOY (Abstract), by J. S. Faulkner and J. Korringa. [1959] [1]p. [AF 18(600)772]
                                                        Unclassified

Presented at meeting of the Amer. Phys. Soc.. Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 276, Apr. 30, 1959.

Our model consists of a linear array of square wells, α and β, with 2 different well depths, equally spaced in a "random" sequence, with specified concentrations. Scattering of electrons with energy E by 1 well is characterized by a 2 x 2 matrix, A or B, expressing traveling waves on 1 side in terms of those on the other side. Scattering by a sequence of N wells is thus given by a product of N matrices, ABBAB···. A random sequence of given concentration is represented by the average of all matrices obtained by permutations of this product. It is shown that the Nth root of this matrix is equal to the sum of our A and B matrices multiplied by energy dependent parameters that may be calculated for fixed N. Diagonalizing, an average reduced wave number k as a function of E is obtained.

1450

Ohio State U. Research Foundation. Dept. of Physics [and Astronomy] Columbus.

PARAMAGNETIC RESONANCE SPECTRA OF FREE RADICALS TRAPPED ON IRRADIATION OF CRYSTAL-LINE CARBOHYDRATES, by D. Williams, B. Schmidt

and cthers. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)772], Quartermaster Institute for the Armed Forces under DA 19-129-QM-932, and Office of Naval Research)
Unclassified

Published in Proc. Nat'l. Acad. Sci., v. 45: 1744-1751, Dec. 1959.

A number of carbohydrate substances were exposed to gamma radiation and their paramagnetic resonance spectra were studied. The extreme simplicity of the spectra for β-D-glucuronic acid and σ-D-galacturonic acid monohydrate allows a reasonable postulation to be made as to the structure of the stable free radicals present in these uronic acids. The relative simplicity of the spectra obtained from irradiated β-maltose monohydrate, β-cellobiose, α,α-trehalose and raffinose further allows postulations to be made concerning the radicals formed on irradiation of these oligosaccharides. On the basis of this work and published data, structures of the free radicals present in irradiated 2-amino-2-deoxy-α-glucopyranose hydrochloride, erythritol, and D-threitol are postulated. (Contractor's abstract)

1451

Ohio State U. Research Foundation. [Dept. of Physics and Astronomy] Columbus.

SPECIFIC HEATS OF METALS AND ALLOYS BELOW 1°K, by C V. Heer. Final rept. Nov. 1959, 7p. incl. illus. refs. (AFOSR-TR-59-198) (AF 49(638)254) AD 232127; PB 161461   Unclassified

The specific heat of a normal metal Na, a ferromagnetic metal Co, a ferromagnetic alloy Co_{93} Fe_7, an antiferromagnetic metal α-Mn, and an antiferromagnetic salt Mn F_2 have been measured in the temperature region between 0.4 and 2°K. A 2-stage magnetic refrigerator isothermal enclosure for future studies between 0.03 and 0.3°K was completed at the end of the contract. (Contractor's abstract)

1452

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

ATOMIC HEAT OF SODIUM METAL FROM 0 4 TO 2 K, by R. E. Gaumer and C. V. Heer. [1959] [3]p. incl. illus. diagrs. refs. (AFOSR-4426) (AF 49(638)-254)   Unclassified

Published in Phys. Rev., v. 118: 955-957, May 15, 1960.

The atomic heat of sodium metal was measured from 0.4 to 2°K using the magnetic refrigerator calorimeter. The experimental data is given by $C = 1.32T + 0.485\ T^3$ millijoule/mol-°K. No anomaly is observed in this

temperature range. The experimental value of the electronic specific heat and the Pauli spin paramagnetism by Schumacher and Slichter are used for comparison with the electronic band theory of sodium and with those modifications introduced by electron-electron and lattice-electron interactions. (Contractor's abstract)

1453

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

SPECIFIC HEATS ON Na, Co, AND Mn BELOW 1°K (Abstract), by R. E. Gaumer and C V. Heer. [1959] [1]p. (AF 49(638)254)   Unclassified

Presented at 14th Calorimetry Conf., Yale U., New Haven, Conn., Sept. 10-12, 1959.

Specific heat measurements on Na, Co, and Mn metals have been extended to 0.4°K by the use of a magnetic refrigerator calorimeter. Experimental measurements were facilitated by the use of a lead thermal valve which is actuated by a superconducting niobium coil immersed in the helium bath, and which either thermally isolates or connects the sample to a reservoir at 0.3°K Specific heat of singly distilled sodium metal is in reasonable agreement with that observed at higher temperatures by Roberts. The equation $C_v = 1.32T + 0.495T^3$ millijoule/mol-°K fits the experimental data between 0.4° and 2°K. No evidence of an anomaly was observed in this temperature region. The specific heat of high purity cobalt is in agreement with the previous measurements of Heer and Erickson down to 0.4°K ($C/R = 233(T/433)^3 + 5.7$ x $10^{-4}T + 4$ x $10^{-4}/T^2$). The $1/T^2$ term is a measure of the coupling between the cobalt nucleus and the electronic magnetic moment of the atom. Preliminary specific heat measurements on anti-ferromagnetic manganese and on a face-centered-cubic alloy of cobalt-iron are discussed with respect to the effect of structure on the coupling.

1454

Ohio State U. [Research Foundation. Dept. of Physics and Astronomy] Columbus.

EXACT TREATMENT OF THE ANTIFERROMAGNETIC GROUND STATE (Abstract), by H. L. Davis and J. Korringa. [1959] [1]p. [AF 49(638)264] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 242, Apr. 30, 1959.

For the purposes of this paper an antiferromagnet is defined by the Hamiltonian,

$$H = 2|J| \Sigma_{(neighbors)}\{S_j^z S_k^z + (1-\alpha)[S_j^x S_k^x + S_j^y S_k^y]\},$$

where α is an anisotropy parameter. The ground-state wave function of this Hamiltonian is obtained in terms of a linked-spin-cluster expansion, similar to Goldstone's linked-Feynman-diagram expansion, which gives, in principle, an exact solution of this magnetic many-body problem. The ground-state energy, short-range order, and long-range order are given for 1-, 2-, and 3-dimensional spin arrays and compared with the corresponding quantities calculated by variational means. A discussion is given, for both ground-state and excited state problems, of the applicability of the linked-spin-cluster method to Hamiltonians other than the 1 used here.

1455

Ohio State U. Research Foundation. Dept. of Physiological Chemistry, Columbus.

MECHANISM OF ACTION OF DEOXYRIBONUCLEASE, by W. J. Frajola. Final rept. Nov. 10, 1959, 15p. incl. illus. refs. (AFOSR-TR-59-188) (AF 18(603)125) AD 231402; PB 156105   Unclassified

Procedures are described for the examination of DNA in the electron microscope before and after treatment of the DNA with the enzyme, DNase. These procedures include a technique involving spraying the DNA solution upon freshly-cleaved mica and a technique involving the withdrawal of a monomolecular film of DNA upon a freshly-cleaved surface of mica. Either technique may be utilized for the production of long thin strands of DNA molecules. The enzymatic digestion of the DNA appears to occur in a random fashion without the production of smaller particles of uniform size or shape observable by the present techniques of electron microscopy. (Contractor's abstract)

1456

Ohio State U. [Research Foundation. Dept. of Psychology, Columbus].

SOME DESCRIPTIVE ASPECTS OF TWO-PERSON NON-ZERO-SUM GAMES, by A. Scodel, J. S. Minas and others. [1959] [6]p. incl. tables. (AFOSR-TN-59-396) (AF 49(638)317) AD 232544   Unclassified

Also published in Jour. Conflict Resolution, v. 3: 114-119, Mar. 1959.

This paper reports the initial results of a study designed to understand how people actually behave in game situations. It involved pairs of subjects in 2-person non-zero-sum game situations of a certain type (G type). G is played by 2 persons, 1 and 2. Each has 2 choices, α_1 and α_2 for player 1 and β_1 and β_2 for player 2. There are thus 4 possible outcomes; associated with each is a couple (x_i, x_j) that denotes the value of the

outcome to the players. The results suggest that persons involved in competitive play will seek to best one another rather than strive for a larger monetary gain which, in the course of the game, might allow the opponent to best him. It is suggested that perhaps this is related to a guarded behavior between people who are strangers to each other. The choice is between doing as well as or better, running the risk of doing worse. Under these conditions most subjects made the former choice, even at the sacrifice of a utility such as money.

1457

Ohio State U. [Research Foundation] Dept. of Psychology, Columbus.

INTERNAL AND EXTERNAL CONTROL AS DETERMINANTS OF DECISION MAKING UNDER CONDITIONS OF RISK, by S. Liverant and A. Scodel. [1959] [9]p. incl. tables, refs. (AFOSR-TN-59-888) (AF 49(638)-317) AD 232546   Unclassified

Also published in Psychol Repts., v. 7: 59-67, Aug. 1960

It is hypothesized that behavior in a situation involving decision making under conditions of risk is influenced by a dimension of internal-external control. Internally controlled persons (Is) are conceptualized as persons who attempt to maintain control in chance-dominated situations by a cautious and planned selection of probabilities, whereas externally controlled persons (Es) decide according to "hunches" or previous outcomes. As differentiated by a forced choice personality test, 28 Is and 26 Es engaged in a gambling situation in which each S was required to bet on the outcome of the toss of a pair of dice 30 times. On each trial S selected one of four amounts to bet on one of seven alternative outcomes with known objective probabilities. The principal differences between Is and Es were that the Is chose significantly more intermediate and significantly fewer low probability bets than the Es, significantly more Is than Es never selected an extreme high or low probability bet, the amount of money wagered on safe as against risky bets was significantly greater for Is, and there was a tendency for Is to be less variable in choice of alternatives. (Contractor's abstract)

1458

Oklahoma [State U.] Stillwater.

RECTIFICATION AND PHOTOEFFECTS IN SEMICONDUCTING DIAMONDS, by M. D. Bell. Thesis, Aug. 1956, 43p. incl. diagrs. refs. (AFOSR-TN-59-135) (AF 18(603)40) AD 211034   Unclassified

Two semiconducting diamonds were investigated with regard to rectification, photovoltaic, and photoconductive properties. The measurements of the rectification properties on both diamonds studied, indicate that the work function of the metal contact has very little effect

in forming the rectifying barrier. Metals of both high and low work functions give considerable rectification and also show variations in the degree of rectification over the surface of the diamond. These results imply the existence of surface levels that are inhomogeneous because of crystal imperfections or impurity atoms near the surface. The sign of the rectification indicates that the diamonds are predominately p-type semiconductors at the surface. In the determination of the photoeffects as a function of wavelength, there are several significant observations: (1) the occurrence of photoeffects in the visible and IR, (2) the indication of 2 peaks in the photovoltage response, (3) the apparent polarization effects of light indicated by the decrease of the photovoltage and the reversal of current flow on interrupting the light, (4) the indication of 2 peaks occurring in the photoconduct' ty response curve, and (5) the high residual dark currents after excitation by either UV or IR light. (Contractor's abstract)

1459

Oklahoma State U., Stillwater.

MEASUREMENT OF CARRIER LIFETIMES IN SEMICONDUCTING DIAMOND, by J. H. Wayland, Jr. Thesis, Aug. 1958, 44p. incl. diagrs. refs. (AFOSR-TN-59-136) (AF 18(603)40) AD 211035   Unclassified

The general methods used in obtaining carrier lifetimes in semiconductors were used in an attempt to measure lifetimes in the type IIb semiconducting diamond. These methods do not seem to provide effective means for actual measurement of carrier lifetimes in the present study. The diffusion length experiment did not show a detectable effect. The photoelectromagnetic short-circuit current method of measuring lifetimes did not succeed because the high surface recombination rate rendered the effect practically impossible to measure. The pulse response method indicated that the decay times vary with the depth of the traps. Observations were made on the buildup and decay of the photocurrent produced by a 480-c light chopper. The conductivity lifetime was concluded to be less than 100 μsec.

1460

Oklahoma [State U.] Stillwater.

DETERMINATION OF ENERGY LEVELS IN SEMI-CONDUCTING DIAMOND BY OPTICAL TRANSMISSION METHODS, by H. J. Stein. Thesis, May 1957, 44p incl. illus. diagrs. tables, refs. (AFOSR-TN-59-137) (AF 18(603)40) AD 211036   Unclassified

The optical properties of 2 semiconducting diamonds were investigated to obtain information on the nature of the imperfections responsible for the anomalous behavior of these rare diamonds. Optical absorption properties were examined from the fundamental cut-off in the UV to 13 μ. Observations of phosphorescence

were conducted to gain further knowledge of the energy levels and trapping levels in the forbidden energy gap. The UV cut-off value of 225 μ indicated that the forbidden energy gap is about 5.5 ev. The color of the phosphorescence suggests a trapping level near the center of the forbidden gap. Birefringence observations suggest that the level may be introduced by a slip condition in the diamond. Two possible mechanisms of conduction are formulated from the optical studies. One mechanism requires the Fermi level to lie on the acceptor level nearest the valence band. The activation energy corresponds with the 1.87-μ region and all other peaks occurring at longer wavelengths may be associated with excited states of the impurity atom. Another mechanism requires the Fermi level to lie about halfway between the valence band and the acceptor level. The activation energy is then associated with the 3.56-μ peak and the absorption at shorter wavelengths in the continuum may represent structure in the valence band.

1461

Oklahoma State U., Stillwater.

THE HALL EFFECT IN SEMICONDUCTING DIAMOND, by T. Young. Thesis, Aug. 1958, 40p. incl. diagrs. table, refs. (AFOSR-TN-59-138) (AF 18(603)40) AD 211037   Unclassified

An investigation was conducted on the Hall effect in semiconducting diamonds. For comparison, the diamonds are separated into 2 classes, type I and type II. These 2 types differ in 4 qualities. Type I diamonds have an absorption band at 8μ in the IR which is absent in type II. Type II diamonds are usually of a more mosaic character on their surface. Type I diamonds cut off in the ultraviolet at 3000A whereas Type II diamonds transmit at wavelengths as low as 2240A. Further subdivisions of type II into type IIa and IIb are made on the basis of their electrical resistivity. Although several other investigators have measured the Hall constant in type IIb diamond, this investigation was the first in which the resistivity of a diamond sample was as high as 10^5 ohm-cm. Previous investigations were made on samples whose resistivities were below 500 ohm-cm. The relatively high resistivity made some adjustments in the technique of measurements necessary, particularly in the area of contact phenomena.

1462

Oklahoma State U., Stillwater.

PHOTOCONDUCTIVITY IN SEMICONDUCTING DIAMONDS, by C. C Johnson. Thesis, May 1958, 39p. incl. diagrs. refs. (AFOSR-TN-59-139) (AF 18(603)-40) AD 211038   Unclassified

Photoconductivity in the type IIb diamond was studied as a function of intensity of illumination, spectral dis-

distribu*· · electric field strength, temperature, and crysta' ·ientation. Various aspects of the photovoltaic e' t were also studied. Alternating current meas· ements were made to eliminate the error induced by the dark current changing from point to point. This change in the dark current is the result of shallow trapping. Ultraviolet induced photocurrent in the diamond is much greater than the photocurrent induced by visible light when corrected in terms of photocurrent/photon. The photocurrent peaks instead of giving a continuum, probably because of transition probabilities. The directional dependence of the peak in the visible region appears at the same wavelength regardless of direction of the applied electric field. The magnitude of the photocurrent does not appreciably change with direction. Spectral distribution of the photovoltaic effect in the visible region is very similar to the photoconductivity, except that the region is not as broad. An additional peak appears at approximately $0.4\,\mu$ when the illuminated contact is on the blue end. The $0.4\,\mu$ peak, after correction to photovoltage/photon, is the predominant peak. Evidently this peak is a surface phenomenon. The photoconductivity peaks shift toward shorter wavelengths and decrease in absolute magnitude with decreasing temperature.

1463

Oklahoma State U. Dept. of Chemistry, Stillwater.

ON THE MECHANISM OF UREASE ACTION, by G. Gorin. [1959] [3]p. incl. table. (AFOSR-TN-59-278) (AF 18(603)135) AD 212712   Unclassified

Also published in Biochim. et Biophys. Acta, v. 34: 268-270, 1959.

Experiments designed to determine if carbamate is an intermediate in the formation of NH_3 and CO_2 from urease-catalyzed hydrolysis of urea are reported. The results indicate that this is true when no buffering agents are added and the pH is about 9; results with a citrate buffer at pH 5.5 have also indicated carbamic acid as an intermediate. It is reported that Nessler's agent was used to indicate the absence of carbamate.

1464

Oklahoma State U. Dept. of Chemistry, Stillwater.

ISOLATION AND CHARACTERIZATION OF ELECTRO-PHORETICALLY HOMOGENEOUS UREASE, by G. Gorin, J. M. Katyal and others. Sept. 1959 [14]p. incl. diagrs. tables, refs. (Technical note no. 4) (AFOSR-TN-59-749) (AF 18(603)135) AD 226850
                                          Unclassified

Description is given of the preparation of urease by a slight modification of Sumner's procedure of crystallization. Special ground jack beans were used as a source of the material. Urease preparations that behave

homogeneously on electrophoresis at pH 7 were obtained. The activity of the preparations was 97 Sumner unit/mg, and the sulfur content was 1.18 g/16 g of nitrogen.

1465

Oklahoma State U. Dept. of Chemistry, Stillwater.

KINETICS AND MECHANISM OF HYDROLYSIS OF AMMONIUM CARBAMATE, by G. Gorin and M. F. Butler. July 1959 [12]p. incl. diagrs. tables. (Technical note no. 3) (AFOSR TN-59-775) (AF 18(603)135) AD 227610; PB 144018   Unclassified

Ammonium carbamate is hydrolyzed in 0.1 $\underline{M}$ sodium hydroxide solution at 25° with a 1st-order specific rate constant of about 0.13 hr^{-1}. The rate is approx. inversely proportional to the pH in the range 0.05 - 0.25 $\underline{M}$ hydroxide. It is proposed that the decomposition of carbamic acid is the rate-determining step under these conditions. (Contractor's abstract)

1466

Oklahoma U Dept. of Physics, Norman.

EXCITATION FUNCTION OF HELIUM 3^1P FOR ELECTRON COLLISIONS, by R. M. St. John, C. J. Bronco, and R. G. Fowler. [1959] [5]p. incl. diagrs. refs. (AFOSR-TN-59-935) (AF 49(638)41) AD 235361
                                          Unclassified

Also published in Jour. Opt. Soc. Amer., v. 50: 28-32, Jan. 1960.

The function for the excitation of the helium 3^1P level by electron impact has been determined optically. Light intensity of the $3^1P - 2^1S$ transition (5016 A) was detected by a sensitive photomultiplier; its output was measured by a microammeter. The intensity of the 5016A line was proportional to electron beam current for all currents used and proportional to helium pressure for less than 3×10^{-4} mm. Above 3×10^{-4} mm pressure imprisonment of resonance radiation enhanced the light intensity. The excitation function has a peak value of 2.4×10^{-18} cm^2; this occurs at an electron energy of 100 ev. Absolute determination of the cross section was possible through the calibration of the light detection system by a tungsten ribbon standard lamp The experimental curve is corrected by removing cascade components from it. (Contractor's abstract)

1467

Oklahoma U. [Dept. of Physics] Norman.

LOW PRESSURE HELIUM EXCITATION FUNCTION

(Abstract), by R. M St. John and F. E. Fajen. [1959] [1]p. (AFOSR-TN-59-936) [AF 49(638)41]

Unclassified

Presented at Twelfth annual Gaseous Electronics Conf., Washington, D. C., Oct. 14-16, 1959.

Presented at meeting of the Amer. Phys. Soc., Rice Inst., Houston, Tex., Mar. 4-5, 1960.

Published in Bull. Amer. Phys. Soc., Series II, v. 5: 120, Mar. 4, 1960.

The excitation function for several excited states of helium have been examined for electron energies from 30 to 500 ev. The absolute value of the 3^1P function has been obtained through the use of a tungsten strip standard lamp. A sensitive photomultiplier was used for light detection. Pressures utilized in the excitation measurements were as low as 1×10^{-4} mm and absorption of resonance radiation was negligible for pressures below 3×10^{-4} mm. Filters were used for wavelength selection. When more than 1 line was transmitted, spectrographic data gave relative intensities. Levels contributing cascade components to the 3^1P level were studied and their effects eliminated. The 3^1P function of excitation by electron impact only has a peak value of 2.4×10^{-18} cm^2 at 100 ev. (Contractor's abstract)

1468

Oklahoma U. [Dept. of Physics] Norman.

EXCITATION CROSS-SECTION MEASUREMENTS ON HELIUM 3^1P LEVEL BY OPTICAL METHODS (Abstract), by R. M. St. John, R. G. Fowler, and C. [J.] Bronco. [1959] [1]p. [AF 49(638)41]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Texas U., Austin, Mar. 6-7 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 105, Mar 6, 1959.

Absolute measurements on cross sections for excitation of the helium atom from ground to the 3^1P level by electron impact have been made. Observations were made on 5016A radiation using a high gain photomultiplier. The photomultiplier current was measured with a microammeter for moderate light intensity levels, but with single pulse counting techniques at low levels. The light intensity from the collision chamber was measured as a function of electron beam current and helium pressure. The intensity was proportional to the current. This showed multiple collisions by a single electron were not prevalent. The intensity was propo - tional to pressure for pressures up to about 7×10^{-3} mm Hg. Above this pressure the intensity rose more

rapidly, indicating that resonance radiation effects were in operation. Relative intensity data by Fowler and Duffendack have been used to extend the intensity-pressure curve to pressures as high as 0.1 mm Hg.

Last, the excitation function of the 3^1P level was found with helium pressures low enough to prevent resonance radiation effects. The maximum cross section occurred for electrons of about 65- or 70-ev energy.

1469

Oklahoma U [Dept. of Physics] Norman.

OPTICAL EXCITATION CROSS-SECTION MEASURE- MENTS OF HELIUM 3^1P LEVEL (Abstract), by R. M. St. John, C. [J.] Bronco, and R. G Fowler. [1958] [1]p. [AF 49(638)41]   Unclassified

Presented at Eleventh Annual Gaseous Electronics Conf., New York, Oct. 22-25, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 110, Mar. 6, 1959.

Absolute measurements on cross sections for excitation of atoms by electrons are being made. The helium 3^1P level is being studied by observing 5016A light from the collision chamber. Low gas pressure and small electron beam currents require the use of single-pulse counting techniques in which a high-gain photomultiplier, linear amplifier, and scaler are used. The photomultiplier is employed at liquid air temperatures to reduce dark counts. The apparent cross section for the helium 3^1P level was found to be independent of electron beam current. It showed a broad maximum whose peak occurred at an electron energy of about 120 ev. The cross section appeared to be independent of pressure for pressures as high as 10^{-2} mm Hg. Thus, secondary processes presumably were not taking place. Absolute values of the excitation cross section of the 3^1P level will be obtained when calibration of the light-measuring equipment is completed. Estimates place the peak value near 10^{-18} cm^2.

1470

Oregon State Coll., Corvallis.

PROCEEDINGS OF THE 1959 INTERNATIONAL SYM- POSIUM ON COLOR CENTERS IN ALKALI HALIDES, Oregon State Coll., Corvallis, Sept. 8-11, 1959. [Salem] Oregon State Board of Higher Education, 1959, 39p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [CSO-680-59-14], National Science Foundation, Office of Naval Research, and Oregon State College).   Unclassified

This symposium grouped together for mutual study and communication many of the investigators concerned with color center phenomena. Projects reported on the production of color centers by various means including heating in alkali vapor, electrolysis, and x-ray irradiation, as well as the related subjects on photoconductivity, F-center formation, and crystal purity.

1471

Oregon U. Dept. of Chemistry, Eugene.

CHEMICAL STRUCTURE AND CHROMATOGRAPHIC ADSORBABILITY OF AROMATIC HYDROCARBONS ON ALUMINA, by L. H. Klemm, D. Reed and others. [1959] [10]p. incl. tables, refs. (AFOSR-TN-59-295) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)473 and Office of Ordnance Research under DA 04-200-ORD-176) AD 231605   Unclassified

Also published in Jour. Organic Chem., v. 24: 1468-1477, Oct. 1959.

An investigation of structural factors involved in the relative chromatographic adsorbabilities of binary mixtures of aromatic hydrocarbons on alumina was made using elution of the components with petroleum ether or petroleum ether-benzene and analysis of the effluent fractions by evaporation and m.p. determination on the residues. The Law of Inequalities—i.e., if (in adsorbability) A > B and B > C, then A > C—was found to hold. Moreover, adsorbability was found to increase with increasing (a) no. of double bonds, (b) approach to coplanarity, (c) symmetry no., (d) extent of conjugation, and (e) no. of sterically unhindered methyl or alkylene groups. In 2 alkylarene series R-Ar, the effect of R in fostering adsorbability was found to be Me (unhindered) > Et > H > i-Pr, tert-Bu. From the fact that the adsorbability relationships are closely analogous to those found for fostering stability in bona fide 1:1 π-type molecular compounds in solution it is proposed that adsorption on alumina also involves π-type complexation where the "active spots" on the alumina are relatively broad electron-attracting areas on to which the electron-donating hydrocarbon substrate is held monomolecularly and preferentially (where such arrangement is sterically possible) in a planar configuration parallel to the surface. (Contractor's abstract)

1472

Oregon U. Dept. of Chemistry, Eugene.

OPTICAL RESOLUTION BY MOLECULAR COMPLEXATION CHROMATOGRAPHY, by L. H. Klemm and D. Reed. [1959] [5]p. incl. table. (AFOSR-TN-59-730) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)473 and Office of Ordnance Research under DA 04-200-ORD-176) AD 237070
Unclassified

Also published in Jour. Chromatog., v. 3: 364-368, 1960.

Partial optical resolutions of 3 racemic aromatic compounds have been achieved by chromatography on silicic acid impregnated with optically active α-(2, 4, 5, 7-tetranitro-9-fluorenylideneaminooxy) propionic acid using petroleum ether as solvent. The success of this method is ascribed to the occurrence of molecular complexation (between the widely dispersed molecules of the impregnant and the aromatic compound) on the surface of the silicic acid support. (Contractor's abstract)

1473

Oslo U. [Inst. of Chemistry] (Norway).

INVESTIGATION OF MOLECULAR STRUCTURES, by O. Hassel. June 30, 1959, 1v. incl. diagrs. tables, refs. (Technical scientific note no. 1) (AFOSR-TN-59-916) (AF 61(052)71) AD 226443; PB 143638   Unclassified

A report is given consisting of 5 investigations dealing chiefly with chemical work and x-ray crystallographic analysis of solid addition compounds. The works include OSL.01:001, Vol. II, and item nos. 1474, 1475, 1476, 1477, Vol. III. Summarily the results show the structure of 2 addition compounds having chlorine as an electron acceptor, the structure of the compound 3 quinoline-CHI_3, and work on 1:1 compounds formed by oxalyl chloride (and bromide) and dioxan. Additional work is going on with iodine compounds of aromatic amines.

1474

Oslo U. Inst. of Chemistry (Norway).

CHARGE TRANSFER COMPOUNDS WITH A HALOGEN ATOM LINKED TO CARBON, HALOGEN BEING THE ELECTRON ACCEPTOR. CRYSTAL STRUCTURE OF THE COMPOUND $CHI_3 \cdot$ 3 QUINONLINE, by O. Hassel and T Bjorvatten. [1959] [4]p. incl. diagr. (AFOSR-3642) (Bound with its AFOSR-TN-59-916; AD 226443) (AF 61(052)71)   Unclassified

Also published in Acta Chem. Scand., v. 13: 1261-1262, 1959. (Title varies)

The principal features of the quinoline compound structure are given. It is reported that the primitive rhombohedral unit cell contains 1 molecule of iodoform, 3 molecules of quinoline. The findings concerning position confirm the suggestion that the iodine atoms act as electron acceptors, the nitrogens as donors. It appears likely that the electron accepting iodine atom has acquired a 10 electron system resembling that of the halogen atom directly attached to the donor atom in addition compounds formed by halogen molecules.

1475

Oslo U. Inst. of Chemistry (Norway).

CRYSTAL STRUCTURE OF THE ADDITION COM-
POUND 1,4-DIOXAN-CHLORINE, by O. Hassel and
K. O Strømme. [1959] [12]p. incl. diagrs. tables.
(AFOSR-3643) (Bound with its AFOSR-TN-59-916;
AD 226443) (AF 61(052)71)   Unclassified

Also published in Acta Chem. Scand., v. 13: 1775-1780,
1959.

An x-ray analysis of the 1:1 compound 1,4-dioxan-chlo-
rine carried out at temperatures between -30° and
-90°C shows that the crystals are isomorphous with
those of the corresponding bromine compound. The
monoclinic unit cell has the dimension a = 9.36A, b =
8.83A, c = 4.13A and β = 91.5°. The observed O-Cl and
Cl-Cl distances associated with the chlorine molecule
bridges are 2.67 and 2.02A, respectively. (Contrac-
tor's abstract)

1476

Oslo U. Inst. of Chemistry (Norway).

CRYSTAL STRUCTURE OF THE ADDITION COM-
POUND BENZENE-CHLORINE (1:1), by O. Hassel and
K. O Strømme. [1959] [10]p. incl. diagrs. tables.
(Bound with its AFOSR-TN-59-916; AD 226443)
(AF 61(052)71)   Unclassified

Published in Acta Chem. Scand., v. 13: 1781-1786, 1959.

The crystal structure of an equimolecular addition com-
pound benzene-chlorine was determined using single
crystal Weissenberg technique and working at low tem-
peratures, mainly about -90°C. The crystals are
monoclinic (space group C2/m) and isomorphous with
those of the corresponding benzene-bromine compound
Chains of alternating benzene and chlorine molecules
are present in the crystal, the Cl-Cl distance is 1.99A
and the distance from one particular chlorine atom to
the nearest benzene plane (3.28A), a little shorter than
the corresponding distance in the bromine compound.
(Contractor's abstract)

1477

Oslo U. Inst. of Chemistry (Norway).

CRYSTAL STRUCTURE OF THE ADDITION COM-
POUND 1,4-DIOXAN-SULPHURIC ACID, by O.
Hassel and Chr. Rømming. [1959] [5]p. incl. diagr.
tables. (Bound with its AFOSR-TN-59-916; AD 226443
(AF 61(052)71)   Unclassified

A determination of the structure of 1 compound formed
by an ether and a strong inorganic acid is made by
analyzing the crystal structure of the 1:1 compound
1,4-dioxan-sulphuric acid. The entire structure con-

sists of chains of alternating sulphuric and dioxan mol-
ecules. The 2 dioxan molecules linked to a particular
sulphuric acid molecule by hydrogen bonds are not crys-
tallographically equivalent but both are of the "chair"
form and the directions of the hydrogen bonds are all
"equatorial". The distance from the sulphur atom to
the nearest "keto" oxygen atoms is 1.41A, whereas the
distance to the oxygen atoms involved in hydrogen bond
formation is 1.47A. The O-O distance of the hydrogen
bridges is 2.57 ± 0.04A

1478

Oslo U. Inst. of Theoretical Astrophysics (Norway).

ON THE PROPAGATION OF TRANSVERSE ELEC-
TROMAGNETIC WAVES IN A PLASMA IN A MAG-
NETIC FIELD, by Ø Holter. 1959 [56]p. incl. diagrs.
refs. (Scientific rept. no. 1) (AFOSR-TN-59-1312)
(AF 61(052)49) AD 232059   Unclassified

Boltzmann's equation is the basis for the most general
determination of the propagation constants by statisti-
cal theory. The rather drastic simplifications neces-
sary make the solution valid for a Lorentz gas only.
By assuming a constant collision frequency the mac-
roscopic approximation is obtained, in which a general
formula for the refractive index is evaluated explicitly.
The latter formula contains the Appleton-Hartree
formula and Astrom's results as special cases. An
investigation of the collision effect on Åstrom-Ferraro
waves gives the limiting velocity equal to zero as the
frequency approaches zero. (Contractor's abstract)

1479

Oslo U. Inst. of Theoretical Astrophysics (Norway).

THEORETICAL RESEARCHES IN MAGNETO-HYDRO-
DYNAMICS, by Ø. Holter, E. Jensen and others. Final
technical rept. June 30, 1959, 19p. (AFOSR-TR-59-92)
(AF 61(052)49) AD 219370; PB 145065   Unclassified

Researches were made in the general field of magneto-
hydrodynamics by the Institute of Theoretical Astro-
physics, Oslo. The subjects covered are plasma oscil-
lations in the classicial sense; general theory of wave
propagation in a plasma; the form and importance of
viscous forces in plasma phenomena when magnetic
fields are active; plasma shock waves; and forces in a
plasma conditioned by certain deviations from thermal
equilibrium, in particular deviations from equipartition
of kinetic energy.

1480

Oslo U. Neurophysiological Lab. (Norway)

FUNCTIONAL LOCALIZATION WITHIN THE AMYG-
DALOID COMPLEX IN THE CAT, by H. Ursin and B. R.
Kaada. [1959] [23]p. incl. refs. (AFOSR-TN-59-483)

(Sponsored jointly by Air Force Office of Scientific Re-
search under AF 61(514)1127 and Norwegian Research
Council for Science and the Humanities) AD 215736
Unclassified

Also published in Electroencephalog. and Clin.
Neurophysiol., v. 12: 1-20, Feb. 1960.

The behavior, somatomotor and autonomic effects
observed from stimulation of 182 electrode sites in the
amygdala (149 in unanesthetized cats) are reported. The
results, together with a closer analysis of the data pub-
lished by other authors, indicate a definite topographic
organization of different functions within the amygdala,
although with some overlapping. Each type of response
is discussed under the various sections. Behavior at-
tention in conjunction with EEG desynchronization is re-
lated to the basolateral division of the amygdaloid com-
plex. The responsive zone can be traced medially
through the region of the central nucleus into the inter-
nal capsule. This extension appears to correspond to
the c-bundle of Fox (Jour. Compar. Neurol., v. 72: 1-
62, 1940). Fear (flight) and anger are produced from 2
separate areas running approximately parallel within
the attention zone from the basolateral nuclei and into
the internal capsule and brain stem. Various somato-
motor (sniffing, licking, chewing, facial contractions)
and autonomic effects (salivation, respiration pupillo-
dilation, micturition, defecation, piloerection) are
elicited from different portions of the amygdaloid com-
plex. The pathways for some of these reactions are
briefly discussed. (Contractor's abstract)

1481

Oslo U. Neurophysiological Lab. (Norway).

THE TEMPORAL LOBE SUBSTRATE OF FEAR AND
ANGER: A REVIEW OF RECENT STIMULATION AND
ABLATION STUDIES IN ANIMALS AND HUMANS, by
H. Ursin. [1959] 24p. incl. refs. (AFOSR-TN-59-994)
(Sponsored jointly by Air Force Office of Scientific Re-
search under AF 61(514)1127 and Norwegian Research
Council for Science and the Humanities) AD 226753
Unclassified

Also published in Acta Psychiat. et Neurol. Scand.,
v. 35: 378-396, July 1960.

A review is given of recent stimulation and ablation
studies in animals and humans regarding the importance
of temporal lobe structures for emotional behavior. In
animals fear has been produced by stimulation of the
temporal cortex and from a limited portion of the
amygdala (anger from the amygdala only). The 2 types
of emotional behavior patterns appear to be related to 2
separate subdivisions of the amygdaloid nuclear com-
plex. The observations in humans, although as yet not
conclusive, seem in the whole to be in agreement with
the results from the animal experiments. (Contractor's
abstract)

1482

Oslo U. Neurophysiological Lab. (Norway).

GENERALIZED ELECTROCORTICAL ACTIVATION
BY CORTICAL STIMULATION IN THE CAT, by B. R.
Kaada and N. B. Johannessen. [1959] [14]p. incl. refs.
(AFOSR-TN-59-995) (Sponsored jointly by Air Force
Office of Scientific Research under AF 61(514)1127 and
Norwegian Research Council for Science and the Humani-
ties) AD 226752 Unclassified

Also published in Electroencephalog. and Clin. Neuro-
physiol. Jour., v. 12: 567-573, Aug. 1960.

The cerebral cortical areas have been determined. From
electrical stimulation, a generalized electrocortical ac-
tivation (desynchronization) can be elicited for these
areas. Positive sites were located in: (1) the medial
frontal cortex and cingulate and hippocampal gyri; (2)
the intermediate lateral frontal cortex; (3) the temporo-
occipital cortex; (4) the orbito-insulo-temporal polar re-
gion; and (5) the parietal cortex. The responsive areas
correspond to those from which a behavior attention
response, various autonomic effects, and inhibition of
spontaneous movements can be obtained. Through pro-
jections to the brain stem or thalamic reticular areas,
these cortical fields probably contribute to the initiation
and maintenance of wakefulness and directed attention.

1483

Oslo U. Neurophysiological Lab. (Norway).

BEHAVIOR "ATTENTION" AND FEAR INDUCED BY
CORTICAL STIMULATION IN THE CAT, by C. Fangel
and B. R Kaada. [1959] [29]p. incl. refs. (AFOSR-TN-
59-996) (Sponsored jointly by Air Force Office of
Scientific Research under AF 61(514)1127 and Norwegian
Research Council for Science and the Humanities)
AD 226751 Unclassified

Also published in Electroencephalog. and Clin. Neuro-
physiol. Jour., v. 12: 575-583, Aug. 1960.

The cerebral cortical areas have been determined from
which a behavior attention response can be induced by
stimulation in the unanesthetized cat. Three components
may be distinguished in this behavior pattern: (1) arrest
of all ongoing spontaneous movement; (2) increased
alertness; and (3) orienting movements towards the con-
tralateral side. The responsive areas include: (1) the
cortex of the medial frontal surface, the cingulate and
hippocampal gyri; (2) the intermediate lateral frontal
cortex; (3) a large temporo-occipital field; (4) the orbito-
insular-temporal polar region; and (5) a weaker parietal
field. These cortical zones correspond to those from
which a generalized electrocortical activation have been
elicited in the cat and monkey. The positive areas coin-
cide with those previously known to produce inhibition

of spontaneous movements, various autonomic effects and contraversion. Fear resulted from stimulation of the cingulate and temporo-occipital cortex. (Contractor's abstract)

1484

Oslo U. Neurophysiological Lab. (Norway).

INTERHIPPOCAMPAL IMPULSES. I. ORIGIN, COURSE AND DISTRIBUTION IN CAT, RABBIT, AND RAT, by P. Andersen. [1959] [47]p. incl. refs. (AFOSR-TN-59-997) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 226758   Unclassified

Also published in Acta Physiol. Scand., v. 47: 63-90, 1959.

The 1st in a series of studies concerned with the activation of the hippocampal fields CA1 and CA3 by interhippocampal impulses is described. The evoked potential technique was employed in cats, rabbits and rats under urethane-chloralose anesthesia. The origin of the interhippocampal impulses was the point homotopic to the recording electrode. In both CA1 and CA3, the stimulus thresholds were lowest in the pyramidal cell body and their apical dendritic shaft layers. The interhippocampal impulses of CA1 and of CA3 were abolished by ventral psalterium section. The CA1 commissural response consisted of a surface positive/negative wave with a spike on the positive wave. The positive wave was recorded negative (interpreted as an excitatory postsynaptic potential) in the layer of the apical dendritic shafts which presumably is the main termination of interhippocampal impulses to CA1, confirming anatomical studies. The CA3 commissural response was a diphasic spike (fimbria fibre activity) followed by a negative wave with a spike. The negative wave, probably an excitatory postsynaptic potential, was recorded in the layer of the basal dendrites, making this the probable termination site of CA3 interhippocampal impulses. (Contractor's abstract)

1485

Oslo U. Neurophysiological Lab. (Norway).

INTERHIPPOCAMPAL IMPULSES. II. APICAL DENDRITIC ACTIVATION OF CA1 NEURONS, by P. Andersen. [1959] [42]p. incl. refs. (AFOSR-TN-59-998) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 226757   Unclassified

Also published in Acta Physiol. Scand., v. 48: 178-208, 1960.

An analysis of the commissural response of the field CA1 of the hippocampus, a surface positive wave with a spike followed by a negative wave, is described. The major, later part of the surface positive wave was recorded negative in the layer of apical dendritic shafts. This deep negative wave is interpreted as a summated excitatory postsynaptic potential. It seems to have a causal relationship to the production of the spike. The spike most often showed its shortest latency in the apical dendritic shaft layers, increasing in both directions along the dendritic tree. The speed of propagation along the dendritic shaft was about 0.35 m/sec. The surface negative wave is confined to the basal layers and is probably partly due to the spread of the depolarizing wave along the dendrites and partly to the activity of superficially located neurons. In the CA1 apical dendritic membrane, 2 mechanisms were found: one was responsible for the production of the deep negative wave; the other was responsible for the initiation and propagation of the spike along the dendrites. (Contractor's abstract)

1486

Oslo U. Neurophysiological Lab. (Norway).

INTERHIPPOCAMPAL IMPULSES. III. BASAL DENDRITIC ACTIVATION OF CA3 NEURONS, by P. Andersen. [1959] [31]p. incl. refs. (AFOSR-TN-59-999) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 226756   Unclassified

Also published in Acta Physiol. Scand., v. 48: 209-230, 1960.

The commissural afferents to the hippocampal field CA3 terminate in the layer of the basal dendrites only, making selective basal dendritic activation possible. The response of CA3 in response to a symmetrical contralateral stimulation is a diphasic spike followed by a negative wave, sometimes with a superimposed spike. The diphasic spike represents interhippocampal fibre activity. The negative wave was recorded only from the CA3 basal dendritic layer. It is partly an excitatory postsynaptic potential produced in the basal dendrites by the commissural volley, partly a postsynaptic CA3 neuron discharge. The spike is a more synchronous discharge of the same neurons. The commissural volley elicits spikes more seldom in CA3 than in CA1, where apical dendritic activation is the most prominent, suggesting that a cell discharge is easier produced by apical than by basal dendritic activation. The susceptibility to anoxia is similar for the 2 fields. Strychnine normally produces great changes in CA1 potentials, but has only minor influence on the CA3 commissural response. (Contractor's abstract)

1487

Oslo U. Neurophysiological Lab. (Norway).

TELENCEPHALIC "AROUSAL" AREAS: THEIR

RELATION TO THE SITE OF ACTION OF PSYCHO-
TROPIC DRUGS, by B. R. Kaada. [1959] [10]p. incl.
refs. (AFOSR-TN-59-1000) [AF 61(514)1127]
AD 226755   Unclassified

Also published in First Internac'l. Cong. of Neuro-
pyschopharmacology Symposium on Methods and
Analysis of Drug-Induced Behavior in Animals, Rome
(Italy), Sept. 1958, Amsterdam, Elsevier Publishing
Co., 1959, p. 38-45.

Problems of functional localization within limbic
structures are discussed. The pyriform cortex, parts
of the amygdala, the olfactory tubercle, bed nucleus
of the stria terminalis, etc. are the areas of olfaction.
The areas related to autonomic activity are the anterior
cingulate, the orbito-insulo-temporal polar cortex, and
part of the amygdala. The hypothalamus and brain stem
retincular formation are the principal sites of fear-
producing and arousal activity. A probable major ther-
apeutic site of action of tranquilizer drugs was con-
sidered to be in the telencephalic arousal areas or
their reticular (inclusive thalamic recticular) counter-
parts or both.

1488

Oslo U. Neurophysiological Lab. (Norway).

EFFECTS OF BARBITURATES AND NITROUS
OXIDE ON THE LEVEL OF 17-OH STEROIDS AND
EOSINOPHILE CELLS IN CAT, by B. R. Kaada, J.
Setekleiv, and O. E. Skaug. [1959] [9]p. incl. refs.
(AFOSR-TN-59-1001) (Sponsored jointlyby Air Force
Office of Scientific Research under AF 61(514)1127
and Norwegian Research Council for Science and the
Humanities) AD 226754   Unclassified

Also published in Acta Pharmacol. et Toxicol., v. 16:
87-96, 1959.

Experiments were carried out to study the effects of
sodium pentobarbital, diallybarbituric acid, and ni-
trous oxide on the 17-OH-steroid level and eosinophile
cells in cats (to avoid stress sensibility under anes-
thesia, the specimens were exposed to cold for a cer-
tain period). The results support the non-specific
character of an eosinopenia in cat, and can be sum-
marized as follows: (1) Both pentobarbital and dial
barbiturates produced a marked initial and temporary
rise of the plasma 17-OH-steroids in cats. This in-
crease appears to be related to and possibly depend-
ent of the length of the initial excitatory state. During
the anesthetic stage the plasma level of the 17-OH-
steroids is fairly constant. (2) The plasma 17-OH-
steroids varied considerably in samples taken under
a few min nitrous oxide anesthesia, possibly corre-
sponding to the varying degree of excitement in the
induction stage. (3) Dial seemed to have a less block-
ing effect than pentobarbital on the adrenocortical re-
sponse to a moderate stress (exposure to +4°C for
90 min). (4) No constant relationship was found be-

tween the plasma 17-OH-steroids and the blood
eosinophiles. Eosinopenia cannot be used as a reliable
index of adrenocortical function in the cat.

1489

Oslo U. Neurophysiological Lab. (Norway).

INTERHIPPOCAMPAL IMPULSES. IV. A CORRELA-
TION OF SOME FUNCTIONAL AND STRUCTURAL
PROPERTIES OF THE INTERHIPPOCAMPAL FIBRES
IN CAT, RABBIT AND RAT, by P. Andersen. July 9,
1959 [23]p incl. ilius. diagrs.tables, refs. (AFOSR-
TN-59-1317) (Sponsored jointly by Air Force Office
of Scientific Research under AF 61(514)1127 and
Norwegian Research Council for Science and the Hu-
manities) AD 244781   Unclassified

Also published in Acta Physiol. Scand., v. 48: 329-351,
1960

The interhippocampal fiber activity was previously
found to be represented by an initial diphasic spike of
the response of the field CA3 to contralateral symmet-
rical stimulation. Since all the interhippocampal fibers
are thin (around 1μ) an myelinated, it was felt that this
tract might serve as a suitable structure for a study
of the properties of thin fibers within the central nerv-
ous system. A correlation was made between various
functional and structural properties of these fibers.
A comparison of the results obtained in cat, rabbit, and
rat can be summarized as follows: (1) The conduction
velocity of the interhippocampalimpulse was 3.3 m/sec
in cat, 5.6 m/sec in rabbit, and 7.5 m/sec in rat; it
decreased with lowering the temperature; and it de-
creased with increasing the anoxia duration. (2) In
all 3 species, the absolute and relative refractory
periods were 1.2-1.3 msec and 4-5 msec, respectively.
The period of latent period was 0.3 msec.

1490

Oxford U. Dept. of Biochemistry (Gt. Brit.).

[ACETATE METABOLISM IN MICROORGANISMS]
Final technical rept. Feb. 1, 1957-Jan. 31, 1959.
15p. incl. diagrs. refs. (Rept. no. 825) (AFOSR-TR-
59-48) (AF 61(514)1180) AD 215261   Unclassified

This research is concerned with ascertaining the vari-
ous metabolic pathways whereby acetate can serve as
sole carbon and energy source for the growth of micro-
organisms when they are restricted to an acetate diet.
Preliminary findings indicate that malate can be formed
from acetate by a route not involving the tricarboxylic
cycle. It was surprisingly found that isocitrate is in
equilibrium with succinate and glyoxylate which reacts
with acetyl coenzyme A in yield malate. The role of
acetyl coenzyme A in the conversion of fat to carbohy-
drates is investigated also. The metabolism of other
C_2-compounds is also discussed. Since some micro-

organisms do not posses isocitratase, the metabolic routes whereby glycine, glycollate, and oxalate can serve as sole carbon source and energy source for growth become very important. It is suggested that glycine can participate as a donor and recipient in C_1-

transfer reactions similar to the reported metabolism in some anaerobic bacteria. The possible pathways whereby glycollate can provide the carbon source have not yet been elucitated but that some organisms can grow on such a diet is an established fact. The oxalate studies show that phosphoglyceric acid plays a role in the biosynthesis, but this pathway is still under investigation. The metabolism of C_1-compounds is further discussed also.

1491

Oxford U. Dept. of Biochemistry (Gt.Brit.)

CARBOXYDISMUTASE ACTIVITY IN FORMATE- AND OXALATE-GROWN PSEUDOMONAS OXALATICUS (STRAIN OX 1), by J. R. Quayle and D. B. Keech. [1959] [2]p.incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research under AF61(514)1180 and Rockefeller Foundation)   Unclassified

Published in Biochim. et Biophys. Acta, v. 31: 587-588, Feb. 1959.

Experiments on P. oxalaticus (OX 1) which indicate that CO_2 fixation via ribulose 1,5-diphosphate represents, at the most, a minor pathway for fixation of oxalate carbon into cell constituents are presented. P. oxalaticus (OX 1)growing on oxalate as sole carbon source incorporated very little carbon from $NaH^{14}CO_3$. The extracts of oxalate-grown organisms also possessed very little activity when measured for the incorporation of $NaH^{14}CO_3$. However, when the cells were placed in fresh grown medium containing formate as sole carbon source the activity rose 15 fold. The experiments show that: (1) Carboxydimutase is synthesized before growth on formate commences. This is consistent with earlier findings that a Calvin cycle of CO_2 fixation is involved during growth on this subtract. (2) This cycle cannot operate during growth on oxalate since carboxydismutase is not synthesized, and CO_2 fixation processes occur only to a minor extent under these circumstances.

1492

Oxford U. Dept. of Biochemistry (Gt. Brit.).

ASSAY METHODS FOR KEY ENZYMES OF THE GLYOXYLATE CYCLE (Abstract), by G. H. Dixon and H. L. Kornberg. [1959] [1]p. [AF 61(514)1180]
                                        Unclassified

Presented at 381st meeting of the Biochemical Society. Oxford U. (Gt. Brit.), Mar. 20, 1959.

Published in Biochem. Jour., v. 72: 3P,May 1959.

Two assay methods for key enzymes of the glyoxylate cycle are discussed. The 1st, concerned with isocitratase depends on measurement of the rate of increase of optical density at 324 mμ consequent upon the formation of glyoxylic acid phenylhydrazine from glyoxylate. The principle of the latter depends on the measurement of the rate of decrease of optical density at 232 mμ consequent upon breakage of the thio-ester bond of acetyl coenzyme A in the presence of glyoxylate. Both methods demand use of spectrophotometers sensitive at high optical densities.

1493

Oxford U. Dept. of Biochemistry (Gt. Brit.).

CARBON ASSIMILATION BY PSEUDOMONAS OXALATICUS (OX 1). I. FORMATE AND CARBON DIOXIDE UTILIZATION DURING GROWTH ON FORMATE, by J. R. Quayle and D. B. Keech. [1959] [8]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1180 and Rockefeller Foundation)   Unclassified

Published in Biochem. Jour., v. 72: 623-630, Aug. 1959.

The incorporation of carbon from either $[C^{14}]$formate or $[C^{14}]$bicarbonate by cultures of P. oxalaticus (OX 1) grown on formate has been studied. Isotope appeared in both the aqueous ethanol-soluble and protein fractions of the cells during 5 min incubation periods. The distribution of radioactivity within the non-volatile constituents of these fractions, after incubation for from 12 sec to 5 min, was analyzed by chromatography and radioautography. Over 80% of the radioactivity incorporated at the earliest time into the ethanol-soluble fractions was present in phosphorylated compounds, and 5% in malate, with either $[C^{14}]$formate or $[C^{14}]$bicarbonate. After incubation for 1 min, radioactivity also appeared in citrate, aspartate and glutamate. In 12 sec, over 80% of the radioactivity initially incorporated into phosphorylated compounds was present in 3-phosphoglyceric acid; phosphates of glucose, fructose, sedoheptulose and ribose (to a minor extent) became labeled in the later samples. The specific radioactivity of cellular material obtained from cells grown on $[C^{14}]$formate in air was reduced 17-fold by bubbling air + carbon dioxide (95:5, v/v) through the growing culture. Thus at least 94% of the carbon incorporated must have passed through the stage of carbon dioxide or a compound in ready equilibrium with it. These results show that the organism synthesizes cell constituents from carbon dioxide by a cycle similar to that found in photosynthetic organisms and other autotrophic organisms. The necessary energy is derived from oxidation of the formate to carbon dioxide. (Contractor's abstract)

1494

Oxford U. Dept. of Biochemistry (Gt. Brit.).

CARBON ASSIMILATION BY PSEUDOMONAS OXA-
LATICUS (OX 1). II. FORMATE AND CARBON DI-
OXIDE UTILIZATION BY CELL-FREE EXTRACTS OF
THE ORGANISM GROWN ON FORMATE, by J. R.
Quayle and D. B. Keech. [1959] [7]p. incl. diagrs.
tables, refs. (Sponsored jointly by Air Force Office of
Scientific Research under AF 61(514)1180 and Rocke-
feller Foundation)   Unclassified

Published in Biochem. Jour., v. 72: 631-637, Aug. 1959.

Reactions of $[C^{14}]$formate and $[C^{14}]$bicarbonate in
cell-free extracts (prepared with a Hughes press) of P.
oxalaticus (OX 1) grown on formate was studied. The
extracts catalyze the incorporation of $[C^{14}]$bicarbonate
into 3-phosphoglycerate in the presence of either ribu-
lose 1:5-diphosphate or ribose 5-phosphate plus adeno-
sine triphosphate. These findings show the existence
of phosphoriboisomerase, phosphoribulokinase and car-
boxydismutase in the extracts. 3-Phospho$[C^{14}]$glyceric
acid is also formed in the extracts from $[C^{14}]$formate
and ribulose 1:5-diphosphate. This enzymic activity is
removed by centrifuging the extract and restored by re-
combining the particulate and supernatant fractions. In-
cubation under anaerobic conditions reduced the phos-
phoglycerate formation from $[C^{14}]$formate to 1/3 of that
observed on aerobic incubation. Addition of methylene
blue restored the anerobic incorporation to 72% of that
observed under aerobic conditions. The particulate
fraction of the extract oxidizes formate to carbon di-
oxide. These results show that the ribulose 1:5-diphos-
phate-dependent incorporation of $[C^{14}]$formate in the ex-
tract is preceded by oxidation of the formate to carbon
dioxide. The extracts incorporate $[C^{14}]$bicarbonate into
malate in the presence of pyruvate and reduced di- or
tri-phosphopyridine nucleotide. The latter coenzyme was
the more effective. $[C^{14}]$Bicarbonate incorporation into
malate and oxaloacetate in the presence of phosphopy-
ruvate is catalyzed by the extracts. (Contractor's
abstract)

1495

Oxford U. Dept. of Biochemistry (Gt. Brit.).

ASPECTS OF TERMINAL RESPIRATION IN MICRO-
ORGANISMS, by H. L. Kornberg. [1959] [30]p. incl.
diagrs. tables, refs. [AF 61(514)1180]   Unclassified

Published in Ann. Rev. Microbiol., v. 13: 49-78, 1959.

It is the main purpose of this review to discuss some
of the difficulties encountered in the study of microbial
oxidative processes, to survey some of the evidence in
support of the TCA cycle, and to review reactions ancil-
lary to the cycle, including the possible routes whereby
microorganisms utilize as substrates compounds more
highly oxidized than acetate, such as glycollate, glycine,
oxalate and formate.

1496

Oxford U. Dept. of Biochemistry (Gt. Brit.)

BIOSYNTHESIS OF CELL CONSTITUENTS FROM
C_2-COMPOUNDS. PART I. FORMATION OF MALATE
FROM GLYCOLATE BY PSEUDOMONAS OVALIS
CHESTER, by H. L. Kornberg and A. M. Gotto. PART
II. FORMATION OF GLYCERATE FROM OXALATE BY
PSEUDOMONAS OXALATICUS (OX 1) GROWN IN OXA-
LATE, by J. R. Quayle and D. B. Keech. [1959] [5]p.
incl. diagrs. refs. (AFOSR-TN-59-1137) (Sponsored
jointly by Air Force Office of Scientific Research under
AF 61(052)180 and Rockefeller Foundation) AD 232067
                                        Unclassified

Also published in Nature, v. 183: 1791-1793; 1794-
1795. June 27, 1959.

Part I: It is shown that cells grown on glycolate contain
enzymes capable of forming malate from glycolate, and
a possible route for the formation of cell constituents
from glycolate is suggested. Although full experimental
details are reported elsewhere, the observations which
led to this suggested route are presented. Part II: Grow-
ing cultures of P. oxalaticus were incubated with oxalate-
C^{14} and the entry of C^{14} into the cells was followed by
chromatographic and radioautographic techniques. The
isotope from oxalate enters glycine first, and then phos-
phoglycerate along with other metabolites, such as sugar
phosphates and alanine, become labeled. Work with
cell-free extracts, using in some cases C^{14}-glyoxylate
and in some cases C^{14}-oxalate, produced results which
indicate that the following reactions may occur in the
crude extracts: (1) 2 oxalate + 2 acetyl coenzyme A → 2
oxalyl coenzyme A + 2 acetate; (2) 2 oxalyl coenzyme A
+ 2 $DPNH_2$ → 2 glyoxylate + 2 coenzyme A + 2 DPN;
(3) 2 glyoxylate + $DPNH_2$ → glycerate + CO_2 + DPN.

The DPN represents diphosphopyridine nucleotide.
The conclusion reached is that incorporation of oxalate
follows a similar route to that suggested for other pseu-
domonads growing on glycolate. The essential difference
lies in the reduction of oxalate to glyoxylate, the latter
compound being the first common intermediary metabolite
of these 3 growth substrates.

1497

Oxford U. Engineering Lab. (Gt. Brit.).

RADIATION AND ENERGY LOSS OF AN ELECTRON IN
AN INFINITELY LONG WAVE-GUIDE FILLED WITH A

LINEAR MEDIUM, by H. Motz and M. Nakamura. Oct. 1958 [54]p. incl. diagrs. (Technical note no. 2) (AFOSR-TN-59-43) (AF 61(514)1183) AD 209215
Unclassified

Also published in Ann. Phys., v. 7: 84-131, May 1959.

Electromagnetic fields excited by a single electron with a prescribed motion in an infinitely long cylindrical space surrounded by perfectly conducting walls, and filled with a uniform linear medium, are investigated. The medium is assumed to be lossy to avoid complexities arising from the radiation condition. A general expression is obtained for the electric Hertz vector. Electric fields are calculated from this Hertz vector for (1) uniform motion of the electron parallel to the axis of of a waveguide of arbitrary cross section, (2) uniform but longitudinally oscillatory motion, and (3) undulating motion with constant velocity parallel to the axis of a rectangular waveguide. Results show that the electric field can be represented as the sum of residues corresponding to different field patterns. The power flow from the electron to the electromagnetic field is calculated. An upper limit is shown to exist for the energy loss including Cerenkov and electrostatic loss. Connected with the fact that undulator radiation is propagated both forward and backward, no upper limit can be given in the case of undulator radiation. In the limit of infinitely large cross section of the waveguide, the formulae tend to the results for the unbounded medium.

1498

Oxford U. Engineering Lab. (Gt. Brit.).

A NON-THERMAL DIRECT-CURRENT PLASMA-HEATING MECHANISM, by D. Reagan. [1959] [1]p. (AFOSR-TN-59-198) [AF 61(514)1183] AD 211475
Unclassified

Also published in Nature, v. 183: 102, Jan. 10, 1959.

The coupling of the E_z component of the applied dc electric field and an electron to generate traveling compressional waves in a plasma has been investigated. The ion relaxation principle suggested by Schlüter has been used to show that if the electron moves undisturbed through a complete vibratory cycle in its magnetic potential well, it will divert all the energy it has gained from E_z in the interval to the magnetic field.

It is possible that such oscillations contribute to the remarkably fast ion heating in recent experiments.

1499

Oxford U. Engineering Lab. (Gt. Brit.).

FAST ION HEATING, by D. Reagan. [1959] [2]p. (AFOSR-TN-59-898) [AF 61(514)1183] AD 225320
Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 82-83, Feb. 1, 1959.

Transverse magnetic compression waves are invoked to account for part of the ion heating which occurs in "Zeta" and "Sceptre". An estimate is quoted of the magnitude of the energy available due to modes excited by the initial collapse of the discharge. The time required to give 100 ev energy to the ion is approximately 0.1 msec.

1500

Oxford U. [Engineering Lab.] (Gt. Brit.).

SOME COMPRESSION WAVES IN PLASMAS, by D. Reagan. [1959] [1]p. incl. table. (AFOSR-TN-59-899) [AF 61(514)1183] AD 225319
Unclassified

Also published in Phys. Fluids, v. 2: 93, Jan.-Feb. 1959.

Experiments are described on the excitation of compression waves in plasmas by transient phenomena such as shocks and arcs, or by hydromagnetic instabilities. The possibility of powering them from an external source is suggested.

1501

Oxford U. Inorganic Chemistry Lab. (Gt. Brit.).

PRODUCTION OF HIGH CONCENTRATIONS OF HYDROGEN ATOMS, by K. R. Jennings and J. W. Linnett. [1959] [2]p. (AFOSR-TN-59-227) (AF 61(514)1117) AD 211810
Unclassified

Also published in Nature, v. 182: 597-598, Aug. 30, 1958.

A detailed description of hydrogen atom production using 9.7 mc/s radiation from a 350 w radiofrequency oscillator is presented. The resulting atomic concentration of 50-60%, 25 cm downstream from the discharge compares favorably with other methods of high concentration hydrogen production.

1502

Oxford U. Inorganic Chemistry Lab. (Gt. Brit.).

THE RECOMBINATION OF OXYGEN ATOMS AT SURFACES, by J. C. Creaves and J. W. Linnett. [1959] [8]p. incl. diagrs. tables. (AFOSR-TN-59-228) [AF 61(514)1117] AD 211841
Unclassified

Also published in Trans. Faraday Soc., v. 54: 1323-1330, Sept. 1958.

Linnett and Marsden's apparatus, with some modifications, was used for determining the accommodation

coefficients for the removal of oxygen atoms at surfaces. The results at room temperature for 28 surfaces (elements, oxides and halides) are presented and discussed. The conclusions may be summarized as follows: (1) For most of the surfaces the decay of atom concentration down the side tube is, within our experimental error, exponential, showing that the wall removal-process is usually 1st order. In the few cases where the decay appears not to be strictly exponential the surface may not be uniform; (2) The range of values for the recombination coefficient is from 10^{-4} to 2×10^{-1}; and (3) The activity cannot be related to any single parameter associated with the surface material though some of the comparisons can be understood on the basis of a particular mechanism. (Contractor's abstract)

1503

Oxford U. Inorganic Chemistry Lab. (Gt. Brit.).

PRODUCTION OF ATOMS USING ELECTRIC DISCHARGES, by J. C. Greaves, K. R. Jennings, and J. W. Linnett. Feb. 1959, 18p. (AFOSR-TN-59-293)
(AF 61(514)1117) AD 213033   Unclassified

Experiences in the production of atoms by electric discharges are reported. Initially, discharges between internal metal electrodes were used. This method was later discarded in favor of electrodeless discharges, with radiation of frequencies near both 10 and 3000 mc used to maintain discharge. Results indicate that an arrangement using an RF transmitter is preferred to microwave radiation for maintaining discharge, and that by this method concentrations of atomic hydrogen greater than 50% at pressure of 1/10 mm can be produced. However, for pressure greater than 10 mm the theory is advanced that microwave radiation might prove superior to RF for producing the discharge. (ASTIA abstract)

1504

Oxford U. Inorganic Chemistry Lab. (Gt. Brit.).

A STUDY OF DIFFUSION IN A REACTING SYSTEM, by P. G. Dickens, D. Schofield, and J. Walsh. Feb. 1960 [17]p. incl. diagrs. table, refs. (AFOSR-TN-59-868) (AF 61(514)1117) AD 236533; PB 147106
                                           Unclassified

Also published in Trans. Faraday Soc., v. 56: 225-233, Feb. 1960. (Title varies)

An effort was made to derive and solve numerically the 3-dimensional, non-linear diffusion equation for the recombination of atoms at surfaces. The following conclusions were made: (1) The simple exponential relationship $\iota = \iota_0 \exp(-2/\delta)^{1/2} z/R$ is an adequate theoretical expression for the measurement of δ for surfaces of low activity if atom concentrations of less than 10% are used. (2) If higher atom concentrations are used, solutions of the non-linear, 1-dimensional equation are the best approximations for inactive surfaces. (3) If probes are used for the measurement of atom concentrations and approximated geometrically to the end plate model, the slope of the graph of ln (ι/ι_0) against L/R for large L/R is independent of the probe activity and is $\sim(2/\delta)^{1/2}$. Quantitatively, for all but the most active surfaces, values of L/R can be used for which ι/ι_0 has fallen to 0.1. Alternatively, for low initial atom concentrations, the procedure adopted by Wise and Ablow (Jour. Chem. Phys., v. 28: 634, 1958) can be used. (4) For conditions of high atom concentrations and active walls, the correct solutions of the diffusion problem cannot adequately be approximated by the solutions of the simpler equations.

1505

Oxford U. Inorganic Chemistry Lab. (Gt. Brit.).

RECOMBINATION OF ATOMS AT SURFACES. PART 7. HYDROGEN ATOMS AT SILICA AND OTHER SIMILAR SURFACES, by M Green. K. R. Jennings and others. Feb. 1960 [27]p. incl. diagrs. refs. (AFOSR-TN-59-869) (AF 61(514)1117) AD 236829; PB 147499
                                           Unclassified

Also published in Trans. Faraday Soc., v. 55: 2152-2161, Dec. 1959.

The recombination coefficients for H at SiO_2, B_2O_3, Al_2O_3, K_2HPO_4, and K_3PO_4 surfaces were measured from 20° to 600°C. The effect of washing and treating the SiO_2 surface in different ways was examined. A reasonable explanation was offered for the wide range of results with temperature by assuming that the surface hydroxyls are inactive, whereas saturated O atoms in the surface are active sites. The mechanism assumed was the loose attachment of an H atom followed by its removal by another one.

1506

Palermo U. Inst. of Physics (Italy).

RESEARCH ON CRYSTAL PLASTICITY, by D. A. Aboav.
Final rept. Jan. 1959, 24p. incl. diagrs. tables, refs.
(AFOSR-TR-59-27) (AF 61(514)1078) AD 212257;
PB 142098   Unclassified

A theory is advanced to describe plastic deformation of
metal crystals, particularly laminar glide in hexagonal
crystals. It is assumed that the internal energy of a
crystal is not uniformly distributed among the elements
of its lattice, but develops a definite configuration, i.e.,
the "secondary structure" of the crystal. To define this
configuration, an additional parameter, the "state" of a
lattice-element is introduced and the energy of a pair of
neighboring lattice elements is assumed to contain a
term proportional to the difference of their states.
Temperature and entropy are defined in terms of ex-
changes of state between neighboring elements. An at-
tempt is made to relate the critical shear stress, the
hardening that accompanies laminar glide, and crystal
recovery to changes in the secondary structure. Within
a certain range of purity, the critical shear stress of a
crystal increases as the cube root of the concentration
of impurity, but below a critical concentration, it is in-
dependent of impurity content. By employing the sec-
ondary structure theory, the indentation hardness, H, of
many pure metals is given as $H = 1/20G/n$, where G is
the shear modulus of elasticity and n is the number of
glide directions. The scratch hardness is independent
of n and roughly proportional to the square root of G.
Metal fatigue is attributed to a universal property of
crystalline matter; the inability of a metal to withstand
as great a stress under cyclic stressing as under static
load arises from a slow irreversible change in the sec-
ondary structure.

Palmer Physical Lab., Princeton, N. J. see
    Princeton U. Palmer Physical Lab., N. J.

Palomar Observatory, Pasadena, Calif. see
    California Inst. of Tech. Palomar Observatory,
    Pasadena.

1507

Paris U. (France).

INTERNAL DOUBLE REFLECTION IN A PERFECT
CRYSTAL, by A. Guinier and E. Guyon. Nov. 15, 1958
[18]p. incl. illus. diagrs. refs. (Scientific note no. 1)
(AFOSR-TN-59-124) (AF 61(052)51) AD 210429
                                             Unclassified

Also published in Jour. Appl. Phys., v. 30: 622-628,
May 1959.

Double Bragg reflections can occur in perfect single
crystals. Streaks are visible starting from the trace

of the direct beam towards the primary Bragg spots.
The geometry of the observed streaks is explained.
Thin intensity cannot be accounted for by the dynami-
cal theory. An attempt to use the kinematic theory
has been made and leads to results which are in quali-
tative agreement with experiments. Examples of this
kind of internal double Bragg-reflections are given for
LiF, diamond and an alloy Al-Cu. (Contractor's
abstract)

1508

Paris U. (France).

STUDIES OF DISLOCATIONS IN METALS BY X-RAY
METHODS. by A. Guinier. Annual summary rept. no.
1, Jan. 1, 1958-Jan. 1, 1959, 9p. incl. diagrs. refs.
(AFOSR-TN-59-348) (AF 61(052)51) AD 213868;
PB 144519   Unclassified

The atomic structure of a dislocation was studied by
means of diffuse x-ray scattering. Suitable specimens
were obtained with single Cu crystals so that only one
system of slip lines would be visible. Theoretical cal-
culations showed that scattering is concentrated in the
immediate vicinity of the normal nodes of the reciprocal
lattice. The scattering due to the thermal agitation is
also maximum around the nodes, and its intensity is
larger than the expected scattering from the dislocations
even at low temperatures. Localization of the imper-
fections or dislocations in a crystal was investigated by
x-ray techniques. Two extreme theoretical cases which
were studied are the perfect crystal with dynamical theo-
ry and the mosaic crystal with the cinematical theory.
The predicted reflecting power is much smaller for the
perfect crystal. (ASTIA abstract)

1509

Paris U. (France).

SMALL ANGLE SCATTERING MEETING. SUMMARIZ-
ING REMARKS, by A. Guinier. [1959] 6p. [AF 61(052)-
51]   Unclassified

Presented at Small X-Ray Conf., Kansas City, Mo.,
Sept. 23-25, 1958.

Published in Jour. Appl. Phys., v. 30: 601-603, May 1959.

The summarizing remarks to the Small Angle X-Ray
Conf. are presented. Some basic facts about small an-
gle scattering techniques are reviewed as well as the
various breakthroughs and new discoveries.

1510

Paris U. Lab. de Physique (France).

ON THE CONNECTION BETWEEN THE S-MATRIX
AND A CLASS OF NON-LOCAL INTERACTIONS, by

Kh. Chadan. [1958] 23p. incl. diagrs. refs. (Technical note no. 11) (AFOSR-TN-59-49) (AF 61(514)1060) AD 209420 Unclassified

Also published in Nuovo Cimento, Series X, v. 10: 892-908, Dec. 1958.

The method of Gourdin and Martin (Nuovo Cimento v. 6: 757, 1957; v. 8: 699, 1958) for finding a phenomenological separable interaction from the S-matrix which gives exact and explicit formulas relating the interaction to the phase-shift and bound state binding energy is generalized to the case where the interaction is the superposition of a non-local separable interaction and a local one, both of them being central. The local part of the interaction is assumed to be known and the separable part can be determined by the S-matrix. The methods and results are analogous to those of Gourdin and Martin, except for a few modifications. Given the local part of the interaction, the phase-shift and the bound states binding energies, the separable part of the interaction can be determined if the phase-shift has a good behavior.

1511

Paris U. Lab. de Physique (France).

[THEORETICAL STUDIES OF NUCLEON-NUCLEON INTERACTIONS] Technical rept. Oct. 1, 1956-Sept. 30, 1958, 1v. incl. tables, refs. (AFOSR-TN-59-224) (AF 61(514)1060) AD 211606; PB 150693
Unclassified

A summary of the accomplishments and a review of the present situation of the theory of nuclear and anti-nuclear forces is presented. The reported results of this work (PAR.01:001-007, Vol. II; and item no. 1510, Vol. III) show the following: (1) Theoretical evidence has been given for a long range imaginary force between nucleon and antinucleon and a mathematical method to calculate it has been produced; (2) A phenomenological analysis of the experimental data has shown that the real potential is likely to explain the results; (3) Progresses have been made in the study of the origin of spin-orbit coupling in nuclei; (4) The problem of deducing a non-local separable interaction from the collision matrix has been completely elucidated and exact solutions have been given; and (5) A powerful method has been given to treat high energy nucleon-nucleon scattering.

1512

Paris U. Lab. de Physique Théorique et Hautes Energies (France).

K^+-DEUTERIUM SCATTERING-I, by M. Gourdin and A. Martin. [1959] 15p. incl. diagrs. (Technical note no. 12) (AFOSR-TN-59-48) (AF 61(052)173) AD 209419; PB 139557 Unclassified

Also published in Nuovo Cimento, Series X, v. 11: 670-678, Mar. 1, 1959.

Theoretical K^+-deuteron scattering, both elastic and inelastic, was studied. Impulse approximation was used for the calculation neglecting final state interactions and P-waves. The sensitivity of the results to the $I = 0$ scattering length was investigated. Results show that the exchange cross section permits conclusions to be drawn on the $I = 0$ elementary scattering amplitude. This preliminary work is unsatisfactory because elementary P amplitudes which are present in the high energy domain were not introduced. Consideration should be given to the interaction of the 2 nucleons in the final state which might enhance the cross sections by an appreciable factor.

1513

Paris U. [Lab. de Physique Théorique et Hautes Energies] (France).

ON THE DESCRIPTION OF UNSTABLE PARTICLES IN QUANTUM FIELD THEORY, by M. Levy. [1959] 36p. incl. diagrs. refs. (Technical note no. 13) (AFOSR-TN-59-417) (AF 61(052)173) AD 214564; PB 142097
Unclassified

Also published in Nuovo Cimento, Series X, v. 13: 115-143, July 1, 1959.

The mass and lifetime of an unstable particle may be defined by the real and imaginary parts of a complex pole appearing on the Riemann surface in which its propagator can be continued analytically. This method, which was originally proposed by Peierls, is studied in detail, first on the basis of a special model, then in a more general field theory. The possibility of analytical continuation of the propagator is discussed, using the conditions of causality and unitarity of the S-matrix. The appearance of unphysical poles in the various sheets of the Riemann surface is also discussed. It is inferred that a physical principle must be used in each case, in order to select the particular pole which can be correctly interpreted as describing the properties of an unstable particle. (Contractor's abstract)

1514

Paris U. [Lab. de Physique Théorique et Hautes Energies] (France).

ON THE VALIDITY OF THE EXPONENTIAL LAW FOR THE DECAY OF AN UNSTABLE PARTICLE, by M. Lévy. [1959] [13]p. incl. diagr. refs. [Technical note no. 15] [AF 61(052)173] Unclassified

Published in Nuovo Cimento, Series X, v. 14: 612-624, Nov. 1, 1959.

The departure from the exponential decay law of an unstable particle is discussed, with the help of the Lee

model, starting from an initial state which is a general superposition of eigenstates of the Hamiltonian. It is shown that the asymptotic behavior and the magnitude of the additional terms are strongly affected by the production mechanism; although they can never vanish exactly, these terms can be made arbitrarily small by an appropriate preparation of the initial state. A possible generalization of this result is discussed. (Contractor's abstract)

1515

Paris U. [Lab. de Physique Théorique et Hautes Energies] (France).

K^+-DEUTERIUM INELASTIC AND EXCHANGE SCATTERING.-II, by M. Gourdin and A. Martin. [1959] [13]p. incl. diagrs. refs. [Technical note no. 14] [AF 61(052)-173]   Unclassified

Published in Nuovo Cimento, Series X, v. 14: 722-734, Nov. 16, 1959.

The importance of the K^+-deuterium scattering in the study of the K^+-nucleon interaction has led to an improved calculation. The final state interaction of the nucleons when the deuterium is split during the collision is taken into account. The other approximations made previously (impulse approximation, constancy of the elementary scattering amplitudes) are maintained. The total cross-sections suffer then relatively small modifications, whereas the differential cross-sections are very sensitive to the final state interaction. The numerical calculations were made on an IBM 704 computer. The angular distributions and the total scattering cross-sections are given. The latter, as well as the ratio of the exchange scattering to the non exchange scattering, appear to be the simplest means of obtaining information on the scattering amplitude of the I = 0 isospin state of the K^+ meson-nucleon system. (Contractor's abstract)

1516

Paris U. [Lab. de Physique Théorique et Hautes Energies] (France).

RELATIVISTIC DEUTERON WAVE FUNCTION.-I, by M. Gourdin and J. T. T. Van. [1959] [14]p. incl. diagrs. refs. [Technical note no. 16] [AF 61(052)173]
                                                                                              Unclassified

Published in Nuovo Cimento, Series X,   1051-1064, Dec. 1, 1959.

The deuteron problem is studied starting from the relativistic wave equation of Bethe and Salpeter. It is possible, after certain approximations, to calculate the coupling constant corresponding to the binding energy measured experimentally and to give an explicit numerical form for the wave function in the energy momentum space. A Fourier transform of this wave function taken at the limit of equal times is compared with the Hulthén

non-relativistic wave function usually used to represent the deuteron. The relativistic corrections produce a repulsive effect analogous to a hard core, and this result is in agreement with the one already found in the nucleon-nucleon scattering problem which was previously worked up. (Contractor's abstract)

1517

Pennsylvania State U. [Dept. of Aeronautical Engineering] University Park.

GASDYNAMICS OF PLASMAS (Abstract), by H. Li. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)647)   Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

A theoretical investigation of the gasdynamics of plasmas has been initiated to study the macroscopic equations of magnetogasdynamics and the expressions for the transport properties (electrical and thermal conductivities, viscosity and diffusion). The hydrodynamic equations (continuity, momentum and energy) will be derived for a gaseous mixture of neutral and charged particles in the presence of an electromagnetic field. This derivation of the equations will be based upon the kinetic theory of gases. At 1st, the effects of the chemical reaction (dissociation and ionization) will be neglected, but later the hydrodynamic equations will be modified for a chemically reacting gaseous mixture with internal degree of freedom. Similarly, a preliminary evaluation of the transport coefficients will be made. This evaluation will be based on a 2nd approximation of the velocity distribution function for a fully ionized gas. Two different models of the particles will be considered. The particles will be taken as rigid elastic spheres in the 1st model and as centers of force in the 2nd.

1518

Pennsylvania State U. Dept. of Chemistry, University Park.

STEREOSPECIFIC TRANS RADICAL ADDITION OF DBr TO THE 2-BUTENES SYNTHESES OF ERYTHRO-AND THREO-3-DEUTERO-2-BROMOBUTANES, by P. S. Skell and R. G. Allen. [1959] 13p. (AFOSR-TN-59-388) (AF 49(638)457) AD 214508; PB 142682
                                                                                              Unclassified

Presented at meeting of the Div. of Org. Chem. of the Amer. Chem Soc., Chicago, Ill., Sept. 7-12, 1958.

Abstract published in 134th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 27-P. (Title varies)

Also published in Jour. Amer. Chem. Soc., v. 81: 5383-5385, Oct. 20, 1959.

Pure erythro- and threo-3-deutero-2-bromobutanes can be synthesized by radical chain additions of deuterium bromide to trans and cis-2-butenes, respectively. Structures and purity were determined by alkaline dehydrohalogenation, erythro- yielding trans-2-butene and cis-2-deutero-2-butene, threo- yielding cis-2-butene and trans-2-deutero-2-butene. The mechanistic implications are considered. (Contractor's abstract)

1519

Pennyslvania State U. Dept. of Chemistry, University Park.

SPECIFIC ROTATIONS OF PURE 2-BROMOBUTANES. STEREOCHEMISTRY OF THE 2-BUTANOL TO 2-BROMOBUTANE CONVERSION, by P. S. Skell, R. G. Allen, and G. K. Helmkamp. May 31, 1959, 18p. incl. diagrs. tables, refs. (AFOSR-TN-59-544) (AF 49(638)-457) AD 216560; PB 142020 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 410-414, Jan. 20, 1960.

There is no satisfactory method for demonstrating the optical purity or for resolving alkyl halides with halogen at the asymmetric center. The purest 2-bromobutane reported in the literature ($[\alpha]_D^{25}$ 28.6°) is now demonstrated to be 28% racemized. Introduction of 1 deuterium in the 3-position creates a 2nd asymmetric center which serves as an internal standard of configuration, enabling one to define the stereochemical course of reactions without resorting to resolutions. Erythro- and threo-3-deutero-2-butanols are converted to the bromides with phosphorous tribromide. Comparison of these products with pure erythro- and threo-3-deutero-2-bromobutanes indicates the alcohol to bromide conversion occurs without skeletal rearrangement and produces a product which is 85-90% inverted at the carbinol carbon corresponding to 20-30% racemization. The remainder has the same configuration as the alcohol. Thus it becomes possible to estimate $[\alpha]_D^{25}$ for optically pure 2-bromobutane (39.4°), erythro-3-deutero-2-bromobutane (38.9°) and threo-3-deutero-2-bromobutane (38.9°). Racemization is minimized by low reaction temperatures, 2-bromobutane with $[\alpha]_D^{25}$ + 32.09° being produced at -15°. (Contractor's abstract)

1520

Pennsylvania State U. Field Emission Lab., University Park.

A SEARCH FOR POLARIZATION OF FIELD-EMITTED ELECTRONS, by W. T. Pimbley. June 1959, 53p. incl. illus. diagrs. table, refs. (Technical rept. no. 10) (AFOSR-TN-59-622) (AF 18(600)672) AD 217686; PB 143174 Unclassified

Experiments were performed designed to detect polarization of field-emitted electrons using Mott scattering. Electrons emitted from various crystallographic planes of a clean tungsten surface, from individual quarters of a phthalocyanine quadruplet on a clean tungsten substrate and from single ferromagnetic domains of iron were analyzed in a temperature range from 21°K to 900°K. In no case was any polarization detected. The average least detectable asymmetry factor that could be determined by the apparatus was calculated to be .04 corresponding to a polarization of 10% in a plane normal to the field emitted beam. (Contractor's abstract)

1521

Pennsylvania State U. Field Emission Lab., University Park.

EXPERIMENTAL MEASUREMENT OF THE TOTAL-ENERGY DISTRIBUTION OF FIELD-EMITTED ELECTRONS, by R. D. Young and E. W. Müller. [1959] [6]p. incl. diagrs. (AFOSR-3506) (AF 18(600)672) Unclassified

Published in Phys. Rev., v. 113: 115-120, Jan. 1, 1959.

Measurements of the energy distribution of field-emitted electrons with an improved retarding-potential analyzer revealed an unexpectedly narrow distribution width. Further study indicated that the tube measures the distribution in total energy of field-emitted electrons. Experimental distributions as narrow as 0.14 ev were measured. Data were obtained at liquid hydrogen, liquid nitrogen, and room temperatures and were found to be in good agreement with the new theory. The resolution of the improved analyzer is estimated to be between 0.02 and 0.03 ev. The experimental results obtained from the very sensitive total-energy distribution measurements serve as a further verification of the Fowler-Nordheim theory in the total-energy representation. (Contractor's abstract)

1522

Pennsylvania State U. Field Emission Lab., University Park.

[THE RESOLUTION CAPACITY OF THE FIELD ION MICROSCOPE] Das Auflösungsvermögen des Feldionenmikroskopes, by E. W. Müller. [1956] [9]p. incl. illus. diagrs. refs. (AFOSR-3507) (AF 18(600)672) Unclassified

Also published in Zeitschr. Naturforsch., v. 11a: 88-94, 1956.

A consideration of the resolution of a field emission microscope appears to be advantageous with ions rather than electrons. Some data on field desorption and field emission is conveyed and the mechanism of this effect is explained. From this, there follows a relationship

for the resolution, which is confirmed experimentally. Helium proves to be quite favorable for the representation of very strong metal surfaces. Cooling of the microscope with solid nitrogen or liquid hydrogen to increase the accommodation coefficient helps keep the atomic structure of the object visible. Adjacent tungsten atoms of 2.74A distance are clearly separated.

1523

Pennsylvania State U. [Field Emission Lab.] University Park.

PERFECTION OF METAL CRYSTAL SURFACES BY FIELD EVAPORATION (Abstract), by E. W. Müller. [1959] [1]p. [AF 49(638)504]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Milwaukee, Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 322-323, June 18, 1959.

The habit of a field evaporated metal crystal is a result of the condition that the field, determined by applied voltage and surface geometry, removes ions from all surface elements at the same rate. For a high-purity crystal a rounded off shape is expected with the local radius of curvature varying in the same sense as the work function of the considered region. A perfect surface with high index net planes can only be developed with high purity materials. If in a cubic lattice the highest Miller index of an appearing plane is h, the concentration of impurities must be less than $1/h^3$, and the minimum tip radius which will allow the development of such a plane is approximately h^3 times the half lattice constant. Experimental examples are shown of pure crystals of the platinum metals exhibiting more than 1000 facet-like net planes with Miller indices up to 11, and of similar tungsten crystals and iron whiskers. Impure crystals and alloys assume an irregular surface because of local randomness of work function and work to field evaporate an ion.

1524

Pennsylvania State U. [Field Emission Lab.] University Park.

FIELD ION MICROSCOPE STUDIES OF SURFACE CORROSION, OF INTERSTITIALS, VACANCIES AND α-IRRADIATION DAMAGE BY CONTROLLED FIELD EVAPORATION OF ATOMIC LAYERS, by E. W. Müller. [1959] [14]p. incl. illus. refs. (Bound with its AFOSR-TR-59-212) [AF 49(638)504]   Unclassified

Also published in Proc. Internat'l. Conf. on Structure and Properties of Thin Films, Bolton Landing, N. Y. (Sept. 9-11, 1959), New York, Wiley and Sons, 1959, p. 476-489.

A study is reported on the use of the field evaporation technique at low temperatures operated with helium ions. Corrosion was accomplished by turning the field off and applying it again after oxygen had come in contact with the surface. The perfect surface was re-established by gradual field evaporation. It was found that the corrosion level could extend as deep as 5 layers in the case of tungsten. Platinum oxidation is slower. Adsorbed hydrogen atoms, it is believed, block the adsorption sites of oxygen and completely prevent the corrosion. Oxygen atoms were found in interstitial positions in the study of rhodium tips. A systematic search of the interior of the platinum tip was conducted in order to locate vacancies. Several were found corresponding to a concentration of 5.9×10^{-4}.

1525

Pennsylvania State U. [Field Emission Lab.] University Park.

[OBSERVATION OF NEARLY PERFECT METAL CRYSTALS AND POINT DEFECTS IN THE FIELD ION MICROSCOPE] Beobachtung von nahezu fehlerfreien Metallkristallen und von Punktdefekten im Feldionenmikroskop, by E. W Müller. [1959] [12]p. [AF 49-(638)504]   Unclassified

Published in Zeitschr. Phys., v. 156: 399-410, 1959.

The perfection of the surface of field-evaporated metallic crystals in low-temperature field ion microscope depends only on the perfection and purity of the inside of the crystal. With this, a plane surface with a high Miller index h can be perfected, the concentration of disordered impurities must be smaller than h^{-3}. Surfaces evaporated crystals from highly pure Pt and W as well as ordinary Re, Pd and Ni are shown. Statistically divided flaws in the form of a Rhodium crystal are explained as oxygen atoms in interstitial spaces. In platinum, empty lattice spaces are produced by burning and quenching, and appear detached. From their directly observed concentration and quenching temperature, an energy of formation of 1.15 ev is produced.

1526

Pennsylvania State U. Groth Inst., University Park.

A PROGRAM FOR PREPARATION OF A MODERNIZED VERSION OF GROTH'S CHEMISCHE KRISTALLOGRAPHIE (Abstract), by R. Pepinsky. [1958] 3p. (AF 49-(638)416)   Unclassified

Presented at meeting of the X-Ray Analysis Groups, Sheffield (Gt. Brit.), Oct. 15, 1958.

A procedure has been introduced for the recording and storage of data in crystal chemistry and physics, which permits its transfer to IBM BCD magnetic tape

in a form most efficient for IBM 704 machine input for a wide variety of crystallographic computations, and for printout by IBM 407 tabulators or cardatype machines, according to any desired categories, and directly onto reproducing (Multilith) mats. Efficient data-abstracting procedures for punched-card primary input, and methods of proof-reading and editing, have been developed. Using these new techniques, a program is in progress to record all crystal data, to compare and evaluate results from various types of measurements, and to carry out automatically all feasible crystallographic computations — including those bearing on morphology, structure analyses and their results, crystal physics, etc.

1527

Pennsylvania State U. Groth Inst., University Park.

CONCERNING ESTABLISHMENT OF THE GROTH INSTITUTE AND REVISION OF GROTH'S CHEMISCHE KRYSTALLOGRAPHIE, by R. Pepinsky. Apr. 2, 1958, 26p. (Rept. no. 2) (AFOSR-TN-59-312) (AF 49(638)-416) AD 221900   Unclassified

The Groth Inst. has recently been established at Pennsylvania State U. to serve as data collecting, interpretation, and editorial center for revision of Paul von Groth's Chemische Krystallographie (an encyclopedia of chemical and physical properties of crystals, published during the early 1900's). The revision is to include bringing the chemical and physical data on all crystalline solids up to date, adding information on crystals measured since the 1st edition, correlating all of this information with knowledge of internal structure as revealed by diffraction methods and other techniques, and correlating other physical and chemical properties with one another. Ultimately all of the information and interpretations on crystal data will be published in a series of volumes entitled Groth's Encyclopedia of Chemical and Physical Crystallography, Revised Edition. This program is rendered manageable through the introduction of new methods of data storage, handling and processing, involving punched card and magnetic tape storage suitable for introduction of data into high-speed large-scale computers (IBM 704), followed by automatic print-out of results on high-speed tabulators and card-to-typewriter devices.

1528

Pennsylvania State U. Groth Inst., University Park.

PRELIMINARY MEMORANDUM CONCERNING AB-STRACTING AND PROCESSING OF DATA FOR GROTH'S ENCYCLOPEDIA OF CHEMICAL AND PHYSICAL CRYS-TALLOGRAPHY, REVISED EDITION, by R. Pepinsky and V. Vand. Mar. 17, 1958 [30]p. incl. diagrs. tables. (Rept. no. 3) (AFOSR-TN-59-313) (AF 49(638)316) AD 228903   Unclassified

It is planned to put all the available information on

crystals on IBM punched cards. These will be further processed for extraction of specific information or special computations. The planning of the format for data requires great care at the initial stages of development, since efficiency of operation depends on it. For data processing, the IBM 704 machine will generally be used. This requires that for efficient transfer to BCD tape the data appear within 8-digit fields, properly located on the card. The present report describes abstracting procedures, and justifies these in terms of methods of data-handling and processing. It also includes some volume and time estimates, and suggests a schedule for steps in preparation of the encylcopedia. (Contractor's abstract)

1529

Pennsylvania State U. Groth Inst., University Park.

LIST OF DEFINITIONS OF ABBREVIATIONS FOR PERIODICALS, by R. Pepinsky and V. Vand. Apr. 21, 1958 [21]p. (Rept. no. 4) (AFOSR-TN-59-314) (AF 49-(638)416) AD 228904   Unclassified

A list of definitions of abbreviations for periodicals has been prepared to help abstractors of crystallographic data at the Groth Inst. in coding the primary reference field. The list is compiled on IBM cards and is reproduced from time to time as new journal abbreviations are devised by the abstractors.

1530

Pennsylvania State U. Groth Inst., University Park.

ILLUSTRATIONS OF NEW PHOTOELECTRIC GONIOMETER FOR AUTOMATIC RECORDING OF CRYSTAL MORPHOLOGY IN THE FORM OF STEREO-GRAPHIC PROJECTIONS, by R. Pepinsky, K. Dranck, and H. Diamant. Apr. 5, 1958 [19]p. incl. illus. diagrs. (Rept. no. 5) (AFOSR-TN-59-315) (AF 49(638)416) AD 228905   Unclassified

The optical goniometer is described and illustrated. The machine utilizes a standard electric bulb source, and a 931A photomultiplier as signal detector, in a well-designed optical system. The photomultiplier is easily removed to permit visual observations of reflections, particularly for line-up purposes. The rotation of the crystal about a vertical axis is coupled with the rotation of a table on which a stereographic projection is automatically drawn. After each complete rotation of crystal and table about this vertical axis, the elevation of the plane of the optical system is raised by 0.5°. A marking device is moved in, radially toward the center of the table, therewith, by a simple coupling system which produces a motion corresponding exactly to that required for a stereographic projection. A light signal received by the photomultiplier actuates the marker, so that a reflection is recorded on a paper placed on the rotating table. The azimuthal and elevation angles are then read on a standard Wulff net. Reproductions of

the first stereographic projections to be obtained with the instrument, from an imperfect crystal of $Li_2CrO_4 \cdot K_2SO_4$ are shown and discussed.

1531

Pennsylvania State U. Groth Inst., University Park.

CONCERNING APRIL 25-26 CONFERENCE AT THE PENNSYLVANIA STATE UNIVERSITY, by R. Pepinsky. May 1, 1958 [25]p. incl. illus. diagrs. (Rept. no. 11) (AFOSR-TN-59-316) (AF 49(638)416) AD 228906
Unclassified

In connection with the Groth Inst. program to revise Paul von Groth's Chemische Krystallographie (see item no. 1527, Vol. III), a conference of American editors, contributors, and other interested crystallographers was to be held at the Groth Inst. on Apr. 25-26, 1958, under the auspices of the Air Force Office of Scientific Research, Solid State Sciences Div. A tentative program was to include discussions on (1) the need for revision of Groth's Chemische Krystallographie, and its preparation; (2) the status and coordination of crystallographic data; (3) abstracting procedures and IBM handling computing and tabulation; (4) and many other related topics.

1532

Pennsylvania State U. Groth Inst., University Park.

PRELIMINARY EXPERIMENTAL ABSTRACT ON AMMONIUM SULFATE, by R. Pepinsky and V. Vand. Mar. 17, 1958 [43]p. incl. tables. (Rept. no. 12) (AFOSR-TN-59-317) (AF 49(638)416) AD 228907
Unclassified

A sample abstract on ammonium sulfate is examined. It is intended to serve several purposes. First, it is an experimental abstract covering future stages of activity of the Groth Inst. to provide material for testing the efficiency of machine card handling systems, which are not yet in operation but which have to be planned well in advance. Second, it serves as a sample to estimate the approximate size of the work ahead. Third, it provides a tangible example of a style which is obtainable by the use of automatic machine data-handling methods, with minimum of human intervention. Fourth, estimates can be made of the probable usefulness of such an abstract. (Contractor's abstract)

1533

Pennsylvania State U. Groth Inst., University Park.

DEFINITIONS AS OF JUNE 11, 1958 FOR ABSTRACTING FOR THE GROTH INSTITUTE, by R. Pepinsky and V. Vand. June 11, 1958, 1v. (Rept. no. 13) (AFOSR-TN-59-318) (AF 49(638)416) AD 228908
Unclassified

This report lists the definitions adopted in the Groth Inst. Abstracts to this date. The report is divided into 3 parts. Part 1 lists short definitions, in alphabetical order of the operation abbreviations. This is useful for ascertaining whether a given abbreviation has already been used, and for quick information. Part 2 lists the short definitions according to subject. Here all abbreviations for electrical, thermal, optical, etc., properties are grouped together. Part 3 gives full definitions of abbreviations, together with their units and scales, and it also defines into which fields the numerical values are placed, and where decimal points and remarks are placed.

1534

Pennsylvania State U. Groth Inst., University Park.

THE IBM CARD LITERATURE IMAGE (STAGE I) OF A SECTION OF THE BARKER INDEX, TETRAGONAL STRUCTURE, by V. Vand and R. Pepinsky. Aug. 30, 1958, 255p. (Rept. no. 14) (AFOSR-TN-59-319) (AF 49-(638)416) AD 228909
Unclassified

This report represents the first step in the Groth Inst. data-processing system. The data was punched onto IBM cards and tabulated directly onto multilith mats, from which the report was printed. It covers all the tetragonal structures contained in the Barker Index, and the cards are arranged in much the same order as in the Barker Index. In the present tabulation, some numerical fields are not easily legible as the numbers of successive fields run into each other. This is a space-saving feature, since for machine processing, number spacing is not necessary. Future reports will be tabulated on a cardtype printer, where it will be possible to punctuate automatically by machine. This report should be used in conjunction with item no. 1535.

1535

Pennsylvania State U. Groth Inst., University Park.

THE PROPERTY SORT (STAGE 2) OF A SECTION OF THE BARKER INDEX, TETRAGONAL STRUCTURES, by V. Vand and R. Pepinsky. Aug. 30, 1958, 239p. (Rept. no. 15) (AFOSR-TN-59-320) (AF 49(638)416) AD 228910
Unclassified

This report represents the 2nd stage in the Groth Inst. processing system (see item no. 1534 for stage 1), in which the cards are tabulated according to the property abbreviation punched in the card columns 8-10. In order to facilitate reading of the report, heading cards have been inserted at the heads of each sort section, each heading card carrying a short definition of the abbreviation. This report can directly answer any simple property questions on tetragonal crystals. Complex questions requiring logical "and" and "or" can be answered by a programmed search on an electronic digital

computer. The cards are pre-sorted within each property, so that only a limited amount need to be taken to the computer at any one time for processing.

1536

Pennsylvania State U. Groth Inst., University Park.

OPERATIONAL NOTES FOR IBM CARD OPERATORS, by V. Vand and R. Pepinsky. Sept. 30, 1958 [11]p. (Rept. no. 16) (AFOSR-TN-59-321) (AF 49(638)416) AD 226911   Unclassified

The activities of the IBM card operators involve card keypunching, verifying, correcting, tabulating for proof-reading, tabulating on multilith mats, sorting, and card filing into cabinets. The operations in this group which are necessary to the production of Uncritical Monographs are described in detail.

1537

Pennsylvania State U. Groth Inst., University Park.

EXAMPLE OF FIVE GROTH INSTITUTE REQUEST REPORTS, by V. Vand and R. Pepinsky. Dec. 10, 1958, 1v. (Rept. no. 17; request repts. nos. 1R-5R) (AFOSR-TN-59-322) (AF 49(638)416) AD 228912
Unclassified

Examples are given of 5 requests received by the Groth Inst. for retabulation of selected data from the Barker Index (contained in item no. 1534). They were: (No. 1R) Tabulate crystal cell ratios of all tetragonal crystals with the chemical names listed as well as the Barker Index numbers; (No. 2R) Tabulate habits of tetragonal crystals, also with chemical names listed; (No. 3R) Tabulate various optical properties of tetragonal crystals with their chemical names listed; (No. 4R) Tabulate twinning of tetragonal crystals with chemical names listed; and (No. 5R) Tabulate polymorphism of tetragonal crystals with chemical names listed. All of the 5 requests were handled jointly and involved the processing of approx 3000 IBM cards in a total of 15 man-hr. It is expected that in the future, requests of this size may be processed within 24 hr from the receipt of the request.

1538

Pennsylvania State U. Groth Inst., University Park.

TETRAGONAL STRUCTURES ARRANGED ACCORDING TO INCREASING CRYSTAL CELL RATIOS, by V. Vand and R. Pepinsky. Dec. 30, 1958, 255p. (Rept. no. 18; request rept. no. 6) (AFOSR-TN-59-323) (AF 49(638)-416) AD 228913   Unclassified

This request report represents a section of the Barker Index, containing the same IBM cards which were tabulated in items nos. 1534 and 1535; but here the compounds are arranged according to increasing crystal cell ratios. This tabulation contains 8600 IBM cards and took only 15 man-hr to prepare, excluding the time spent on abstracting, preparation and presorting of the original cards, and multilithing of the reports.

1539

Pennsylvania State U. Groth Inst., University Park.

LIST OF CODE WORDS FOR PERIODICALS, AND SOME COMMENTS ON OTHER REFERENCE SYMBOLS, by M. Neuberger, V. Vand, and R. Pepinsky. Mar. 9, 1959 [98]p. (Rept. no. 19) (AFOSR-TN-59-324) (AF 49(638)416) AD 228913   Unclassified

This list supersedes the List of Definitions of Abbreviations for Periodicals (item no. 1529, Vol. III), issued on Apr. 21, 1958. Code words for periodicals are formed from the journal name in the original language. The list is arranged alphabetically according to the 3-letter code words used. This is followed by the most common abbreviation, as found in the literature, in capitals. The full title, if fully known, is then given under the abbreviation together with the place of publication. Distinguishing symbols for publications other than journals or periodicals are discussed briefly.

1540

Pennsylvania State U. Groth Inst., University Park.

THE LITERATURE IMAGE (REPORT NO. 2L) OF HEXAGONAL CRYSTALS IN THE BARKER INDEX OF CRYSTALS, VOLUME I, PART II, by V. Vand and R. Pepinsky. Mar. 16, 1959, 135p. (Rept. no. 22) (AFOSR-TN-59-325) (AF 49(638)416) AD 228915
Unclassified

A tabulation of the Hexagonal section of the Barker Index of Crystals is presented. The data are in the form of a literature image on IBM cards, and the arrangement is the same as that used in the Barker Index. The present tabulation represents the 1st full-scale report produced on the Groth Inst. Cardatype printer.

1541

Pennsylvania State U. Groth Inst., University Park.

SPECIFICATIONS FOR THE GROTH INSTITUTE IBM 704 PROGRAMS, by V. Vand and R. Pepinsky. Mar. 23, 1959, 7p. (Rept. no. 23) (AFOSR-TN-59-326) (AF 49(638)416) AD 228916   Unclassified

Detailed specifications for the IBM 704 programs have been formulated, based on the need for an efficient multi-job processing system where one program normally follows another without any machine stops.

1542

Pennsylvania State U. Groth Inst., University Park.

THE LITERATURE IMAGE (REPORT NO. 4L) OF
ORTHORHOMBIC CRYSTALS INDEX NUMBERS 500-
999 IN THE BARKER INDEX OF CRYSTALS, VOLUME
I, PART II, by V. Vand and R. Pepinsky. Apr. 15, 1959,
179p. (Rept. no. 25) (AFOSR-TN-59-502) (AF 49(638)-
416) AD 228894   Unclassified

Report 4L, issued as Groth Institute Report No. 25,
comprises the literature image of the second part of
the Orthorhombic Section of The Barker Index of
Crystals, Volume I, Part II. (Contractor's abstract)

1543

Pennsylvania State U. Groth Inst., University Park.

THE LITERATURE IMAGE (REPORT NO. 3L) OF
ORTHORHOMBIC CRYSTALS INDEX NUMBERS 0-499
IN THE BARKER INDEX OF CRYSTALS, VOLUME I,
PART II, by V. Vand and R. Pepinsky. Apr. 1, 1959,
185p. (Rept. no. 24) (AFOSR-TN-59-503) (AF 49-
(638)416) AD 228893   Unclassified

Report 3L, issued as Groth Institute Report No. 24,
comprises the literature image of the first part of the
Orthorhombic Section of The Barker Index of Crystals,
Volume 1. Part II. Orthorhombic Index Numbers 1-0
through 499-0 are included. It is to be noted that our
IBM Card-a-type is not yet equipped with numerical
zero which is properly distinguishable from capital O.
Barker Index number 320 for the orthorhombic system
presently appears as BI 3200, for example. (Contrac-
tor's abstract)

1544

Pennsylvania State U. Groth Inst., University Park.

FIRST EXAMPLE OF AN AUTOMATIC PRINTOUT
FROM THE GROTH INSTITUTE ABSTRACT IBM
CARDS, by R. Pepinsky and V. Vand. Feb. 25, 1958
[25]p. incl. tables. (Rept. no. 1) (AFOSR-TN-59-
1049) (AF 49(638)416) AD 228887   Unclassified

This is an early example of the automatic printout
whose purpose is to demonstrate the feasibility of the
abstracting system adopted, and to test the convenience
of the abbreviations used. The first section lists the
definitions of operator symbols used. Since then, some
symbols have been changed; for example, the symbols
A/B and C/A have been replaced by ARB and CRA, in
order to assist fast sorting procedures. The second
part includes samples of abstracts from various sources.
The style of the chemical formulae has been changed,
the present rule being that any chemical element sym-
bol must be preceded by a blank. The third part shows
examples of data sorted according to the operator.
This should be valuable for determinative purposes.

The fourth and the fifth parts list the abbreviations a-
dopted for periodicals. There are 26^3 combinations of
three letters possible, and these should be sufficient
to describe some 17,576 periodicals before the system
becomes exhausted. The sixth part shows various ex-
periments in expressing chemical formulae, which are,
however, now abandoned. Included is a typical Groth
Institute form as filled in by an abstractor, a layout of
an IBM card used, and an example of an Abstract Form,
as supplied to the abstractors.

1545

Pennsylvania State U. Groth Inst., University Park.

AN EXAMPLE OF AN AUTOMATIC TABULATION OF
THE GROTH INSTITUTE ABSTRACT IBM CARDS IN
VARIOUS CATEGORIES, by R. Pepinsky and V. Vand.
Apr. 2, 1958 [26]p. incl. tables. (Rept. no. 6) (AFOSR-
TN-59-1050) (AF 49(638)416) AD 228888
                              Unclassified

Automatic tabulation of the Groth Institute abstract IBM
cards according to authors, properties, etc., is de-
scribed which serves as another example of types of
machine output. This tabulation contains too few entries
to be really useful; several books have to be covered in
order to obtain collations of real value. A list of abbre-
viations precedes the categorized tabulations. Several
points are of interest. In the author index, the continue
column reveals whether a single author was mentioned,
or whether the reference has joint authors. In the
former instance, the continue column is blank (example,
1200 AUT Bolland); in the latter instance, it reveals the
order in the joint authorship (example, 3090 AUT3
Berry reveals that Berry is the third joint author). In
the formula index, the style is not completely stabilized,
especially for hydrates. The final formula style to be
adopted will depend on the convenience of control of the
upper and lower case of the Cardatype machine. It is
likely that a comma instead of a period will be used to
separate the water of hydration; otherwise the number of
water molecules will be printed as subscripts, which is
undesirable. (Contractor's abstract)

1546

Pennsylvania State U. Groth Inst., University Park.

EXAMPLE OF AN ABSTRACT: A PORTION OF THE
BARKER INDEX, by R. Pepinsky and V. Vand. Apr.
23, 1958 [29]p. incl. tables. (Rept. no. 7) (AFOSR-
TN-59-1051) (AF 49(638)416) AD 228889
                              Unclassified

The present report shows an example of a Groth In-
stitute abstract of a portion of the Barker Index of
Crystals. The multilith mats used for reproduction
were obtained directly from an IBM 407 Tabulator, us-
ing a multilith ribbon in place of the standard ribbon,
and the data was furnished to the Tabulator on punched

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cards. The 407 Tabulator prints information simultaneously from 120 print wheels, at a rate of up to 18,000 characters a min. The IBM punched cards are read and tabulated at the rate of 150 per min or 9000 per hr. One report page is printed from 35 IBM cards. The present report contains 26 pages, and the entire set of mats required only 6 min for their complete preparation. The 407 Tabulator has upper case characters only, so that the writing of chemical formulae must be adapted to upper case only. This is a difficulty with which we must put up, and to which readers must accustom themselves, until the alternative output printing system is available to us. In any case, 407 Tabulator output will probably be relied on for intermediate-stage reports, because of its high speed. It is noted that the 407 Tabulator adds extra blank columns to improve readability of the text. Thus on the original card

　　　20　COM　G　　ZINN

the G was punched in Format column 12, indicating that the compound name is in German. The word ZINN followed immediately in card column 13-16. On the printout, 2 blanks separate it from G. It is interesting to compare the legibility of type in the present report with that in Report No. 1. The latter printouts were photographically reproduced, at much greater cost than the direct mat printout used here. The advantages of the present reproduction system are evident. (Contractor's abstract)

1547

Pennsylvania State U. Groth Institute, University Park.

LIST OF ABBREVIATIONS USED IN ABSTRACTING THE BARKER INDEX OF CRYSTALS, by R. Pepinsky and V. Vand. May 1, 1958 [5]p. (Rept. no. 8) (AFOSR-TN-59-1052) (AF 49(638)416)
Unclassified

The abbreviations used in abstracting the Barker Index of Crystals are listed and explained. All entries in the index are consecutively numbered, such as T. 5 to indicate the 5th tetragonal structure described. Thus the Working Reference BI 5T means Barker Index, entry T. 5. Some of the abbreviations are as follows: COM-Compound, POL-Polymorphism, ANC-Barker Classification angle of crystal, CCR-crystal cell ratios, CLR-Color, etc. Explanations of each of these are given, such as FOR. Chemical formulae have upper and lower case. Note that $Fe_2O_3 \cdot 12H_2O$ has upper case F;O;1;2;H, lower case $e_{2;3;2}$. Machines are to be told which is upper case and which is lower case. The machines operate in 3 modes. U mode: everything is in upper case. L mode: everything is in lower case. S mode: the 1st letter encountered is upper case, all that follows is lower case. Rule: in chemical formulae the machine is instructed to go into S mode whenever it meets a blank, and go into U when-

ever it meets a comma (,). Thus if the above formula is written FE2 O3,12 H2 O, the machine interprets the formula correctly. Examples of other uses are also given.

1548

Pennsylvania State U. Groth Inst.. University Park.

SUGGESTED AGREEMENT FORM FOR CORRESPONDING MEMBERS OF THE GROTH INSTITUTE, by R. Pepinsky and V. Vand. May 1, 1958 [5]p. (Rept. no. 9) (AFOSR-TN-59-1053) (AF 49(638)416) AD 228890
Unclassified

A form is presented to be filled out and mailed back to the Groth Inst. in order to be placed on its mailing list of various reports and tabulations. It is particuly addressed to abstractors, proof-readers, data reviewers, and data processors, and is offered in return for a certain amount of assistance to the inst.

1549

Pennsylvania State U. Groth Institute, University Park.

SUMMARY OF NEEDS FOR IBM COMPUTING EQUIPMENT FOR THE GROTH INSTITUTE AND THE X-RAY AND CRYSTAL STRUCTURE LABORATORY, by R. Pepinsky and V. Vand. May 1, 1958 [5]p. (Rept. no. 10) (AFOSR-TN-59-1054) (AF 49(638)416) AD 228891
Unclassified

This report discusses the equipment used at the Groth Inst. and its cost. The future needs are briefly outlined, and the locations at which certain facilities are made available are acknowledged. At the time of this report the requirements included three 026 punches, one 858 cardatype, one 082 sorter, one 407 tabulator, one 56 verifier, and 50 card files, 20 drawer.

1550

Pennsylvania State U. Groth Inst., University Park.

RESEARCH ON MODERN CRYSTALLOGRAPHY AT THE GROTH INSTITUTE, by V. Vand and R. Pepinsky. Jan. 30, 1959 [2]p. (Rept. no. 20; progress rept no. 4P) (AFOSR-TN-59-1055) (AF 49(638)416) AD 228884
Unclassified

Progress made to date at the Groth Inst. is briefly discussed. Abstractors have concentrated on Groth's Chemische and volume I has been completed. All 50,000 cards have been converted to the new upper-lower case style. Tabulating procedures are reported as behind schedule which has delayed the proof-reading schedule also. Two IBM 704 programs for computation of refractive index differences have been completed and debugged. Progress on various other operational phases are also discussed.

1551

Pennsylvania State U. Groth Institute, University Park.

USE OF A SIMPLE INFORMATION RETRIEVAL
SYSTEM IN THE GROTH INSTITUTE, by V. Vand and
R. Pepinsky. Feb. 16. 1959 [5]p. (Rept. no. 21)
(AFOSR-TN-59-1056) (AF 49(638)416) AD 228892
Unclassified

A brief explanation of the peek-a-boo information re-
trieval system is given. In this system, determina-
tion of the required document numbers containing
wanted information is performed by a visual deter-
mination of matching holes in selected keyboard
cards. Where the beam from a light source shines
through the superimposed holes in the selected cards,
the hole represents a document indexed under the key-
words stated in the query. The cards are adapted to
carry information for up to 500 documents. A brief
explanation of the column designation is given and
its use. The preparation of the peek-a-boo cards is
outlined with specfic instructions for punching. In
general it can be said that the peek-a-boo card sys-
tem provides a comparatively compact and efficient
multiple search system. Its disadvantages, however,
include its inability to respond to the word order and
its inability to distinguish combinations of words such
as blue-green or green-blue.

1552

Pennsylvania State U. Groth Institute, University Park.

THE LITERATURE IMAGE (REPORT NO. 5L) OF
ORTHORHOMBIC CRYSTALS INDEX NUMBERS 1000-
1499 IN THE BARKER INDEX OF CRYSTALS, VOLUME
I, PART II, by V. Vand and R. Pepinsky. Aug. 3, 1959
[185]p. incl. tables. (Rept. no. 26) (AFOSR-TN-59-
1057) (AF 49(638)416) AD 228895 Unclassified

This report comprises the literature image of the
second part of the Orthorhombic Section of The Barker
Index of Crystals, Volume I, Part II. Orthorhombic
Index numbers 1000-0 through 1499-0 are included.
(Contractor's abstract)

1553

Pennsylvania State U. Groth Institute, University Park.

OPERATIONAL NOTES FOR IBM CARDATYPE
OPERATORS, by V. Vand and R. Pepinsky. May 30,
1959 [2]p. (Rept. no. 37) (AFOSR-TN 59-1058)
(AF 49(638)416) AD 228895 Unclassified

Instructions for operation of the IBM Cardatype are
presented. These are given in the form of 19 rules
starting with the checking of report numbers. Each tab-
ulating operation is followed by a proofreading instruc-

tion. The operation also utilizes xerox photographing
of the corrected material. Much emphasis is placed
on the verifying that all information is correct and
complete.

1554

Pennsylvania State U. Groth Inst., University Park.

THE LITERATURE IMAGE (REPORT NO. 6L) OF
ORTHORHOMBIC CRYSTALS INDEX NUMBERS 1500-
1999 IN THE BARKER INDEX OF CRYSTALS, VOLUME
I, PART II, by V. Vand and R. Pepinsky. Aug. 17, 1959
[180]p. incl. tables. (Rept. no. 27) (AFOSR-TN-59-
1059) (AF 49(638)416) AD 228896 Unclassified

This report is comprised of the literature image of the
second part of the Orthorhombic Section of The Barker
Index of Crystals, Volume I, Part II. Orthorhombic
Index numbers 1500-0 through 1999-0 are included.
(Contractor's abstract)

1555

Pennsylvania State U. Groth Inst., University Park.

THE LITERATURE IMAGE (REPORT NO. 7L) OF
ORTHORHOMBIC CRYSTALS INDEX NUMBERS
2000-2156 IN THE BARKER INDEX OF CRYSTALS,
VOLUME I, PART II, by V. Vand and R. Pepinsky.
Aug. 24, 1959 [56]p. incl. tables. (Rept. no. 28)
(AFOSR-TN-59-1060) (AF 49(638)416) AD 228897
Unclassified

This report is comprised of the literature image of the
second part of the Orthorhombic Section of The Barker
Index of Crystals, Volume I, Part II. Orthorhombic
Index numbers 2000-0 through 2156-0 are included.
(Contractor's abstract)

1556

Pennsylvania State U. Groth Inst., University Park.

PROPERTY SORT (REPORT NO. 2S) OF HEXAGONAL
CRYSTALS INDEX NUMBERS 1-434 IN THE BARKER
INDEX OF CRYSTALS, VOLUME I, PART II, by V.
Vand and R. Pepinsky. Aug. 31, 1959 [133]p. incl.
tables. (Rept. no. 29) (AFOSR-TN-59-1061) (AF 49-
(638)416) AD 228898 Unclassified

This report involves the same IBM cards as those tab-
ulated in the Report No. 22 (Report No. 2L), The
Literature Image, of a section of The Barker Index,
Hexagonal Crystals. This is the 2nd stage (Property
Sort) in The Groth Institute processing system, in
which the cards are tabulated according to the proper-
ty abbreviation punched in the card columns 8-10.
Heading cards have been inserted at the heads of
each sort section, carrying a Short Definition of each
abbreviation. (Contractor's abstract)

1557

Pennsylvania State U. Groth Inst., University Park.

USE OF THE CARDATYPE MACHINE TO PREPARE
PEEK-A-BOO CARDS, by R. Mainoski, V. Vand, and
R. Pepinsky. Aug. 7, 1959 [14]p. incl. illus. tables.
(Rept. no. 30) (AFOSR-TN-59-1227) (AF 49(638)416)
AD 228899   Unclassified

A method of preparation of Peek-A-Boo cards on the
IBM 858 Cardatype Machine is presented. The pro-
cedure begins by placing the original abstract cards
into groups which contain the required information.
These cards are then sorted in order by compound
number. The original cards are placed in the Carda-
type Machine, and the Key Punch spaces to the appro-
priate column, punches the last digit, and awaits the
next card. The card is then read into the Arithmetic
Unit, and the spaces already taken are subtracted from
the spaces to be made. A card of space 4 and punch 1
gives 4 spaces, allowing the card to have a number 1
punched in column 4. The next card with space 6 and
punch 1 gives 2 spaces, because the 4 spaces previ-
ously taken are subtracted from it. This permits the
card to have a number 1 punched in column 6. This
then produces the 10 provisional cards which have all
1's, 2's, 3's, etc. punched on them. These cards are
then duplicated onto 1 card, which is the final Peek-
A-Boo card. Examples of this procedure are given.
A method of wiring to produce numerical Peek-A-Boo
cards on 858 Cardatype Accounting Machine and a new
system of using the 407 Tabulator in addition to the
Cardatype are discussed also.

1558

Pennsylvania State U. Groth Inst. , University Park.

GROTH INSTITUTE EXTRACTOR'S MANUAL, FIRST
REVISED EDITION, PART II: SPECIFIC DIRECTIONS
AND DEFINITIONS OF OPERATIONS, by R. Pepinsky
and V. Vand. Oct. 1, 1959, 75p. incl. illus. tables.
(Rept. no 32) (AFOSR-TN-59-1228) (AF 49(638)416)
AD 228901   Unclassified

The purpose behind the preparation of this new edition
of the Groth Institute Extractor's Manual, previously is-
sued as Groth Institute Report No. 13, are 3-fold: to fa-
cilitate necessary reorganization of extracting proce-
dures within the Institute proper, as has been shown
necessary after a year and a half of experience; to
reduce the possibility of errors in the entire retrieval
system, and to assist in the organization and operation
of extracting centers outside of the Institute but collab-
orating with it. Material from the extracting section
should flow to the IBM section with a minimum of cor-
rections and revisions. The filled-in extractors' forms
are submitted to checkers, who compare the data with
the original information from which the extracting was
done. The extract forms are next submitted for IBM
card punching and verifying. The verified cards are
then submitted for fast tabulation on the IBM 407, and

these tabulations are examined by checkers. After cor-
recting cards are punched, a second tabulation is made
on a Cardatype machine. The 1st Cardatype tabulation
is read by checkers and then by knowledgeable editors.
A 2nd Cardatype tabulation is then accomplished, and
cards are duplicated in the Cardatype punch. The cor-
rected Cardatype printouts are then transferred by
xerography to reproducing mats, for report reproduc-
tion. (Contractor's abstract)

1559

Pennsylvania State U. Groth Inst., University Park.

GROTH INSTITUTE EXTRACTOR'S MANUAL FIRST
REVISED EDITION, PART III: LISTING OF CODE
WORDS FOR PERIODICALS, by R. Pepinsky and V.
Vand. Oct. I, 1959, 201p. incl. tables. (Rept. no. 33)
(AFOSR-TN-59-1229) (AF 49(638)416)
                                          Unclassified

Several lists of code words for periodicals are presented
in alphabetical form. They include alphabetical indexes
of code with journal abbreviations, of journal title ab-
breviations, of code with journal titles, of country and
city, and of journal titles. Typical examples would be
ACJ as a code for the journal abbreviation, AM. CHE., J.
AJP is the code, listed alphabetically, for the journal
title American Journal of Pharmacy. The country and
city index is alphabetically constructed by country 1st
and then city of the journal publication site.

1560

Pennsylvania State U. Groth Inst., University Park.

ABSTRACTS OF THREE PAPERS ON THE STATUS
OF THE GROTH INSTITUTE PROGRAM. I: ORGAN-
IZATION AND PROGRAM. II: DATA-HANDLING
PROCEDURES. III: IBM 704 PROGRAMMING, by R.
Pepinsky, V. Vand and others. July 1, 1959 [7]p.
(Rept. no. 35) (AFOSR-TN-59-1230) (AF 49(638)416)
                                          Unclassified

Part I presented at Internat'l. Cryst. Convention,
Leningrad (U.S.S.R.). May 21-27, 1959.

Presented at meeting of the Amer. Cryst. Assoc.
Cornell U., Ithaca, N. Y., July 19-24, 1959.

I. Organization and Program - The Groth Institute
program is designed to record all available crystal
data on IBM punched cards and subsequently transfer
it to magnetic tape for handling and computation by
IBM 704 computers. The system facilitates machine
searching, sorting, collating and indexing of the data.
The program presently produces a 100-page report
of abstracted data a wk. II. Data-Handling Procedures -
Reports can be prepared at each stage of IBM proces-
sing: the literature image, the property sort, the un-
critical compound monograph, and the critical compound

monograph. At any of these stages, the information can also be retrieved. The IBM 704 or 709 computers can extract any combination of information from magnetic tapes. The Institute system presently contains over 1/2 million IBM cards, and is handling approx 1000 compounds per wk. III. IBM 704 Programming - The Groth Institute library consists of approx 1 doz running programs, including one for refractive indices, calculating of powder data from single-crystal data, a peek-a-boo retrieval program, calculating of formula weights, formula translation, and symmetry search.

1561

Pennsylvania State U. Groth Inst., University Park.

SUMMARY REPORT ON THE GROTH INSTITUTE, by R. Pepinsky. Oct. 21, 1959, 5p. (Rept. no. 36) (AFOSR-TN-59-1231) (AF 49(638)416) AD 228902
Unclassified

In the Groth Institute scheme, information is abstracted and transferred to IBM punched cards, and subsequently to IBM binary-coded-decimal (BCD) tape or RAMAC discs, for a variety of collations, crystallographic computations, and print-outs-on-demand-from tape- and card-controlled tabulators and typewriters. The fundamental principles of the Institute system are: (1) all crystal data are transferred, after suitable abstracting, to punched cards, in a succinct form which permits identification of crystal species, reference source, and nature of the data; (2) each data card is characterized by operator, which informs the computer what can be or is to be done with the information; (3) collation and indexing of data, all feasible computations, and printouts, are possible automatically; (4) the information of crystal chemistry and physics is thus available implicitly in the storage, programs and tabulations of the machine; (5) no attempt is made to publish all of the best mass of available or computable information in crystallography; instead, it is automatically printed, as desired for special needs, monographs and summaries, on demand; (6) all data is automatically prepared for small-scale, nonmechanized search, using the Peek-A-Boo system.

1562

Pennsylvania State U. Groth Inst., University Park.

PROPERTY SORT (REPORT NO 3S) OF ORTHORHOMBIC CRYSTALS, INDEX NUMBERS 0-499, IN THE BARKER INDEX OF CRYSTALS, VOL. 1, PART II, by V. Vand and R. Pepinsky. Nov. 1, 1959, 175p. incl. tables. (Rept. no. 39) (AFOSR-TN-59-1232) (AF 49(638)416)
Unclassified

This report involves the same IBM cards as those tabulated in the Report No. 24 (Report 3L). This is the second state (Property Sort) in The Groth Institute processing system, in which the cards are tabulated according to the property abbreviation punched in the card

columns 8-10. Heading cards have been inserted at the heads of each sort section, carrying a short definition of each abreviation. When all property sorts for the orthorhombic system have been tabulated in this manner, a merged property sort for that system will be prepared. This will of course be accomplished as well for all other sections of the Barker Index. Merging of the property sorts for the entire Index will be accomplished finally. (Contractor's abstract)

1563

Pennsylvania State U. Groth Inst., University Park.

[PHOTO-COPY OF] CHEMISCHE KRYSTALLOGRAPHIE, VOLUMES I, II, III, IV, AND V, by P. Groth. Dec. 30, 1959, 5v. incl. diagrs. tables, refs. (AF 49(638)416)
Unclassified

This photo-reproduction of Paul von Groth's Chemische Krystallographie, now long out of print, has been prepared and issued by the Groth Institute College of Chemistry and Physics in order to assist co-workers of the institute in the re-editing of this work. The new edition will be entitled Groth's Encyclopedia of Chemical and Physical Crystallography, Revised Edition. The program for this revision is described in Concerning Establishment of The Groth Institute and Revision of Groth's Chemische Krystallographie, by R. Pepinsky (see item no. 1527).

1564

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

X-RAY STUDIES OF COMPLEX IONS AND THEIR SALTS WITH ORGANIC BASES AND ORGANIC OXYGEN COMPOUNDS, by R. Pepinsky. Summary final rept. Oct. 1, 1959, 4p. (AFOSR-TR-59-184) (AF 18-(600)1556)
Unclassified

The research under this contract involves the development of a method whereby molecules to be studied can be crystallized in structures whose x-ray analysis would be certain of success. In essence, the method involves precipitation in crystalline form of the organic molecule, generally in ionic form, but diluted structurally by sizeable groups of atoms of the class known as complex ions, which dominate the packing of the structures. The structure of these complex ions is generally known, and in any case readily determined. They contain heavier atoms of the sort necessary for application of the classical heavy-atom x-ray method. A brief outline is given of the studies accomplished by this method.

1565

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

THE CRYSTAL STRUCTURE OF TRIS(THIOUREA)

COPPER(I)CHLORIDE, $Cu(SCN_2H_4)_3Cl$, by C. B.
Knobler, Y. Okaya, and R. Pepinsky. [1959] [13]p. incl.
diagrs. tables, refs. (Sponsored jointly by Air Force
Office of Scientific Research under AF 18(600)1556,
Office of Naval Research under N6onr-26916, National
Institutes of Health and Shell Oil Company)
Unclassified

Published in Zeitschr. Krist., v. 111: 385-397, Oct.
1959.

Tris(thiourea)copper(I) chloride crystallizes in the
tetragonal system with a = 13.41A, c = 13.79A; the
space group is $P4_12_12$ or its enantiomorph $P4_32_12$.

The crystal structure was determined using full 3-
dimensional x-ray data. The structure is ionic, with
chloride ions and infinite spiral chains of $[Cu(thiou-rea)_3]^+$. The latter shows the usual tetrahedral con-

figuration for monovalent copper by sharing 1 of the
3 sulfur atoms of the thiourea ligands; the tetrahe-
dron around the copper is slightly distorted, with
Cu-S distances ranging from 2.31_3A to 2.42_4A and

S-Cu-S angles from 110° to 118°. A planar configu-
ration is observed around the shared sulfur atom in-
volving the 2 copper atoms and carbon atom of the
thiourea ligand. The N-H $\cdots$ Cl hydrogen bonds and
the configurations of the thiourea ligands are dis-
cussed. (Contractor's abstract)

1566

Pennsylvania State U. [X Ray and Crystal Analysis Lab.]
University Park.

ABSOLUTE CONFIGURATION OF FERROELECTRIC
CRYSTALS, I. TETRAGONAL $BaTiO_3$ (Abstract), by Y.
Okaya, R. Pepinsky, and F. Unterleitner. [1959] [1]p.
(Sponsored jointly by Air Force Office of Scientific Re-
search under AF 18(603)35, Atomic Energy Commission,
and Signal Corps) Unclassified

Presented at meeting of the Amer. Phys. Soc., New
York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 63,
Jan. 28, 1959.

Pepinsky and Okaya have pointed out that the absolute
configuration of tetragonal ferroelectric $PbTiO_3$ could
be established from a map of the function $P_s(u) =$
$\sum \Delta F_H^2 \sin 2H\pi \, h \cdot u$, when $MoK\alpha$ x-rays are employed. A

program for determination of absolute configurations of
several ferroelectric structures is in progress, using
such anomalous dispersion effects. The structure of
tetragonal $BaTiO_3$ has been established by neutron dif-

fraction, and shifts from cubic positions accurately de-
termined. No evidence of the direction of these shifts
with respect to an applied field is achievable with neu-

trons. Using $CoK\alpha$ x-rays to excite the barium ions,
clearly observable differences $\Delta F_H^2 = |F_H^2| - |F_{-H}|^2$
are obtained. The signs of these agree well with the
model based on the assumption that the Ti ion moves in
the field direction.

1567

Pennsylvania State U [X-Ray and Crystal Analysis Lab.]
University Park.

A NEW CLASS OF FERROELECTRICS: ACID SELE-
NITES (Abstract), by R. Pepinsky, K. Vedam and others.
[1959] [1]p. (Sponsored jointly by Air Force Office of
Scientific Research under AF 18(603)35, Atomic Energy
Commission, and Signal Corps) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York
Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v.4: 63,
Jan. 28, 1959.

Optical observation of a reversible transition in potas-
sium acid selenite has led to the dielectric examination
of other acid selenites. Two new ferroelectric species
have therewith been discovered: $LiH_3(SeO_3)_2$, ferro-

electric at room temperature; and $NaH_3(SeO_3)_2$, ferro-

electric below -75°C. $LiH_3(SeO_3)_2$ shows well-saturated

square hysteresis loops over the temperature range from
-190°C to +80°C. At room temperature the spontaneous

polarization is 10.0 microcoulombs/cm^2, and the coer-
cive field is 1.5kv/cm. X-ray observations reveal mono-
clinic symmetry, space group Pn, with $a = 6.255$ A, $b =$
7.899 A, $c = 5.443$ A, $\beta = 105°23'$ The polar axis is per-
pendicular to the (001) plane. The material appears to
be of practical importance. $NaH_3(SeO_3)_2$ is not iso-

morphous with $LiH_3(SeO_3)_2$. In the room-temperature

phase the symmetry is monoclinic, space group P_{21}/a,

with $a = 11.77$ A, $b = 4.84$ A, $c = 5.80$ A, $\beta = 118.5°$. The
ferroelectric phase has triclinic symmetry (space group
P1; if axes are denoted as for room-temperature phase,
space group C1). The polar direction is along [310],
referred to the monoclinic phase.

1568

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.]
University Park.

PHASE TRANSITIONS IN HEXAFLUOPHOSPHATE
SALTS (Abstract), by K. Vedam, R. Pepinsky and others.
[1959] [1]p. (Sponsored jointly by Air Force Office of
Scientific Research under AF 18(603)35, Atomic Energy
Commission, and Signal Corps) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

$NH_4PF_6 \cdot NH_4F$ is tetragonal at room temperature, and has 2 low-temperature transitions: at -45°C (= T_{uc}) and at -101°C (= T_{Lc}). Both low-temperature phases are orthorhombic. The dielectric constant $\epsilon_{[110]}$ exhibits a small anomaly at T_{uc}, and a pronounced anomaly at T_{Lc}. X-ray examination reveals superstructuring along the $\underline{a}$ and $\underline{b}$ axes below T_{uc}, and a doubling of the $\underline{c}$ axis below T_{Lc}. The lowest phase is antiferroelectric. A detailed structural investigation is required to reveal the dielectric character of the intermediate phase. An order-disorder transition has been observed in KPF_6 at 4°C. A detailed x-ray structure analysis reveals hindered rotation of the $(PF_6)^{-1}$ octahedra.

A large thermal anomaly at the transition temperature suggests a "freezing in" of the hindered rotations in the lower phase.

1569

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

THE USE OF ANOMALOUS DISPERSION FOR DIRECT X-RAY ANALYSES OF NON-CENTRIC CRYSTAL STRUCTURES (Abstract), by R. Pepinsky. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35]. National Institutes of Health, and Office of Naval Research) AD 418316
Unclassified

Presented at Internat'l. Cryst. Convention, Leningrad (U.S.S.R.), May 21-27, 1959.

The $P_s(\underline{u})$ function, defined as $P_s(\underline{u}) = \sum_{\underline{H}} |F_{\underline{H}}|^2 \sin2\pi\underline{H}\cdot\underline{u}$, has proved of great power in the direct analyses of the structures and absolute configurations of a number of non-centric crystals containing scatterers of atomic number 16 (sulfur) or greater. In one recent example of the method, the structure and hand of ferroelectric (glycine)$_3 \cdot H_2SO_4$, as a function of electric field direction, were directly observable in $P_s(\underline{u})$, using CuKα radiation with proportional-counter intensity measurements and making use of the imaginary component of the sulfur structure factor. This analysis established unquestionably the superiority of use of $P_s(\underline{u})$ over use of the simultaneous quadratic equations method, involving individual structure factor pairs $F_{\underline{H}}$ and $F_{-\underline{H}}$. In other analyses, the structures and absolute configurations of ferroelectric $BaTiO_3$ and KD_2AsO_4 were simi-

farly established, with respect to the direction of the polarizing electric field; and determination of the absolute configuration of ferroelectric Rochelle salt as a function of field direction is in process of establishment, using the imaginary component of potassium scattering CuKα radiation.

1570

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

X-RAY ANALYSES OF THREE ORGANIC NATURAL PRODUCTS (Abstract), by R. Pepinsky. [1959] 2p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Atomic Energy Commission, National Institutes of Health, and Office of Naval Research)
Unclassified

Presented at meeting of Internat'l. Cryst. Convention, Leningrad (U.S.S.R.), May 21-27, 1959.

The crystal structures of the antibiotic aureomycin·HCl and 2 hydrohalide salts of the alkaloid gelsemine have been solved in 3 dimensions and refined by least-squares and differential syntheses. The earlier-reported structure of cobaltous aspartate tri-hydrate has been further refined by least-squares. R-factors for aureomycin·HCl, gelsemine·HCl and cobalt aspartate are respectively 0.15, 0.16 and 0.08, for 3-dimensional data within the CuKα sphere. The standard deviation of coordinates is approximately 0.02A for all 3 of these crystals. The aureomycin ($C_{22}H_{23}N_2O_3Cl \cdot HCl$) analysis confirms the major features of the structure, but the resonance state of the molecule differs from that proposed chemically, and the dimethylamino group on ring 1 has the steric position proposed chemically for $\underline{epi}$-aureomycin. Except for bonds to the chloride ion, only $\underline{intra}$-molecular hydrogen bonds are found; between organic portions of adjacent molecules only van der Waals contacts appear. The structure of gelsemine, $C_{20}H_{22}N_2O_2$, was previously unknown except for the existence of an oxindole nucleus, a double-bonded carbon pair in a vinyl side-chain, and a tertiary N-methyl group. The x-ray analysis completely established the configuration of the molecule in the hydrochloride and hydroiodide salts. (Contractor's abstract)

1571

Pennsylvania State U. X-Ray and Crystal [Analysis] Lab., University Park.

$LiH_3(SeO_3)_2$: NEW ROOM-TEMPERATURE FERRO-ELECTRIC, by R. Pepinsky and K. Vedam. [1959] [2]p. incl. diagrs. (AFOSR-4129) (Sponsored jointly by Force Office of Scientific Research under [AF 18(603)-35], Atomic Energy Commission, and Signal Corps)
Unclassified

Also published in Phys. Rev., v. 114: 1217-1218, June 1, 1959.

$LiH_3(SeO_3)_2$ crystallizes in the monoclinic system and exhibits useful ferroelectric properties in the entire temperature range -196°C to 90°C. The spontaneous polarization and coercive d at room temperature are

15.0 μ coulombs/cm^2 and 1400 ν/cm, respectively. X-ray examination reveals that the crystals belong to the space group Pn, with cell dimensions a = 6.25$_8$A, b = 7.88$_6$A, c = 5.43$_3$A, β = 105.2°, and 2 formula units per unit cell. The polar direction is perpendicular to the (001) plane. No Curie temperature could be observed. $NaH_3(SeO_3)_2$ is not isomorphous, but is ferroelectric below -79°C. (Contractor's abstract)

1572

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

CRYSTAL-STRUCTURAL MECHANISM OF THE FERROELECTRIC BEHAVIOR OF $(GLYCINE)_3 \cdot H_2SO_4$ (Abstract), by R. Pepinsky. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Atomic Energy Commission, Office of Naval Research, and Signal Corps)   Unclassified

Presented at Internat'l. Cryst. Convention, Leningrad (U.S.S.R.), May 21-27, 1959.

Presented at meeting of the Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.

The crystal structure of ferroelectric $(glycine)_3 \cdot H_2SO_4$ which crystallizes at room temperature in the monoclinic system with $\underline{a}$ = 0.41$_7$A, $\underline{b}$ = 12.64$_3$A, $\underline{c}$ = 5.73$_5$A, β = 110°23' was determined from full 3-dimensional x-ray diffraction data, using CuKα radiation. It is shown that out of the 3 glycine molecules in the crystal, 1 has the usual zwitterion configuration with the NH_3^+ group out of the plane of the other atoms; the remaining 2 glycines are mono-protonated, and planar within experimental error, and are designated as glycinium ions. Thus the chemical formula is properly written as

$(NH_3^+CH_2COO^-) \cdot (NH_3^+CH_2COOH)_2 \cdot SO_4^{--}$, and the compound is best described by the chemical name glycine diglycinium sulfate. It is found that 1 of the planar glycinium ions lies near but not in the plane $\underline{y}$ = $\frac{1}{4}$. The nitrogen atoms form N-H··O hydrogen bonds of the usual strength, whereas a quite strong O-H··O hydrogen bond with a distance of 2.43$_8$A is found between the oxygen atom of the carboxyl group of the zwitterion glycine and that of the planar glycinium ion which lies near plane $\underline{y}$ = $\frac{1}{2}$.

1573

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

DIFFUSE X-RAY SCATTERING AND DISORDER IN $(GLYCINE)_3 \cdot H_2SO_4$ (Abstract), by T. Mitsui, I. Shibuya and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)-35] and Signal Corps)   Unclassified

Presented at meeting of the Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.

A study of the diffuse x-ray scattering from the ferroelectric phase of $(glycine)_3 \cdot H_2SO_4$ has been initiated in order to obtain information about the local order, coupling of ferroelectric dipoles and the temperature dependence of these constants. This information is important in understanding the physical properties of the crystal near its Curie point. A series of Laue photographs was taken, and the intensity distribution of the diffuse scattering was measured around the (040) Bragg reflection. From the observed data, and the crystal structure, the pair-correlation functions were obtained for various neighbors. It should be emphasized that when the crystal structure is known, the pair-correlation functions are derivable from the observed diffuse scattering for any neighbors. A theory was also developed to correlate obtained results with the dielectric constant of the crystal. (Contractor's abstract)

1574

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

ON SEVERAL NEW FERROELECTRIC CRYSTALS (Abstract), by R. Pepinsky, K. Vedam, and Y. Okaya. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Atomic Energy Commission, Office of Naval Research, and Signal Corps)   Unclassified

Presented at meeting of the Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.

Continuation of studies on hydrogen-bonded sulfate and related anion salts has led to the discovery of several new ferroelectrics and antiferroelectrics. Certain crystal-chemical conditions become apparent which serve as guides for the discovery of new ferroelectrics. These are traceable ultimately to the pioneering discoveries of Matthias and coworkers on guanidinium aluminum sulfate hexahydrate, $(NH_4)_2SO_4$ and $(glycine)_3 \cdot H_2SO_4$, and related discoveries in the Penn State laboratory. These conditions are discussed. In the sulfate-selenate-fluoberyllate family, the following materials are of more recent interest: (a) $NH_4NaSO_4 \cdot 2H_2O$; (b) NH_4LiSO_4; (c) NH_4HSO_4; (d) $(NH_4)_3H(SO_4)_2$;

(e) $Li(N_2H_5)SO_4$; and (f) $RbHSO_4$. The discovery of all of these follows logically from the most important $(NH_4)_2SO_4$ case, contributed by Matthias. Isomorphous selenates, fluoberyllates and monofluophosphates of some of them have already been prepared, and others are in preparation. Properties of those already measured are given. The Li-containing salts are of particular interest, and have led to discovery of the important $LiH_3(SeO_3)_2$ discussed below. $RbHSO_4$ is of prime interest, since it is the first sulfate not containing ammonium or substituted ammonium ions; it is a most promising ferroelectric. The discovery of ferroelectric selenites is a natural consequence of activity in sulfates. $LiH_3(SeO_3)_2$ is a room-temperature ferroelectric with extraordinarily high spontaneous polarization. It is entirely stable, and grows easily in very large crystals. $NaH_3(SeO_3)_2$ is ferroelectric below room temperature. $CsH_3(SeO_3)_2$ is apparently antiferroelectric. Related anions are suggested by activity in the selenites, and some already prove interesting. (Contractor's abstract)

1575

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

SCADAC: SINGLE-CRYSTAL AUTOMATIC DIFFRAC-TOMETER AND ANALOGUE COMPUTER (Abstract), by K. Drenck, H. Diamant, and R. Pepinsky. [1959] [3]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35] Atomic Energy Commission, and Office of Ordnance Research)

Unclassified

Presented at Internat'l. Cryst. Convention, Leningrad (U.S.S.R), May 21-27, 1959.

Presented at meeting of the Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.

SCADAC is one of a number of machines designed for automatic collection of single-crystal diffraction data. The machine requires reciprocal lattice vectors as input, and from these solves the Ewald construction, by means of an internal analogue computer. This computer provides information to servo amplifiers which then motor-drive the crystal and scintillation counter detector to positions satisfying the Laue conditions. The crystal and counter then scan the reflection a number of times concommitant with the required accuracy of measurement, after inserting a correct filter and proper scale factor for the scaling circuit. The counts are then printed out at pre-determined intervals of the scan angles, and are also totalized, subtracted from background, and the integrated intensities printed out, on a paper tape, along with the Miller indices, scale and filter factors. Relay circuits permit the avoidance of measurements at reciprocal lattice points where space-group symmetries produce absences. The machine is con-

structed in equatorial mounting, to simplify the use of the Ewald construction for non-zero level reciprocal lattice planes. It can be programmed to follow any given plane curve in reciprocal space, as well as to explore reciprocal lattice nodes.

1576

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

TWO INSTRUMENTAL SYSTEMS FOR AUTOMATIC DIFFRACTION DATA COLLECTION FROM SINGLE CRYSTALS, by R. Pepinsky, K. Drenck and others. [1959] 4p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Atomic Energy Commission, and Office of Ordnance Research)

Unclassified

Presented at meeting of Internat'l. Union of Crystallography on Commission on Instrumentation, Stockholm (Sweden), June 10-12, 1959.

Presented in part at meeting of Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959. (Title varies)

Two schemes for automatic single-crystal diffractometry are reported. The 1st, SCADAC (single-crystal automatic diffractometer and analogue computer) is designed for rapid, accurate x-ray measurements, and includes an internal (analogue) computer which solves Laue's equation by an analogue to Ewald's construction in reciprocal space. The computer requires reciprocal lattice vectors as input. The counts are printed out at pre-determined intervals of scan angles, and are also totalized, subtracted from background, and the integrated intensities printed out on a paper tape along with the Miller indices of the reflection, the filter factor and the number of scans. The 2nd type of machine reported is an automatic machine designed and constructed for single-crystal neutron observation. The diffractometer is a miniaturized neutron goniometer which has been fitted with separate motor drives for both the crystal and counterarm shafts. Instructions for angle settings are provided to the machine in the form of 5 pre-set decade switch settings, corresponding to the crystal or counter positions for a given Laue peak for each digitalizer. All measurements and settings are automatically recorded on paper tape. The latter machine is preferable for neutron studies, because of the necessarily slow rate at which neutron measurements can be accomplished. For x-ray diffraction a machine of the SCADAC type seems preferable, and 1 machine will provide enough data for a sizable laboratory.

1577

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

X-RAY AND NEUTRON ANALYSIS OF $(NH_4)_2BeF_4$

(Abstract), by M. Kay, J. Lajzerowicz and others.
[1959] [2]p. (Sponsored jointly by Air Force Office of
Scientific Research under [AF 18(603)35], Atomic Ener-
gy Commission, Brookhaven National Laboratory, Of-
fice of Naval Research, and Signal Corps)

Unclassified

Presented at meeting of the Amer. Cryst. Assoc.,
Cornell U., Ithaca, N. Y., July 19-24, 1959.

The discovery of ferroelectricity in $(NH_4)_2SO_4$ and

$(NH_4)_2BeF_4$ and subsequent studies of superstructures

and non-isomorphism of the low-temperature phases of
these crystals have prompted careful re-examination of
their structures. X-ray and neutron analyses of the su-
perstructured room-temperature phase of $(NH_4)_2BeF_4$

are reported here. A neutron analysis of the c-axis
projection of a deuterated crystal was carried out, and
the projection was refined first using difference maps
and least-squares. The error index, with deuteriums
included, dropped to 0.15. The subsequent Fourier
synthesis indicated that the BeF_4 groups were either

librating about the Be nuclei or systematically tilted in
accordance with the superstructure. Assigning ani-
sotropic temperature corrections to the F nuclei low-
ered the error index to 0.13, and reduced the standard
deviations of the F coordinates by one-half.

1578

Pennsylvania State U [X-Ray and Crystal Analysis Lab.]
University Park.

X-RAY STUDIES OF ABSOLUTE CONFIGURATIONS OF
FERROELECTRIC CRYSTALS: II (Abstract), by F.
Unterleitner, Y. Okaya and others. [1959] [3]p. (Spon-
sored jointly by Air Force Office of Scientific Research
under AF 18(603)35, Atomic Energy Commission, Of-
fice of Naval Research, and Signal Corps)

Unclassified

Presented at meeting of the Amer. Cryst. Assoc.,
Cornell U., Ithaca, N. Y , July 19-24, 1959.

Recently a program for determination of the absolute
configurations of certain ferroelectric transition struc-
tures has been initiated, in order to provide a more
complete understanding of charge distributions and the
physical mechanism of the spontaneous polarization and
its field-reversibility. The absolute configurations of
ferroelectric KD_2AsO_4 and $(glycine)_3 \cdot H_2SO_4$ are re-

ported. The method used in these studies is that intro-
duced by Okaya and Pepinsky, involving application of
the $P_s(u)$ function. In the KD_2AsO_4 study, MoKα radia-

tion was used to excite As, for which f'' = 2.2 electrons.
The (h. k, l) intensities were measured, using a propor-

tional counter, and the generalized projection $P_s^1(u,v) =$

$\int_0^1 P_s(u,v,w)$ (sinlw) dw was computed. The measure-

ments showed that the polarization occurs in the direc-
tion of the displacement of P within the PO_4 tetrahedra.

The phosphorus must carry the largest positive charge
(about 3 or 4 times as great as that carried by K). This
is directly in contradiction with the assumption of Bacon
and Pease, who had assumed the polarization in the op-
posite direction. The absolute configuration of the fer-
roelectric phase of $(glycine)_3 \cdot H_2SO_4$ was established,

using CuKα to excite S in the SO_4 group; f'' for S is less

than 0.5 electrons. It was established that the amino
group of the glycinium ion near the plane y = 1/4 moves
in the direction of the applied field. This substantiates
the switching mechanism proposed by Hoshino et al.
This is a remarkable illustration of the great power of
the $P_s(u)$ function.

1579

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.]
University Park.

X-RAY STUDIES OF FERROELECTRIC AND SELENITES
(Abstract), by K. Vedam, F. Unterleitner and others.
[1959] 2p. (Sponsored jointly by Air Force Office of
Scientific Research under [AF 18(603)35], Atomic En-
ergy Commission, Office of Naval Research, and Sig-
nal Corps)   Unclassified

Presented at meeting of Amer. Cryst. Assoc.,
Cornell U., Ithaca, N. Y., July 19-24, 1959.

$NaH_3(SeO_3)_2$ crystallizes in the monoclinic system with

space group $P2_1/n$ and with cell dimensions a = 10.36A,

b = 4.84A, c = 5.80A, β = 91.2°, Z = 2. It exhibits a fer-
roelectric phase transition at -79°C, the low tempera-
ture phase being triclinic with space group Ci and the
unit cell dimensions at -125°C being a_L = 20.60A ≈ $2a$,

b_L = 9.56A ≈ $2b$, c_L = 5.76 ≈ c, α_L = 89.8°, β_L = 91.0°,

γ_L = 90.3°, Z = 8. The polar direction is along [313] re-

ferred to the monoclinic axes. The structure analysis
of the room-temperature phase of this crystal has been
carried out following the usual procedure, using the
hkO, hOl and Okl reflections for CuKα radiation. After
least-squares refinement with the IBM 704, the R factor
has been reduced to 0.10. The structure consists of so-
dium atoms in special positions (0,0,1/2; 1/2, 1/2, 0)
and pyramidal SeO_3 groups with Se-O distances 1.69A.

1.73A and 1.70A. The mean bond angle O-Se-O is 99.6°.
The hydrogen bonds in this crystal form a 3-dimen-
sional network interlinking the SeO_3 groups. In the

latter crystal the SeO_3 groups are joined together by

hydrogen bonds to form double layers parallel to (110),
the cleavage plane. No such cleavage plane could be
detected in $NaH_3(SeO_3)_2$. A structure analysis of the

low-temperature phase of this crystal is in progress.
$LiH_3(SeO_3)_2$ also crystallizes in the monoclinic system,

but with space group Pn and cell dimensions a = 6.258A, b = 7.886A, c = 5.433A, β = 105.2°. This crystal exhibits ferroelectric properties at room temperature, and no phase transition could be detected in the temperature range -196°C to 110°C. A 3-dimensional structure analysis is in progress. (Contractor's abstract)

1580

Pennsylvania U., Philadelphia.

He I GROUND-STATE WAVE FUNCTION OF THE FORM $\psi = f(r_1)f(r_2)g(r_{12})$, by L. C. Green, C. Stephens and others. [1959] [5]p. incl. tables, refs. (In cooperation with Haverford Coll., Strawbridge Observatory, Pa.) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)660], National Science Foundation, and Office of Naval Research)
Unclassified

Published in Jour. Chem Phys., v. 30: 1061-1065, Apr. 1959.

A variational trial wave function of the form $\psi = f(r_1)f(r_2)g(r_{12})$ has been applied to the ground state of He I. In section I, (r) is taken to be an arbitrary function and $g(r_{12})$ is taken as linear. The form of f(r) and the slope of $g(r_{12})$ are chosen to yield the minimum energy. The energy, $-5.79613R_{He}hc$, and the form of f are compared with the results of earlier work and with the results obtained with analytic functions. A table of f(r) and the charge distribution is given. The charge distribution is compared with that obtained from a Hartree-Fock wave function and the difference is discussed. In section II, '(r) is taken as an exponential and $g(r_{12})$ is taken to be an arbitrary function. The coefficient in the exponent in f(r) and the form of $g(r_{12})$ are chosen to yield the minimum energy. The energy, $-5.7852R_{He}hc$, and the form f are compared with the results obtained with analytic wave functions. The behavior of g is shown in a table by its asymptotic series. The probable effectiveness of ψ if both f(r) and $g(r_{12})$ are taken as arbitrary is discussed. (Contractor's abstract)

1581

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

[MATHEMATICS OF SMOOTHING OPERATORS], by I. J. Schoenberg. Final rept. Aug. 1959, 4p. incl. refs. (AFOSR-TR-59-112) (AF 18(600)1158)
Unclassified

This paper reviews the subject matter of the various reports issued under this contract. The difficulties

encountered are mentioned as well as the solutions used to overcome them. Mention is also made of the contributions made by visiting researchers.

1582

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

THE INTEGRABILITY OF CERTAIN FUNCTIONS AND RELATED SUMMABILITY METHODS, by I. J. Schoenberg. [1959] [15]p. incl. refs. [AF 18(600)1158]
Unclassified

Published in Amer. Math. Monthly, v. 66: 361-375, May 1959.

Let γ_n, $1 < n \leq \infty$, be any sequence. Put $s_n = \sum_{d|n} \varphi(d)\gamma_d / \sum_{d|n} \varphi(d)$, where $\varphi(n)$ is Euler's φ function. It is shown that $\gamma_n \to \lambda$ implies $s_n \to \lambda$, but that the converse is not true. In fact, it is proven that $\lim s_n = \lambda$ implies γ_{nv} if and only if $\liminf_{v \to \infty} \varphi(n_v)/n_v > 0$. (Math.

1583

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

ON A CONJECTURE CONCERNING SCHLICHT FUNCTIONS, by B. Epstein and I. J. Schoenberg. [1959] [3]p. [AF 18(600)1158]
Unclassified

Published in Bull. Amer. Math. Soc., v. 65: 273-275, July 1959.

Let S be the class of all power series which converge and are univalent in the unit circle. It was conjectured that $\Sigma a_n z^n \in S$ and $\Sigma b_n z^n \in S$ implies $\Sigma n^{-1} a_n b_n z^n \in S$. This conjecture is disproved by the following counterexample. By a general result of Pólya and Schoenberg on de la Vallée-Poussin means (Pacific Jour. Math., v. 8: 295-334, 1958) the polynomial $P(z) = 15z + 12z^2 + 3z^3$ lies in S. This polynomial is composed with the general power series in S which can be obtained from Loewner's differential equation. The composition series is again a polynomial p(z) of degree 3. By proper choice of the Loewner parameter function, one can achieve that $\dot{p}(z)$ vanishes in the unit circle. Thus, p(z) cannot be univalent and a counterexample is constructed. (Math. Rev. abstract)

1584

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

THE INTEGRABILITY OF CERTAIN FUNCTIONS AND

RELATED SUMMABILITY METHODS II. by I. J.
Schoenberg. [1959] [2]p. [AF 18(600)1158]
Unclassified

Three remarks to a previous paper (1582; The integra-
bility of Certain Function etc., Vol. III) are made. A
simple proof of Besicovitch is presented of the fact
that to every δ there exists an n_0 so that for every
$n > n_0$ each subinterval $I\delta$ of length δ contains a frac-
tion m/n, $(m,n) = 1$. (Math Rev. abstract)

1585

Pennsylvania U [Dept. of Mathematics] Philadelphia.

[RISING ARCS WITH VANISHING SLOPES AND RE-
LATED PROBLEMS] Sur les arcs ascendants á pente
partout nulle et des problémes qui s'y rattachent
(Abstract), by A. S Besicovitch and I J. Schoenberg.
[1959] [2]p. [AF 18(600)1158]   Unclassified

Let $x = i(t)$ be a Jordan arc in real Euclidean or Hilbert
space E, and let $g(t)$ be a continuous function $0 < t < 1$.
If $\lim_{h \to 0} \frac{g(t+h)-g(t)}{f(t+h)-f(t)} = 0$ for all t, it follows that $g(t)$ is
constant if E is a line, and it is not a constant if E is
Hilbert space or the plane. The latter conclusion re-
sults from the construction of a plane arc J with the
property that to each $\epsilon > 0$ corresponds a constant C_ϵ
such that the plane measure of the subarc with ex-
tremities ν and ν' is positive and less than $C_\epsilon |\nu-\nu'|^{2-\epsilon}$.
This condition cannot be satisfied for $\epsilon = 0$. Two re-
lated results are: If $x = f(t)$ is a plane arc then lim inf
$\Sigma 1^n |f(t_i) - f(t_{i-1})|^2 = 0$, where the lim inf is taken over
all subdivisions $0 = t_0 < t_1 < \cdots < t_n = 1$ as max $|t_i -
t_i| \to 0$. A corollary is that $g(t)$ satisfies a Lipschitz
condition $|g(t) - g(t')| \leq C|f(t) - f(t')|^2$ then $g(t)$ is con-
stant. (Math. Rev. abstract)

1586

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

ON THE MAXIMA OF CERTAIN HANKEL DETERMI-
NANTS AND THE ZEROS OF THE CLASSICAL ORTHO-
GONAL POLYNOMIALS, by I J. Schoenberg. [1959]
[9]p. [AF 18(600)1158]   Unclassified

A proven proposition is generalized for $n = 2$ supposed
by Nelder, Hammersley and Ulin: If one places $1_v =
\int_0^\infty x v_e^{-x} dF(x)$ with a positive measure $dF(x)$ in (0, ∞)
of total value 1, then the Hankel determinant of this in-
tegral (1) $D(F) = \det I_{i+j}$ $o,n \leq e^{-n(n+1)}(2^2 3^3 \cdots
n^n)^2 = A_n (A_0 = 1)$, with an equality exact in the case,
where $dF(x)$ is simplified to $n+1$ points equal to the
quantity $1/(n+1)$ equal to points (2) $x_0 = 0$, $x_i (i = 1,\ldots n)$
where x_i the zero points of Laguerre polynomials are
$L_n^{(1)}(x)$. The existence of a function $\eta(x)$ is proven which
assigns the greatest value $D(\eta)$ to the determinant (1).
Ulins train of thought is followed with the addition of 2
conditions necessary for a general n. The result of this
is that $\eta(x)$ possesses exactly $n+1$ points of increase x_0.
$x_i (i = 1,\ldots,n)$, (2) $x_0 = o < x_1 < \ldots < x_n$. With the help of
the function $f(s) = \int_0^\infty e^{-sx} dF(x)$, which takes on the value
$\Sigma_{v=0}^n A_v e^{-sx}v$ for $F = \eta$ one finds $\Phi = \exp(-\Sigma_{i=1}^n x_i)$
$\prod_{i=1}^n x_i^2 \prod_{i>j} (x_i - x_j)^2$, $D(\eta) = A_0 A_1 \ldots A_n \Phi$. The basis
of the study is a proposition demonstrable by means of a
theorem by Stieltjes: Φ just attains in (2) its maximum
value when x_i are the zero points of the Laguerre poly-
nomials $L_n^{(1)}(x)$. A more general theorem by the author
refers to the polynomial $L_n^{(\alpha)}(x)$, and he develops
ramifications of the theorem in the range $(-\infty, \infty)$ for
the Hermite polynomial, and in $(-1, 1)$, for Jacobian
polynomials, with the weights e^{-x^2} and $(1-x)^{\alpha+1}
(1-x)^{\alpha+1} (1+x)^{\beta+1}$ (instead of $x^{\alpha+1}e^{-x}$) in inte-
grands of I_v.

1587

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

ON VARIATION DIMINISHING APPROXIMATION
METHODS, by I. J. Schoenberg. [1959] [26]p. incl. refs.
[AF 18(600)1158]   Unclassified

This report investigates approximations of a given
function $f(x)$ by ordinary or trigonometric polynomials
from the point of view of "variation-diminishing" oper-
ators in the special case where the approximation is
generated by a linear functional operator. At first the
important result is established that the approximation
of $f(x)$ by Bernstein polynomials $B_n(x)$ is variation
diminishing. This leads to some very explicit

information about the behavior of this Bernstein approximation. If, for instance, $f(x)$ is convex (without being linear), then $B_n(x)$ is also convex and $B_n(x) > f(x)$.

Moreover, $B_{n-1}(x) > B_n(x)$ unless $f(x)$ is a polygonal line of special type. Analogous properties hold for the approximation of a periodic function $f(t)$ by the so-called de La Vallée Poussin means. Both methods of approximation avoid therefore unnecessary oscillations of the approximating functions. In the 2nd part of the paper, it is shown that "variation-diminishing" in the sense that it is defined, also leads under certain assumptions to a decrease of the total variation $T(f)$ of the given function. The result of Popoviciu $T(B_n) < T(f)$ is re-established, and it is shown that the equality sign holds in this relation if and only if $f(x)$ is monotone. In the last chapter variation-diminishing integral-operators of the convolution type and a wider class of "convexity-preserving" kernels are introduced. (Math. Rev. abstract)

1588

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

FOURIER-STIELTJES SERIES OF WALSH FUNCTIONS, by N. J. Fine. [1957] [10]p. (AFOSR-5041) [AF 18(603)65]   Unclassified

Also published in Trans. Amer. Math. Soc., v. 86: 246-255, Sept. 1957.

It is known that a trigonometric series is a Riemann-Stieltjes series if and only if its $(C, 1)$ sums are bounded in the L_1 norm. The analogous problem for the Walsh system needs a slight reformulation, since the Walsh functions are not continuous. Morgenthaler (Trans. Amer. Math. Soc., v. 84: 472-507, 1957) has proved that a Walsh series is a Riemann-Stieltjes corresponding to a continuous determining function of bounded variation if and only if

(1) $\int_0^1 |\sigma_n(x)| \, dx = O(1)$ and (2) $\dfrac{S_n(x)}{n} \to 0$ uniformly in

$[0, 1]$, where S_n and σ_n are the partial sums and the $(C, 1)$ sums, respectively, of the given series. This still leaves open the general case, in which a Lebesgue-Stieltjes integral is used, the determining function being merely of bounded variation. It is the purpose of this paper to settle the question by giving necessary and sufficient conditions, and to show how the determining function may be recovered from the given series. It turns out that (1), which is necessary, is not sufficient. However, the analogy with the trigonometric case can be restored completely by transferring attention to the dyadic group, of which the Walsh functions are essentially the characters.

1589

[Pennsylvania U   Dept. of Mathematics, Philadelphia]

UNIVERSAL MINIMAL SETS, by R. Ellis. [1959] 4p. (AFOSR-TN-59-1119) (AF 49(638)569) AD 234511
                                          Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 540-543, Aug. 1960.

Let T be an abstract group. Then a universal minimal set for T is a transformation group (X, T) with compact phase space X such that (X, T) is minimal and such that any other transformation group (Y, T) with Y compact and (X, T) minimal is a homomorphic image of (X, T). A universal minimal set is shown to exist for every group T and to be unique. The action of T on X is strongly effective. (Contractor's abstract)

1590

Pennsylvania U. [Dept. of Metallurgical Engineering] Philadelphia.

ON THE ROLE OF CONDENSED VACANCIES AND INTERSTITIALS IN FATIGUE, by R. K. McCrone and D. Kuhlmann-Wilsdorf. [1959] [2]p. (AFOSR-TN-59-705) (AF 49(638)435) AD 611384   Unclassified

Also published in Naturwissenschaften, v. 46: 334-335, 1959.

The phenomenon of extrusions and intrusions arising in the course of fatigue seems to be a key to the understanding of the mechanism of fatigue. In this paper the role of vacancies and interstitials in the formation of extrusions and intrusions is considered.

1591

Pennsylvania U. [Dept. of Physics] Philadelphia.

PHOTOPROTON SCINTILLATION SPECTROMETER, by A. Whetstone, B. Allison and others. [1958] [5]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)472] and Office of Naval Research)   Unclassified

Published in Rev. Scient. Instruments, v. 29: 415-419, May 1958.

An apparatus is described for the measurement of the energy and angular distribution of protons from (γ,p) reactions. A method is presented for obtaining energy spread of 3% for protons of 3 to 15 mev with a NaI scintillator of 1-in. diam aperture. Energy calibration of the detector with monoenergetic protons gives an energy vs pulse-height line having an intercept of 0.46 ± 0.10 mev. The ratio of α particle to proton energy for equal pulse heights is found to be 1.93 ± 0.04 for 4.48 mev α particles. A CsI scintillator, similarly

mounted, yields an intercept of -0.17 ± 0.15 mev and α-proton energy ratio of 1.66 ± 0.07 for 5.3-mev α particles. A modification of the phoswich to provide discrimination against electrons is described. (Contractor's abstract)

1592

Pennsylvania U. Dept. of Physics, Philadelphia.

STUDIES IN PHOTONUCLEAR REACTIONS. Annual rept. Oct. 15, 1958, 10p. incl. refs. (AFOSR-TR-59-189) (AF 18(600)472) AD 209806   Unclassified

A brief review of the research conducted under this contract is presented. The areas of interest include the betatron energy control system, the neutron detection system, the photoneutron thresholds, elastic scattering of photons, measurement of short half-life residuals, and neutrino-electron angular correlation in the β decay of He^6. The methods used to accomplish better detection, more precise control, and more accurate measurements is discussed. The new method for precise energy control of a 25 mev betatron reportedly gives short term stability of better than ± 4 kev and long term stability of better than ± 15 kev. The results of the neutron detection system, which utilizes 3 BF^3 counters imbedded in a paraffin moderator with cadmium and Boro-paraffin shielding, shows the detection sensitivity to fall rapidly from threshold to about 100 kev above threshold and then displays a more gradual decline for about 1 mev. The results on photoneutron thresholds shows good agreement with previous results except in the case on oxygen which apparently has a photoneutron threshold of 190 ± 25 kev above the Q value (15.6). The state and progress of the research in the other mentioned fields is reported also but further experiments remain to be completed.

1593

Pennsylvania U. Dept. of Physics, Philadelphia.

THE INFLUENCE OF RADIATION INDUCED AND OTHER IMPERFECTIONS ON THE MECHANICAL, THERMAL AND OPTICAL PROPERTIES OF ALKALI HALIDE CRYSTALS, by B. R. Russell, P H. Miller, Jr., and M. E Caspari. Final rept. July 1959, 1v. incl. diagrs. table, refs. (AFOSR-TR-59-123) (AF 18(600)561) AD 230224; PB 144350 Unclassified

The thermal expansion of LiF single crystals were determined by macroscopic measurements and the x-ray determination of the lattice constant with temperature. The value obtained by the x-ray technique was 6% smaller than the macroscopic value. The generation of point imperfections and F-centers by weak ionizing irradiation, and the optical properties and the crystal dimensions were studied in Harshaw KCl and NaCl single crystals. A linear relationship existed between the relative linear expansion produced by a

certain dose of x-ray irradiation and the F-center concentration produced by that dose. The effect of annealing on the growth of the F-center curve was also determined. In a partially shielded crystal, vacancies were formed upon irradiation even in the shielded portion. Attempts to reproduce this effect by quenching annealing and fast cooling, annealing and slow cooling, and plastic deformation were unsuccessful. (Contractor's abstract)

1594

[Pennsylvania U. Dept. of Physics, Philadelphia]

THE DARKENING OF POTASSIUM CHLORIDE CRYSTAL BY X-RAYS, by C.-Y. Sheng. [1959] [19]p. incl. diagrs. (Bound with its AFOSR-TR-59-123; AD 230224; PB 144350, as appendix I) [AF 18(600)561]
Unclassified

X-ray irradiated single crystals of KCl were examined spectrophotometrically, in order to study the darkening, i.e., the formation of color centers in alkali halide when irradiated by x-rays. To a first approximation, the density of F-centers produced by x-rays was found to be proportional to x-ray intensity and time of irradiation; the stronger the x-rays and the longer the irradiation time, the larger the density. The darkenability varied from crystal to crystal, and over various portions of the same crystal. Observations showed that annealed crystals treated with x-rays have a higher density of F-centers than "as-received" crystals under identical conditions. It was also noted that when subsequent halves of a crystal were irradiated while shielding the adjacent half, the last irradiated portion always showed a higher F-center density than the initially irradiated part. This phenomena could not be explained. The problem of bleaching during measuring is discussed.

1595

[Pennsylvania U. Dept. of Physics, Philadelphia]

THE F-CENTER DENSITY IN PARTIALLY IRRADIATED POTASSIUM CHLORIDE CRYSTALS, by P. D. Howley. [1959] [17]p. incl. diagrs. table, refs. (Bound with its AFOSR-TR-59-123; AD 230224; PB 144350, as appendix II) [AF 18(600)561]
Unclassified

Two aspects of L. Y. Lin's work on NaCl and KCl crystals (Phys. Rev., v. 102: 968, 1956) are investigated; namely the fractional irradiation of the crystal, and the irradiation of successive halves of the crystal. In particular, an attempt was made to determine whether the results observed were due to some particular state of imperfection present in Lin's crystal. The F-center density was found to be independent of the fractional surface area irradiated, and there was no increase in the F-center density as a result of previous irradiation of an adjacent part of the crystal, as

reported by Lin. Evidence is cited, however, to support the theory that this effect may occur in crystals of a purer state than those used in the present experiment.

1596

Pennsylvania U. Dept. of Physics, Philadelphia.

STUDIES IN PHOTONUCLEAR REACTIONS. Annual rept. Oct. 15, 1959, 14p. incl. tables, refs. (AFOSR-TN-59-1211) (AF 49(638)454) AD 228406
Unclassified

A brief review is given of the investigations carried out to date under this project. The new betatron control system was calibrated using thresholds for photoneutrons from deuterium, bismuth, copper and for the isochromat from the 15.12 mev level in carbon. A total of 73 photoneutron thresholds were measured throughout the periodic table with an average accuracy of the order of 50 kev. In some instances the observed photoneutron threshold did not correspond to the neutron binding energy for the initial nucleus. The apparent threshold represents either (1) resonant photon absorption at an energy slightly greater than the kinematic threshold energy, or (2) neutron emission leaving the residual nucleus in an excited state having a more favorable spin. The activation curves for carbon, nitrogen, oxygen and flourine were analyzed to yield the (γ,n) cross section in the neighborhood of threshold. Activation curves measured for carbon and oxygen show fine structure in good agreement with the known level schemes. Cross section analysis using the measured isochromat to generate the photon spectrum is presently in progress. Preliminary results indicate that these levels are wider than previously obtained from "break" data alone.

1597

Pennsylvania U. [Dept. of Physics] Philadelphia.

PHOTONEUTRON THRESHOLD MEASUREMENTS (Abstract), by K. N. Geller, E. G Muirhead, and J. Halpern. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)454] and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 32, Jan. 28, 1959.

Photoneutron thresholds of 45 mono- and di-isotopic elements have been measured using our 25-mev betatron with improved energy stability. Neutron yields in the vicinity of threshold were measured in steps of approximately 25 kev. Thresholds were obtained by extrapolating the direct yield curve into the measured background. Other methods of extrapolation were used to refine this crude value. For most elements neu-

trons were detected directly by using three BF_3 counters embedded in a paraffin block. For light elements, greatly improved sensitivity was obtained by measuring the annihilation radiation from the residual positron activity with two NaI(Tl) crystals. The primary energy calibration of the betatron is based on the thresholds of the (γ, n) reaction in D(2.226 mev), Bi^{209} (7.43 mev) Cu^{63} (10.83 mev), P^{31} (12.33 mev), and of elastic scattering of the photon isochromat by the 15.11-mev level in C^{12}. The final energy calibration includes many other photoneutron thresholds as secondary standards. The energy scale so obtained is linear on an electron momentum versus "dekavider" setting plot to within the accuracy of measurements ($\pm$ 25 kev in the range 2-20 mev). Comparison of the present results with other threshold measurements and with recent mass data will be made.

1598

Pennsylvania U. [Dept. of Physics] Philadelphia.

ENERGY LEVEL PARAMETERS FROM NUCLEAR RESONANCE FLUORESCENCE AT 7 MEV, by K. Reibel and A. K. Mann. [1959] [54]p. incl. diagrs. tables. refs. (AFOSR-TN-59-1203) (AF 49(638)537)
Unclassified

Also published in Phys. Rev., v. 118: 701-713, May 1, 1960.

The recoil broadened photon spectrum from the reaction $F^{19} (p,\alpha\gamma)O^{16}$ has been used to measure the elastic photon scattering cross sections at 7 mev of 31 elements. The observed angular distributions are consistent with dipole transitions. A plot of the cross sections versus mass number shows definite peaks around the closed shell regions near $Z = 50$, $N = 82$ (Sn, Te and Ba), and $Z = 82$, $N = 126$ (Pb and Bi). For 6 medium and heavy elements self absorption measurements were made which, when analyzed in terms of a number of non-overlapping Breit-Wigner resonances, yield values of the average partial radiation widths to the ground states, the average total radiation widths, and the average level spacings for those elements. The radiation widths are significantly larger than those determined from slow neutron scattering and capture experiments and, excepting Pb and Bi, the average level spacings are also appreciably greater than would be expected from the neutron data. The observed widths and spacings are in order of magnitude agreement with the recent interpretation of the modified single particle calculation of Blatt and Weisskopf. (Contractor's abstract)

1599

Pennsylvania U. Inst. for Cooperative Research, Philadelphia.

A NOTE ON THE POSSIBILITY OF A DIVIDED STRUCTURE FILE PERMITTING ARBITRARY SUBSTRUCTURE SEARCHES, by J. O'Connor. [1959] [14]p. (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under [Nonr-55135])
AD 243354   Unclassified

Given a file of structures $S_1....S_N$ and an arbitrary question structure Q, to find which S_i's include Q as a substructure. Organic molecule structures provide an example of this problem. The problem can be solved by comparing Q with all NS_i's. However, the question arises as to whether the following approach can be used: divide the file, with duplicate storage entries for S_i's, so that (1) the search for any Q need examine at most K file structures, with K some fraction of N; (2) the average number of storage entries per S_i is $< D$; and (3) at most Z headings have to be compared with Q to determine which part of the file to search. Attention is confined to those Q's which are included in at least one and no more than M file structures. Among these Q's are some, $B_1,...B_t$, which form an included basis for the rest, in that any other Q includes at least one B_k.
(Contractor's abstract)

1600

Phillips Petroleum Co., Bartlesville, Okla.

A CALORIMETRIC STUDY OF TRAPPED RADICALS PRODUCED BY GAMMA RADIATION, by R. L. Arnett, E. D. Guth, and J. R. Berreth. Sept. 1959 [46]p. incl. diagrs. refs. (Research Div. rept. no. 2574-60R) (AFOSR-TN-59-894) (AF 49(638)45) AD 235427; PB 149002   Unclassified

Presented at Fourth Internat'l. Symposium on Free Radical Stabilization, Nat'l. Bur. Standards, Washington, D. C., Sept. 1959.

Several pure gases in the crystalline state (ammonia, methane, nitrogen, argon) and a glass of ammonia, water, acetone, have been irradiated in a gamma field. The amounts of energy stored in the solids are determined by calorimetry. A description is given of the calorimeter and experimental techniques. The energy stored amounts to a few joules/g (up to 12 in 1 experiment with methane) and represents only 2 to 5% of the gamma energy absorbed. From comparison of these results with those obtained by condensing an electrodeless discharge gas, it is suggested that the trapped energy carriers are in their ground state when generated by gamma radiation of solids and at least some are trapped in excited states when condensed from a discharged gas. (Contractor's abstract)

1601

Phillips Petroleum Co., Bartlesville, Okla.

CHEMICALLY REACTIVE SPECIES. THEIR PRODUCTION, STABILIZATION, CONCENTRATION AND STORAGE, by R L. Arnett, E. D. Guth, and J. R. Berreth. Final rept. Oct. 1959 [39]p. incl. illus. diagrs. tables, refs. (Research Div. rept. no. 2478-59R) (AFOSR-TR-59-190) (AF 49(638)45) AD 235428; PB 150072
                          Unclassified

The continual search for higher energy propulsive fuels has fostered research on the generation and stabilization of free radicals. This investigation (for which this is the final report) is part of the general military sponsored program aimed at determining the feasibility of making such a fuel, and is specifically concerned with direct determinations of the energy stored in various free radical containing systems. The radicals are generated in situ in solids by gamma irradiation. The solids are condensed low molecular weight gases; e.g., ammonia, methane, nitrogen. The energy stored in these systems is measured by direct calorimetric observations of the apparent heat capacity of the irradiated material as compared to that for the unirradiated mate rial The apparatus for making these measurements is described and a summary discussion of the results is given. No 'fuel-level' concentration of stored energy was approached in any experiment - this level being 10,000 times greater than any found. A low efficiency (3 - 4%) for the trapping process is a general feature of the results with a decrease in this efficiency as the level of stored energy increases. Curves are given showing the energy released as the solid is warmed for each system examined.

1602

Pisa U. Inst. of Aeronautics (Italy).

THE AERODYNAMICS OF AIRFOILS IN NON-UNIFORM STREAMS OF INCOMPRESSIBLE FLUID, by E. Pistolesi and M. Marini. [1959] [18]p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-59-111) (AF 61-(514)1051) AD 210391; PB 140150   Unclassified

An aerodynamic study was conducted on an airfoil immersed in a bidimensional stream of incompressible perfect fluid, adjacent to another bidimensional stream of incompressible perfect fluid having a different velocity. The interface between the 2 streams is constituted by a rigid wall, from infinity upstream to a point situated at a finite distance from the airfoil. An uncambered airfoil of zero thickness, is disposed at a small angle of attack in the stream. The vortex in the aerodynamic center of the airfoil has a strength equal to the total circulation existing around the airfoil. The aerodynamic effects on the airfoil are determined as a first approximation in conformal mapping. The same problem may also be solved without conformal mapping by adopting convenient functions for the complex velocity which satisfy the condition of no flow at the rigid wall.

1603

Pisa U. Inst. of Aeronautics (Italy).

THE AERODYNAMICS OF AIRFOILS IN NON-UNI-
FORM STREAMS: SUBSONIC AND SUPERSONIC
STREAMS, by E. Pistolesi and M. Marini. [1959] [19]p.
incl. diagrs. tables. (Technical note no. 2) (AFOSR-
TN-59-112) (AF 61(514)1051) AD 210392; PB 140149
Unclassified

The aerodynamic characteristics are studied of an
airfoil situated in a subsonic stream adjacent to a
supersonic stream. The supersonic stream is consti-
tuted of a stream of finite width bounded at the lower
side by a rigid wall or constituted of a jet of finite
width. Convenient hypotheses were adopted to facilitate
study by means of linearized theory. After calculating
the values of the velocities induced in the aerodynamic
center of the airfoil, the values of the ratios between
the real values of the circulation and of the lift, and
the corresponding values for an airfoil in a uniform
stream were deduced.

1604

Pisa U. Inst. of Aeronautics (Italy).

THE AERODYNAMICS OF AIRFOILS IN NON-UNI-
FORM SUPERSONIC STREAMS, by E. Pistolesi
and M. Marini. [1959] [43]p. incl. diagrs. tables.
(Technical note no. 3) (AFOSR-TN-59-113) (AF 61-
(514)1051) AD 210393; PB 140147 Unclassified

The aim of the present research is the study of the
aerodynamic characteristics of an airfoil situated in a
bidimensional supersonic stream (1) adjacent to another
bidimensional supersonic stream (2) having different
velocity. The research has been accomplished adopting
the small perturbation theory; the airfoil has been sup-
posed to be a flat plate disposed at a small angle of
attack in the stream (1). All the compression and ex-
pansion waves have been supposed weak and such as to
be represented by means of Mach waves.

1605

Pisa U. Inst. of Physiology (Italy).

EFFECT OF UNILATERAL CHRONIC LESIONS OF
THE MIDBRAIN ON THE ELECTROCORTICAL
ACTIVITY OF THE CAT, by J. P Cordeau and M.
Mancia. [1959] [26]p. incl. diagrs. refs. (AFOSR-TN-
59-117) (AF 61(514)1125) AD 210422 Unclassified

Also published in Arch. Ital. Biol., v. 96: 374-399, 1958.

A complete hemisection of the midbrain at the superior
collicular level produces a striking asymmetry in the
electrocortical activity of the cat's brain. The ipsi-
lateral hemisphere shows nearly continuous synchro-
nized activity, while the contralateral side shows the

usual EEG variations in line with the behavior of the
animal. It is concluded from this observation that the
ascending reticular system separates into 2 distinct
streams, one for each hemisphere, at the mesencephalic
level. However, activating impulses can still cross from
the normal half of the brain stem, rostrally to the level
of the section. The asymmetry recorded after a mes-
encephalic hemisection is at its greatest immediately
after the operation, fading gradually until its complete
disappearance some 5-8 days post-operatively. From
various combinations of unilateral partial lesions of
the midbrain tegmentum at the superior collicular level
in the normal cat and in the midpontine pretrigeminal
cat, it was concluded that the destruction of the medial
and lateral parts of the reticular formation as well as
the section of the lateral specific sensory pathways
contribute to the ipsilateral synchronization produced
by the complete hemisection.

1306

Pisa U. Inst. of Physiology (Italy).

[ELECTROENCEPHALOGRAM AND BEHAVIOR AF-
TER CHRONIC LESIONS OF THE RETICULAR SUB-
STANCE AND OF THE WAYS OF SPECIFIC SENSI-
BILITY] Elettroencefalogramma e comportamento
dopo lesioni croniche della sostanza reticolare e delle
vie della sensibilità specifica, by G. F Rossi. [1957]
[21]p. incl. diagrs. refs. (AFOSR-TN-59-386)
(AF 61(514)1125) Unclassified

Also published in Atti Convegno Parma, Nov. 23-24,
1957, p. 131-151.

The sight is due to the activity of the ascendent reticu-
lar system according to most sources. This is ques-
tioned on the basis of the demonstration given of the
experimental anatomy of a system of sensitive fibers
ascending along the medial part of the encephalic
trunk, topographically placid near the reticular sys-
tem and terminating in the aspecific diencephalic
structure. It is concluded experimentally that the im-
pulses that keep the superior centers active in the
pretrigeminal mediopontine preparation with the af-
ferent receptors removed, are developed from an as-
cendent reticular system whose function is explained
by the influx of sensitive afferents. The reticular sub-
stance seems capable of an autochthonous activity and
the sustaining electroencephalographic rhythms of
high frequency and low amplitude that characterize
sight.

1607

Pisa U. Inst. of Physiology (Italy).

[RECENT CONTRIBUTIONS TO THE PHYSIOLOGY OF
SLEEP] Recenti contributi alla fisiologia del sonne, by
G Moruzzi, G. F. Rossi, and A. Zanchetti. [1958]
[12]p. incl. diagrs. refs. (AFOSR-TN-59-387) (AF 61-
(514)1125) Unclassified

Also published in Atti Soc. Lombarda Sci. Med. Biol., Suppl., v. 13: 1-12, 1958.

Various data and experiments related to studies of the physiology of sleep are presented. The reaction of electroencephalographic arousal produced by a short whistle in the non-anaesthetized whole cat is shown. A schematic representation is given of the anatomical and electroencephalographic characteristics of the prepared "isolated encephalon" and "isolated cerebellum". According to Bremer's original hypothesis, wakefulness in the first preparation and sleep in the second would be owed to the action and respectively to the suppression of the centripetal impulses carried from sensitive paths (in black in the anatomical scheme shown). The topography and extent of the reticular substance in the encephalic trunk in the cat are shown. An anatomical functional schematic representation of the ascending reticular system and of the paths of specific sensibility is shown. A diagram shows the levels figured from the trunk of the cats encephalon for the transversal pretrigeminal mediopontine and rostropontine sections. Several related experiments are summarized.

1608

Pisa U. Inst. of Physiology (Italy).

[SPONTANEOUS ELECTRICAL ACTIVITY OF THE PIGEON'S OPTIC LOBES] Attività elettrica spontanea dei lobi ottici del piccione, by A. Borrazzo and A. Mollica. [1958] [2]p. incl. refs. (AFOSR-TN-59-419) (AF 51(514)1125) Unclassified

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1029-1030, 1958.

The study is made of spontaneous physiological electrical activity and its mechanisms. The electrical activity of the optic lobes is registered in the pigeon's thalamus far from the narcotic, either in the surface by means of bipolar or unipolar macroelectrodes of cotton, or deeply by means of fluctuating unipolar microelectrodes, of platinum or steel, 25-37µ in cross section. The results obtained are: (1) spontaneous electrical activity showing a series of small rapid potential oscillations of elevated frequency; (2) such activity is not appreciably modified by either illumination of the surroundings or by the introduction of curare (Sincurarina) at paralyzing dosages; (3) the suppression of the retinal afference of an optic lobe produces a net and persistent amplitude reduction of the spontaneous electrical activity; (4) a persistent depression of the spontaneous electrical activity without any trace of synchronization is observed in the decerebrated and bilaterally blinded pigeon; (5) such states are produced by parenteral introduction of barbiturates; and (6) the local application of strychnine causes typical convulsive phenomena (clonus) of the controlateral musculature. Different spontaneous electrical activity phenomena in the pigeon varying from mammals are found to be in the absence of physiological, pharmacological and convulsive synchronization phenomena.

1609

Pisa U. Inst. of Physiology (Italy).

[ELECTROPHYSIOLOGICAL ANALYSIS OF THE INTERACTION PHENOMENA BETWEEN THE OPTIC LOBES OF THE DECEREBRATED PIGEON] Analisi elettrofisiologica dei fenomeni di interazione fra i lobi ottici del piccione decerebrato, by A. Borrazzo and A. Mollica. [1958] [2]p. incl. refs. (AFOSR-TN-59-420) (AF 61(514)1125) Unclassified

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1031-1032, 1958.

Researches investigate this interaction between the optical systems of the 2 sides, recording with unipolar or bipolar method, the surface response of an optic lobe to short light stimulations applied to the contralateral eye at the rate of 1/sec. An acutely decerebrated pigeon is used which is completely curarized and artificially ventilated. The following results have been obtained: (1) the surface responses of the surface of an optic lobe to a short luminous stimulus applied to the contralateral eye is complex; (2) for the homolateral eye on the optic lobe constantly increasing electrical activity is registered after enucleation, cocaine treatment or an opaque filter; (3) if the homolateral eye is illuminated by a white light and the contralateral eye regular light, the electric responses of the lobe appear depressed; (4) the application of a solution of a 0.2-0.5% strychnine sulfate to an optic lobe causes a decrease in the amplitude of the electrical response of the contralateral optical lobe; (5) the application of 1% cocaine chlorohydrate to an optic lobe causes an increase in the electrical responses of the contralateral optic lobe. The activity of one side of the optic system is seen to reduce or inhibit the activity of the other side.

1610

Pisa U. Inst. of Physiology (Italy).

EFFECTS OF COMPLETE PONTINE TRANSECTIONS ON THE SLEEP-WAKEFULNESS RHYTHM: THE MIDPONTINE PRETRIGEMINAL PREPARATION, by C. Batini, G. Moruzzi and others. [1959] [12]p. incl. diagrs. refs. (AFOSR-TN-59-447) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) AD 214809 Unclassified

Also published in Arch. Ital. Biol., v. 97: 1-12, 1959.

Complete pontine transections were performed electrolytically in cats with implanted electrodes in the skull, and the EEG and ocular behavior of these animals were followed up to 9 days. Transections performed through the middle pons, just in front of the trigeminal rootlets (midpontine pretrigeminal preparations), brought about low voltage fast EEG rhythms and ocular behavior suggestive of wakefulness The EEG and eye signs of wakefulness were strikingly more persistent during the

survival time (up to 9 days) of these preparations than in normal intact cats. The sleep-wakefulness balance was definitely shifted toward a state of prolonged vigilance. Transections performed through the upper pons (rostropontine pretrigeminal preparations) induced high voltage slow EEG rhythms and ocular patterns of sleep, which remained unmodified throughout the entire survival period (up to 6 days) Since the rostropontine and the midpontine preparations are both connected to sensory receptors through the first 2 pairs of cranial nerves only, the trigeminal sensory input being thoroughly eliminated in both, the different EEG and behavioral patterns of the 2 preparations can be related to the injury or to the integrity of a small amount of nervous tissue lying in the rostral part of the pons. (Contractor's abstract)

1611

Pisa U. Inst. of Physiology (Italy).

NEURAL MECHANISMS UNDERLYING THE ENDURING EEG AND BEHAVIORAL ACTIVATION IN THE MIDPONTINE PRETRIGEMINAL CAT, by C. Batini, F. Magni and others. [1959] [13]p. incl. diagrs. table, refs. (AFOSR-TN-59-448) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) AD 214772 Unclassified

Also published in Arch. Ital. Biol., v. 97: 13-25, 1959.

The observation by Roger, Rossi and Zirondoli that the gasserectomized "encéphale isolé" cat displays high voltage slow waves was confirmed, and the synchronized electrocortical activity was found to be independent of low arterial pressure or excessive ventilation. The enduring EEG and behavioral patterns of wakefulness characteristic of the midpontine pretrigeminal preparation are changed into those typical of sleep by a subsequent brain stem transection performed at rostropontine levels. This experiment and other data reported in the text indicate that the irritation of activating reticular structures lying just in front of the midpontine lesion cannot be held responsible for the occurrence of low voltage fast activity in this preparation. Other control experiments show that the persistent patterns of wakefulness are not due to increase of adrenaline discharge or arterial carbon dioxide tension. The existence and the nature of an EEG synchronizing influence originating in the lower brain stem are discussed. (Contractor's abstract)

1612

Pisa U. Inst. of Physiology (Italy).

EEG AROUSAL FOLLOWING INACTIVATION OF THE LOWER BRAIN STEM BY SELECTIVE INJECTION OF BARBITURATE INTO THE VERTEBRAL CIRCULATION, by F. Magni, G. Moruzzi and others. [1959] [14]p. incl. diagrs. refs. (AFOSR-TN-59-449) (Spon-

sored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) AD 214771 Unclassified

Also published in Arch. Ital. Biol., v. 97: 33-46, 1959.

Clamping of the basilar artery and adequate cannulation of the lingual and subclavian arteries have permitted selective introduction of a barbiturate, thiopental sodium, into the vascular circuits separately supplying either the rostral pons, midbrain and upper cerebrum, or the medulla and caudal pons. Intracarotid injections of small amounts (0.1-0.6 mg) of thiopental sodium induced a short lasting synchronization of the electrocortical activity in the "encéphale isolé" animal. Slight doses affected ipsilateral cortical activity only, while repeated injections or larger doses produced bilateral synchronization. Intravertebral introduction of equally small amounts (0.3-0.6 mg) of thiopental sodium invariably and reversibly elicited opposite effects, i.e. EEG arousal reaction, provided that the electrocortical activity of the "encéphale isolé" animal displayed synchronized patterns. Thiopental doses as low as 0.1 mg, introduced into the vertebral circulation, proved to be capable of abolishing reflexes normally very resistant to anesthesia, such as the corneal reflex. The EEG arousal following intravertebral injection of thiopental is interpreted to be due to a functional transient inactivation of a synchronizing influence originating in the lower brain stem. (Contractor's abstract)

1613

Pisa U. Inst. of Physiology (Italy).

[EFFECTS OF UNILATERAL MESENCEPHALIC AND PONTINE SECTIONS ON THE ELECTROENCEPHALOGRAM] Effetti di sezioni unilaterali mesencefaliche e pontine sull'elettroencefalogramma, by J. P. Cordeau and M. Mancia. [1959] 12p. (AFOSR-TN-59-465) [AF 61(514)1125] AD 215270 Unclassified

Also published in Ricerca Scient., v. 29: 512-516, Mar. 1959.

A mesencephalic hemisection of the cat's brain is followed by EEG asymmetry. The hemisphere ipsilateral to the section is synchronized while the other is in line with the behavior of the animal. A midpontine hemisection yields a different kind of EEG asymmetry: it is characterized by a greater tendency to synchronization in the contralateral cerebral hemisphere. The possible interpretation of these results is briefly discussed.

1614

Pisa U. Inst. of Physiology (Italy).

EEG ACTIVATION PATTERNS IN THE MIDPONTINE PRETRIGEMINAL CAT FOLLOWING SENSORY

DEAFFERENTATION, by C. Batini, M. Palestini and others. [1959] [7]p. incl. diagr. (AFOSR-TN-59-780) (AF 61(514)1125) AD 225182 Unclassified

Also published in Arch. Ital. Biol., v. 97: 26-32, 1959.

Combined olfactory and visual deafferentiation immediately change the waking EEG patterns of the midpontine pretrigeminal preparation into those typical of sleep. However, with the passage of time, EEG patterns of sleep gradually wane, finally giving way, 1-2 days from the completion of sensory deafferentation, to the previous low voltage fast EEG rhythms. It is concluded that in the midpontine pretrigeminal preparation EEG activation patterns are independent on the sensory inflow. (Contractor's abstract)

1615

Pisa U. Inst. of Physiology (Italy).

[EFFECTS ON THE RETINA INDUCED BY CHEMICAL STIMULATION OF THE OPTIC LOBE] Effetti centrifughi retinici indotti dalla stimolazione chimica dei lobi ottici, by A. Borrazzo and A. Mollica. [1958] [2]p. incl. refs. (AFOSR-TN-59-827) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) Unclassified

Presented at the Twenty-seventh General Assembly of the Ital. Soc. of Experimental Biology, Milan (Italy), Oct. 2-4, 1958.

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1681-1682, 1958.

The study is made of the influence of the optic lobes of birds on the retinal activity shown by the electroretinogram. The experiments were carried out on decerebrated pigeons, completely immobilized and artificially ventilated. The nature of the electroretinogram wave is studied for the behavior of the small polyphase superimposed on the peak of the wave, which registered the simultaneous discharge of various centripetal fibers of the optic nerve.

1616

Pisa U. Inst. of Physiology (Italy).

[THE ELECTROENCEPHALOGRAM OF THE PIGEON] L'Elettroencefalogramma del piccione, by A. Mollica and M. Orsini. [1958] [2]p. incl. refs. (AFOSR-TN-59-828) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) Unclassified

Presented at the Twenty-seventh General Assembly of the Ital. Soc. of Experimental Biology, Milan (Italy), Oct. 2-4, 1958.

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1683-1684, 1958.

Experiments carried out on the electrophysiological analysis of the spontaneous or evoked electrical activity of the cerebral hemisphere of birds are discussed. The subject is immobilized in a way which excludes interference of the electrical potential of muscular origin. The existence of a slow rest rhythm and of a working electroencephalographic reaction is found in birds in a hypnotic state. However, a sleep cannot be induced by barbiturates in birds with an electroencephalogram compared to mammals. The cause is ascribed to the anatomical structure of the telencephalon of birds in which a true and proper cerebral cortex is missing.

1617

Pisa U. Inst. of Physiology (Italy).

[MODIFICATIONS IN THE ELECTROENCEPHALOGRAM AFTER CHRONIC UNILATERAL LESIONS IN THE MESENCEPHALON OF THE CAT] Modificazioni elettroencefalografiche per emilesioni croniche del mesencefalo nel gatto, by J. P. Cordeau and E. Mancia. [1958] [2]p. (AFOSR-TN-59-829) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) Unclassified

Presented at the Twenty-seventh General Assembly of the Ital. Soc. of Experimental Biology. Milan (Italy), Oct. 2-4, 1958.

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1690-1691, 1958.

The purpose of this report is to study the reticulo-cortical connections by means of unilateral chronic lesions in the mesencephalon. The experimental data confirms the anatomical and physiological observations, at the mesencephalic level of the reticulo-cortical paths that exercise an activating effect in each hemisphere. The electroencephalographic asymmetry is less intense and more rapidly compensated for after a complete pretrigeminal mediopontine section. This last observation could be compared with the hypothesis of a major tendency for the activation of the mediopontine preparation through the suppression of the synchronizing action by the central part situated in the caudal parts of the encephalic trunk.

1618

Pisa U. Inst. of Physiology (Italy).

[EXPERIMENTAL EVIDENCE IN FAVOR OF THE EXISTENCE OF A STRUCTURE SYNCHRONIZING THE ELECTROENCEPHALOGRAM IN THE CAUDAL PARTS OF THE BRAIN STEM] Prove sperimentali in favore dell'esistenza di strutture sincronizzanti l'elettroencefalogramma nelle parti caudali del tronco dell'encefalo, by J. P. Cordeau and M. Mancia. [1958] [2]p.

(AFOSR-TN-59-830) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation)   Unclassified

Presented at the Twenty-seventh General Assembly of the Ital. Soc. of Experimental Biology, Milan (Italy), Oct. 2-4, 1958.

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1691-1692, 1958.

The hypothesis is tested that the electroencephalographic asymmetry, produced by the unilateral action of the mesencephalon is less intense and more rapidly compensated for in the pretrigeminal mediopontine preparation. It is believed that the electroencephalographic desynchronization that is seen at the ipsilateral cerebral hemisphere may be due to the interruption of synchronizing paths eminating more caudally and is not, in fact, "irritative" to the change of the activating structure placed rostrally to the section. The evidence supports the hypothesis of the existence of inhibitory or synchronizing mechanisms operating on the cerebral cortex, localized in the caudal part of the encephalic trunk.

1619

Pisa U. [Inst. of Physiology] (Italy).

[CEREBRAL STUDIES ON THE ORIGIN OF THE SYNDROME OF PERSISTANT WAKEFULNESS IN THE MEDIOPONTINE PREPARATION. EVIDENCE FAVORING THE EXISTENCE OF AN INFLUENCE OF BULBO-PONTINE STRUCTURES ON THE ELECTRICAL ACTIVITY OF THE BRAIN] Richerche sull'origine della persistente sindrome di veglia del preparato mediopontino. Dati a favore dell'esistenza di una influenza sincronizzante di strutture bulbo-pontine sull'attivitá elettrica cerebrale, by C. Batini, F. Magni and others. [1959] [4]p. (AFOSR-TN-59-831) (Sponsored jointly by Air Force Office of Scientific Research under AF 61 (514)1125 and Rockefeller Foundation)   Unclassified

Also published in Riv. Neurol., v. 29: 126-129, Mar.-Apr. 1959.

The experimental observations made show that a sleep of long duration in the encephalically isolated cat occurs when an electroencephalographic and ocular syndrome of insomnia is present. These animals must be subjected to a complete transversal sectioning of the encephalic trunk at the level of the medial part of the pons, immediately in front of the trigeminal nerve. The existence of an influence synchronizing the cortical electrical activity, perhaps of a hypnogenic nature, originating from the caudal part of the encephalic trunk, is analyzed.

1620

Pisa U. [Inst. of Physiology] (Italy)

[SYNCHRONIZING INFLUENCES ON THE ELECTRO-ENCEPHALOGRAM AND THEIR ORIGIN IN THE CAUDAL PARTS ON THE BRAIN STEM] Influenze sincronizzanti l'elettroencefalogramma e loro origine nelle parti caudali del tronco dell'encefalo, by J. P. Cordeau and M. Mancia. [1959] [3]p. (AFOSR-TN-59-832) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation)   Unclassified

Also published in Riv. Neurol. v. 29: 132-134, Mar.-Apr. 1959.

An investigation is given of the study of electroencephalographic effects of unilateral mediopontine sectioning. The unilateral sectioning of the pons interrupts ascendant paths, from the appropriate side, of the structure situated more caudally and those provided with a synchronizing action on the ipsilateral hemisphere. Such interruption causes an activation of the trace limited to the ipsilateral hemisphere. In communications with the opposite side, synchronizing impulses can freely exercise their action on the hemisphere from the same side across the intact half of the encephalic trunk. The electroencephalographic effects of unilateral midpontine sections regarding the action mechanism could act directly by synchronizing the cortical neurons, inhibiting the ascending reticular system, or facilitating the activity of the thalamic pacemakers.

1621

Pisa U. Inst. of Physiology (Italy).

[ROLE OF THE ASCENDING RETICULAR SYSTEM IN SENSORY INTEGRATION] Role du systéme réticulaire ascendant dans l'intégration sensorielle, by G. Moruzzi. Oct. 1958 [32]p. incl. refs. (AFOSR-TN-59-970) (AF 61(514)1125)   Unclassified

The reticular system is considered as a regulatory system and as a support of the excitation level, contributing through that indirectly to sensory integration. The studies discussed suggest the existence, in the most caudal parts of the encephalic trunk, of structures which have an action antagonistic to that of the activating reticular system, since these tend to synchronize the electric pulsations of the cortical neurons. The lesions of the encephalic trunk of the cats tested were made by the stereotaxic method and their tension was controlled histologically.

1622

Pisa U. Inst. of Physiology (Italy).

SYNCHRONIZING INFLUENCES OF THE BRAIN STEM AND THE INHIBITORY MECHANISMS UNDERLYING

THE PRODUCTION OF SLEEP BY SENSORY STIMULA-
TION, by G. Moruzzi. [1959] [26]p. incl. diagrs.
(AFOSR-TN-59-971) (Sponsored jointly by Air Force
Office of Scientific Research under AF 61(514)1125, and
Rockefeller Foundation) AD 226323   Unclassified

Presented at Internat'l. Colloq. on the Electroencephalo-
graphic Study of the Higher Nervous Activity Processes
in Animals and Man, Moscow, 1958.

Experiments show that EEG and ocular patterns of wake-
fulness are present in the cat after midpontine pretrige-
minal transection; however, EEG and ocular patterns of
sleep occur when the brain stem is transected a few mm
rostrally. There is possibly a region in the rostral part
of the pons and caudalmost part of the midbrain which is
critical to EEG patterns of wakefulness. It is proposed
that the entire reticular formation of the midbrain, sus-
tained by tonic sensory impulses, is not sufficient to pre-
serve an alert state. The upper part of the pons must at
least remain connected to the midbrain to maintain EEG
activation. (Contractor's abstract, modified)

1623

Pisa U. Inst. of Physiology (Italy).

[ELECTROENCEPHALOGRAM ACTIVITY PRODUCED
BY TEMPORARY INACTIVATION OF THE CAUDAL
PART OF THE BRAIN STEM] Attivazione elettro-
encefalografica prodotta per mezzo di inattivazione
temporanea delle parti caudali del tronco dell'encefalo,
by F. Magni, G. Moruzzi and others. [1959] 7p. incl.
refs. (AFOSR TN-59-972) (Sponsored jointly by Air
Force Office of Scientific Research under AF 61(514)-
1125 and Rockefeller Foundation)   Unclassified

Presented at meeting of the Ital. Soc. of EEG and
Neurofisiologia, Rome (Italy), Nov. 22, 1958.

Also published in Riv. Neurol., v. 29: 129-132, Apr.
1959.

The experiments described in this report are intended
to obtain a temporary and reversible functional inacti-
vation of limited portions of the encephalic trunk. Thio-
pental sodium barbiturate is used because of its prompt-
ness and short duration of its action. The possibility is
suggested of selectively treating the caudal portions of
the encephalic trunk and administering barbiturate by
endoarterial rather than by intravenous means so as to
cause the same activity at smaller doses.

1624

Pisa U. Inst. of Physiology (Italy).

EVIDENCE FOR THE EXISTENCE OF AN ELECTRO-
ENCEPHALOGRAPHIC SYNCHRONIZATION MECHA-
NISM ORIGINATING IN THE LOWER BRAIN STEM, by
J. P. Cordeau and M. Mancia. [1959] [14]p. incl. diagrs.

refs. (AFOSR-TN-59-973) (Sponsored jointly by Air
Force Office of Scientific Research under AF 61(514)-
1125 and Rockefeller Foundation) AD 226322
                                    Unclassified

Published in Electroencephalog. and Clin. Neurophysiol.,
v. 11: 551-564, Aug. 1959.

Cats with brain stem hemisections situated between the
midmedullary and midpontine levels show asymmetry in
the electrocortical activity of the 2 cerebral hemi-
spheres, the contralateral side showing the greater ten-
dency to synchronization while the ipsilateral hemisphere
remains constantly desynchronized. Control experiments
show that asymmetry is unlikely to be due to an irritation
of the ascending reticular system by the lesion. EEG
asymmetry persisted after denervation of both carotid
sinuses and bilateral vagotomy. These results are con-
sidered valid evidence in favor of an EEG synchronizing
mechanism in the caudal portion of the brain stem.
(Contractor's abstract)

1625

Pisa U. Inst. of Physiology (Italy).

RESEARCH ON THE RELATION OF THE BRAIN
STEM RETICULAR FORMATION TO ANIMAL BE-
HAVIOR, by G. Moruzzi. Dec. 15, 1956-Dec. 15, 1958,
16p. incl. refs. (Technical rept. no. 1) (AFOSR-TR-
59-39) (AF 61(514)1.25) AD 214193; PB 142276
                                    Unclassified

Following a chronic transection of the brain stem at
the border between the mesencephalon and pons, the
EEG and ocular behavior is that of a cat deeply asleep,
although an EEG arousal may be obtained with olfactory
stimulations. When the trigeminal inflow is still dis-
connected from the cerebrum, but the brain stem tran-
section is carried out a few millimeters caudally, the
animal shows EEG and ocular behavior of alertness.
Following unilateral transection of the midbrain EEG
sleep patterns are recorded from the ipsilateral cere-
bral hemisphere. This effect is observed also (a) in the
midpontine pretrigeminal cat, (b) when the lesion is
limited to the midbrain tegmentum, sparing the
lemnisci and the pes pedunculi while (c) following com-
pensation a latent EEG asymmetry can be unveiled with
small doses of barbiturate. The hypothesis is made
that the ascending reticular system separates into 2
distinct paths, 1 for each hemisphere, at the rostral
mesencephalic level. Following unilateral midpontine
transection there is a greater tendency to EEG syn-
chronization in the opposite cerebral hemisphere.
Following midpontine ligature of the basilar artery, in-
travertebral injection of Thiopental in the unanesthe-
tized "encéphale isolé" cat evokes EEG arousal, while
EEG sleep patterns are produced by intracarotid in-
jection of the same or smaller doses. The following
hypothesis is made in an attempt to interpret the func-
tional significance of the synchronizing structures of
the brain stem. While the reticular activating system
is excited by any sudden change in the environment

the synchronizing structures mainly localized in the lower brain stem would be bestowed with the opposite property of responding with an avalanching increase of their activity whenever a mcnotonous sersory stimulation is applied. This would explain the so-called Pavlovian sleep, i.e., the soporific influence of repetitive, unconditioned or conditioned, sensory stimulations. EEG and behavioral studies on the intact and on the thalamic pigeon have been started. Preliminary investigations on both cerebral hemispheres and optic lobes have failed to find an EEG test with the striking clarity of the EEC arousal in mammals. Following ablation of one cerebral hemisphere the evoked response of the underlying optic lobe to the photic stimulation of the contralateral eye is increased by (a) blindfolding, (b) cocainizing and (c) enucleating the other eye. It is also respectively increased and decreased by local cocainization and strychninization of the contralateral optic lobe.

1626

Pisa U. Inst. of Physiology (Italy).

[VARIATIONS IN THE TIME OF THE HABITUATION PHENOMENA OF THE POTENTIAL CAUSED BY THE LIGHT STIMULATION IN THE OCCIPITAL CORTEX AND IN THE LATERAL GENICULATE] Diverso andamento nel tempo dei fenomeni d'abitudine del potenziale evocato dalla stimolazione fotica nella corteccia occipitale e nel corpo genicolato laterale, by A. Cavaggioni, G. Gianelli, and G. Santebañez -H. [1959] [2]p. (AFOSR-TN-59-464) [AF 61(052)107] AD 215269
Unclassified

Also published in Boll. Soc. Ital. Biol. Sper., v. 35: 301-302, 1959.

The experiments were carried out on the cat with permanently implanted electrodes. The spontaneous electrical activity of the cerebral cortex and the primary response at the level of visual cortex by means of wires fixed to the cranium. The activity of the lateral geniculate body was registered with a bipolar electrode. Six days after the treatment, the animals were placed in an acoustically insulated cage and stimulated with short luminous stimuli of constant intensity and duration, with a frequency of 1/sec. The potentials caused by the cortex and the electrical activity of the geniculate body were registered on an oscillograph, at the same time, the electroencephalogram was registered on a common writing apparatus.

1627

Pisa U. Inst. of Physiology (Italy).

ON THE MECHANISM OF THE EEG SLEEP PATTERNS ELICITED BY ACUTE VISUAL DEAFFERENTATION, by A. Arduini and T. Hirao. [1959] 27p.

incl. diagrs. refs. (AFOSR-TN-59-466) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)107 and Rockefeller Foundation) AD 215271
Unclassified

Also published in Arch. Ital. Biol., v. 97: 140-155, 1959.

In the midpontine pretrigeminal cat the effects of a functional visual deafferentation produced by ischemic anoxia have been studied on the EEG recorded from different areas of the cerebral cortex. Acute reversible visual deafferentation was followed by EEG sleep patterns in the occipital, parietal and temporal areas, hence on the entire neocortex with the only exception of the frontal fields. These effects of the functional visual deafferentation were not duplicated by darkness nor by dark adaptation. After abolition of the cerebellar outflow (destruction of nucleus dentatus and nucleus interpositus, or severance of the superior cerebellar peduncles) the electrical rhythms of the frontal areas were also synchronized during the ischemic anoxia of the retina. The conclusion is drawn that the tonic retinal discharge which is present in the dark, is responsible for the maintenance of the EEG activation patterns in the acute midpontine preparations. (Contractor's abstract)

1628

Pisa U. Inst. of Physiology (Italy).

EFFECTS OF REPETITIVE PHOTIC STIMULATION ON RESPONSES EVOKED IN THE LATERAL GENICULATE BODY AND THE VISUAL CORTEX, by A. Cavaggioni, G. Giannelli, and G. Santibañez-H. [1959] [10]p. incl. diagrs. refs. (AFOSR-TN-59-512) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)107 and Rockefeller Foundation) AD 234575
Unclassified

Also published in Arch. Ital. Biol., v. 97: 266-275, 1959.

Experiments were carried out on unrestrained, unanesthetized cats with implanted electrodes in the visual cortex and in the lateral geniculate body. Flashes of light were presented to the cats at a frequency of 1 per sec. When the animals were introduced into the cage they showed some signs of agitation, but later on they became behaviorably quiet. At this time the EEG was still activated and the evoked potentials were present. After about 2 hr of stimulation the EEG became synchronized while the evoked potentials started to wane and then to wax again. They finally disappeared, 1st on the cortex and later in the lateral geniculate body. When an extra stimulus was applied to other sensory receptors, the EEG arousal paralleled the reappearance of the evoked potentials (disnabituation). The results of these experiments are discussed with particular regard to the hypothesis of the reticular mechanism of habituation. (Contractor's abstract)

1629

Pisa U. Inst. of Physiology (Italy).

CHANGES OF PHOTICALLY EVOKED POTENTIALS
IN THE VISUAL PATHWAY OF THE CERVEAU ISOLÉ
CAT, by M. Mancia, M. Meulders, and G. Santibañez-H.
[1959] [21]p. incl. diagrs. refs. (AFOSR-TN-59-783)
(AF 61(052)107) AD 234576   Unclassified

Also published in Arch. Ital. Biol., v. 97: 378-398,
1959.

A study of the effect of repetitive photic stimulation on
the evoked responses of the lateral geniculate body and
primary visual cortex has been performed in cerveau
isolé cats. The following results have been obtained:
(1) the phenomenon designated as habituation occurs at
both cortical and subcortical levels under these ex-
perimental conditions; (2) olfactory stimulation produces
dishabituation of visual potentials and EEG arousal;
(3) midbrain reticular activation, yielding EEG arousal,
produces clear-cut dishabituation; and (4) intravenous
injection of small doses Nembutal (1-2 mg/kg) abolishes
both reticular arousal and dishabituation, while leaving
habituation unaffected. The conclusion is drawn that the
brain stem structures lying caudally to the transection
are not essential for producing sensory habituation.
The close parallelism between dishabituation and EEG
arousal suggests actually that the reticular activating
system is essential for the process of sensory dishabitu-
ation. (Contractor's abstract)

1630

Pisa U. Inst. of Physiology (Italy).

CHANGES OF PHOTICALLY EVOKED POTENTIALS
IN THE VISUAL PATHWAY OF THE MIDPONTINE
PRETRIGEMINAL CAT, by M. Mancia, M. Meulders,
and G. Santibañez-H. [1959] [15]p. incl. diagrs. refs.
(AFOSR-TN-59-784) (Sponsored jointly by Air Force
Office of Scientific Research under AF 61(052)107 and
Rockefeller Foundation) AD 234577   Unclassified

Published in Arch. Ital. Biol., v. 97: 399-413, 1959.

The present experiments are concerned with the
phenomenon of visual habituation in the midpontine
pretrigeminal cat. At the beginning of the experiment
the potentials evoked by repetitive flashes of white
light on visual cortex and lateral geniculate body are
easily observed, while the EEG is almost persistently
desynchronized. Only after 20-22 hrs of iterative
stimulation do the responses decrease in amplitude,
first in the visual cortex and later in the lateral ge-
niculate body. At this time the EEG activity becomes
synchronized. When an extrastimulation is applied,
an EEG arousal and a parallel visual dishabituation
are observed. Electrical stimulation of the midbrain
reticular formation before habituation slightly de-
presses the responses of the lateral geniculate body,
but clearly reduces the visual cortical potentials.

After habituation the same reticular stimulation dis-
rupts the synchronous rhythms elicited by the repeti-
tive stimulation while the evoked potentials reappear
both on visual cortex and lateral geniculate body. This
effect (dishabituation) is fully reversible. Small doses
of Nembutal (4-6 mg/kg) injected intravenously in the
habituated animals, do not abolish "habituation", al-
though the EEG arousal elicited by electrical stimula-
tion of the midbrain reticular formation is abolished.
Large doses of Nembutal (15-25 mg/kg) are followed
by reappearance of both types of evoked responses in
confirmation of results of other authors. The results
of these experiments are discussed in relation to the
reticular hypothesis. The conclusion is drawn that the
reticular activating system is not involved in the
mechanism of habituation but that is likely to play an
important role in the opposite mechanism of dishabitu-
ation. The long time required for producing visual
habituation in the midpontine pretrigeminal cat, an ob-
servation that contrasts strikingly with those made in
the cerveau isolé preparation, may be explained by the
great tendency to EEG activation which characterizes
the midpontine animals. (Contractor's abstract)

1631

Pisa U. Inst. of Physiology (Italy).

DIRECT PYRAMIDAL INFLUENCES ON THE DORSAL-
COLUMN NUCLEI, by F. Magni, R. Melzack and others.
[1959] [21]p. incl. diagrs. refs. [Technical note no. 6]
(AFOSR-TN-59-785) (AF 61(052)107) AD 234578
                                        Unclassified

Also published in Arch. Ital. Biol., v. 97: 357-377, 1959.

In curarized cats having a postcollicular section sparing
the pes pedunculi, the pyramidal track was stimulated
at midbrain levels and in the internal capsule, and the
responses of the dorsal-column nuclei were recorded.
Postsynaptic responses to stimulation of the pyramidal
track can be recorded at the dorsal-column nuclei.
These responses are elicited by direct relays from the
pyramidal system to the sensory nuclei without media-
tion through the reticular formation. The pyramidal sys-
tem is capable of diminishing the post-synaptic responses
of the dorsal-column nuclei to somatic sensory nerve
stimulation. (Contractor's abstract)

1632

Pittsburgh U. [Dept. of Chemistry] Pa.

THE HYDRATES OF THE TETRA n BUTYL AND
TETRA i-AMYL QUATERNARY AMMONIUM SALTS,
by G. A. Jeffrey. June 1959, 12p. incl. table, refs.
(AFOSR-TN-59-475) (AF 49(638)456) AD 215718;
PB 146127   Unclassified

The hydrates of tetra n-butyl and tetra i-amyl quater-
nary ammonium salts have been prepared. They form

a tetragonal isomorphous crystal series. These compounds are believed to be of the clathrate type, similar in general character to the gas hydrates.

1633

Pittsburgh U. Dept. of Physics, Pa.

STRENGTHS AND WIDTHS OF MOLECULAR SPECTRAL LINES IN THE INFRARED, by H. Babrov, G. Ameer, and W. Benesch. Final rept. Dec. 1959, 109p. incl. diagrs. tables, refs. (AFOSR-TR-59-207) (AF 18(600)986)   Unclassified

The primary purpose of this work is the measurement of absolute line widths as a function of J for the vibration-rotation lines of the fundamental band of HCl. Both self broadening and foreign gas broadening were studied. A secondary purpose of this work is the determination of the line strengths of this HCl band. A portion of this work has been described elsewhere (item no. 1635, Vol. III). Here the previous work is expanded to include a greater variety of broadening gases and some small corrections are made to the previously published data.

1634

Pittsburgh U. Dept. of Physics, Pa.

MOLECULAR COLLISION CROSS SECTIONS FROM INFRARED ABSORPTION MEASUREMENTS, by H. Babrov, G. Ameer, and W. Benesch. [1959] [6]p. incl. diagrs. tables, refs. [AF 18(600)986]   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 67, Jan. 28, 1959. (Title varies)

Published in Jour. Chem. Phys., v. 33: 145-150, July 1960.

Through measurement of the equivalent width (fractional integrated absorption) of collision-broadened lines of the P branch of the HCl fundamental vibration-rotation at 3.5μ, the Lorentz half-widths of these lines have been determined and optical collision cross sections deduced therefrom. The cross sections which have been obtained are those for collisions between HCl molecules and Ar, CO_2, CO, D_2, H_2, HBr, He, Ne, N_2, O_2, as well as other molecules of HCl. One of the more interesting aspects of these cross sections is their dependence on the rotational state of the absorbing molecule and the various forms which this J dependence takes for the different foreign gases. The line widths range between the extremes of 0.233 and 0.0111 cm^{-1} atm^{-1} while the collision cross sections range between 3.04 x 10^{-14} and 0.091 x 10^{-14} cm^2. Also reported are recently meas-

ured values of the strengths for the first 8 lines of the P branch of the HCl fundamental. The strength of this band based on these measurements has been found to be 143 ± 5 cm^{-2} atm^{-1} at 300°K. (Contractor's abstract)

1635

Pittsburgh U. Dept. of Physics, Pa.

LINE STRENGTHS AND WIDTHS IN THE HCl FUNDAMENTAL BAND, by H. Babrov, G. Ameer, and W. Benesch. [1959] [16]p. incl. diagrs. tables, refs. (AF 18(600)986)   Unclassified

Published in Jour. Molec. Spectros., v. 3: 185-200, Apr. 1959.

Through the application of a method which varies simultaneously the optical density and the foreign gas broadening, the strengths and widths of the first 8 lines of the P-branch of the HCl fundamental vibration-rotation band were obtained with a single absorption cell. The value of the band strength obtained therefrom is 150 ± 5 cm^{-2} $atmos^{-1}$ at 300°K. After a smoothing of the individual line strengths in accordance with the theoretical distribution, measurements were made of the line widths for both self broadening and nitrogen broadening. Optical collision diameters were computed for both self and foreign gas broadening. (Contractor's abstract)

1636

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

THEORY OF SUPEREXCHANGE, by F. Keffer and T. Oguchi. [1959] [7]p. incl. table, refs. (AFOSR-TN-59-192) (AF 49(638)323) AD 211439   Unclassified

Also published in Phys. Rev., v. 115: 1428-1434, Sept. 15, 1959.

The Dirac-Van Vleck-Serber spin-operator expansion, first applied by Anderson to the Kramers superexchange problem, is extended, simplified, and systematized in order to handle all overlap contributions arising from a number of interacting configurations. The linear cation-anion-cation (e.g., Mn^{++}-O^{--}-Mn^{++}) 4-electron problem is worked out in detail, taking account of all contributions from configurations (A) ionic, (B) electron transferred to right, and (C) electron transferred to left. Group symmetry requirements are invoked; and these, together with a simple approximation equivalent to perturbation theory, are shown to reduce the complicated matrix formulation to a single linear equation. The solution contains terms previously obtained, and a number of important extra terms. All superexchange terms are 4th order or higher in the overlap S. A rough numerical evaluation with

modified Slater wave functions appropriate to MnO-type crystals yields an effective superexchange integral of the required size. Brief consideration is given to configurations in which 2 electrons are transferred, in particular (D) simultaneous transfer of electrons to right and to left (Slater mechanism). (Contractor's abstract)

1637

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

THEORY OF THE OVERHAUSER EFFECT IN FERRO- AND ANTIFERROMAGNETS, by T. Oguchi and F. Keffer. [1959] 38p. incl. diagrs. refs. (AFOSR-TN-59-193) (AF 49(638)323) AD 262825   Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 25: 405-421, Apr. 1964.

The theory of the Overhauser effect as formulated from general statistical-mechanical arguments indicates that a forced statistical redistribution may be made to occur in any subsystem A whose principal contact with a heat bath C is indirectly routed through some other statistic-ally distributed system B. For nuclei (system A) in ferro- and antiferromagnets the $k = 0$ magnons (and magnons degenerate in energy with these) form the system B, while the remainder of the magnon spectrum is in effect combined with the lattice into system C. Probably the nuclei are sufficiently isolated from direct contact with C; if not, they may forceably be so isolated by intense resonance excitation of a large number of $k = 0$ magnons at a low temperature. Under conditions of power saturation but below the onset of nonlinear instabilities (perhaps also above, but not considered) an Overhauser-type enhancement of nuclear polarization is shown to occur. This may take place via two- and three-magnon processes. In antiferromagnets the former processes are shown to lead to an antiferromag-netically polarized nuclear array, the latter to ferromagnetic nuclear arrays which, depending upon which antiferromagnetic resonance mode is excited, will be polarized either up or down. (Contractor's abstract)

1638

Pittsburgh U. [Sarah Mellon Scaife] Radiation Lab., Pa.

LIGAND FIELD THEORY AND THE ABSORPTION SPECTRA OF $MnCl_2$ AND $MnBr_2$, by R. Pappalardo. [1959] [12]p. incl. diagrs. tables, refs. (AFOSR-TN-59-458) (AF 49(638)323)   Unclassified

Also published in Jour. Chem. Phys., v. 31: 1050-1061, Oct. 1959.

Optical absorption spectra of $MnCl_2$ and $MnBr_2$ at room temperature and 78°K are reported and discussed. Parameters of electrostatic interaction and internal field are derived. Koide and Pryce's formalism to compute

transition probabilities is extended to ${}^4T$ levels. Many properties of the absorption spectra are well explained by the ligand field theory. (Contractor's abstract)

1639

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

STUDY OF THE WURTZITE-TYPE BINARY COM-POUNDS. IV. THEORY OF DOUBLE REFRACTION, by F. Keffer. [1959] [5]p. incl. tables, refs. (AFOSR-TN-59-707) (AF 49(638)323)   Unclassified

Published in Jour. Chem. Phys., v. 32: 62-66, Jan. 1960.

The Ewald-Born theory of double refraction is applied to wurtzite-type compounds. Except for the small distortion and polarization, these compounds have identical near-neighbor symmetry to zinc blende (cubic) structures, and hence the double refraction is caused primarily by the distant-neighbor interactions. The effects of anisotropy of the Lorentz-Lorenz force and of the Coulomb force are calculated. In the (ionic) approximation of zero cation polarizability the theory predicts a double refraction larger than the measured one by a factor ~2 for all six compounds that have been measured. In the (covalent) approximation of zero effective ionic charge the theory underestimates the double refraction of AlN, but may be made to agree with the measured values of the other compounds by a suitable choice of atomic polarizabilities. In both approximations the theory predicts $n_0 < n_e$, in agreement with long-wavelength observations. Anisotropic interaction of polarized light with the solid as a whole, as in exciton transitions, seems to account for the inversion to $n_0 > n_e$ near the absorption edge of CdS. (Contractor's abstract)

1640

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

NUCLEAR QUADRUPOLE RESONANCES USING IM-PURITY MOLECULES AS PROBES, by R. Baer and C. Dean. [1959] [2]p. incl. tables, refs. (AFOSR-TN-59-750) [AF 49(638)323]   Unclassified

Also published in Jour. Chem. Phys., v. 31: 1690-1691, Dec. 1959.

Frequency shifts for p-dichlorobenzene in several compounds are listed as a survey to test the feasibility of using impurities as probes within materials in which a quadrupole resonance does not otherwise occur. The resonance widths and shifts indicated that enough were homogeneous solid solutions to verify the utility of the technique. Interpretation of the data presented is given and suggestions made for future experiments at intermediate temperatures.

1641

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

THEORY OF SPIN-WAVE INTERACTIONS IN FERRO-
AND ANTIFERROMAGNETISM, by T. Oguchi. [1959]
[7]p. incl. table, refs. (AFOSR-TN-59-751) [AF 49-
(638)323]   Unclassified

Published in Phys. Rev., v. 117: 117-123, Jan. 1, 1960.

- The spin-wave theory in an ideal Heisenberg model of
a ferromagnet is studied using Holstein and Primakoff's
method including the spin-wave interactions. Several
earlier published results of the correction to the spon-
taneous magnetization produced by spin-wave interac-
tions were in disagreement with each other, and they
were not in agreement with Dyson's result which is re-
garded as rigorous at low temperatures. The author's
results are in agreement with Dyson's to the order in
which they have been considered. The method can be
applied to antiferromagnetism easily. The correction
arising from interactions between spin waves have been
obtained. The correction term is quite small. This
means that the simple theory neglecting the spin-wave
interactions is sufficient for practical purposes.

1642

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

SIDE-BAND SUPPRESSION FOR SELF-QUENCHED SU-
PERREGENERATIVE SPECTROMETERS, by V. Rehn
and C. Dean. [1959] [2]p. incl. diagrs. (AFOSR-TN-59-
1130) (AF 49(638)323)   Unclassified

Also published in Rev. Scient. Instr., v. 31: 72-73, Jan.
1960.

An earlier article (PIT.05:001, Vol. II) described a sys-
tem which uses a modulated quench frequency to sup-
press the multiple-side-band responses of an external-
ly quenched superregenerative rf spectrometer. Subse-
quent investigation has shown that, although the effec-
tive audio gain over the range of a self-quenched spec-
trometer changes tremendously over the range of al-
lowable quench frequencies, its basic signal-to-noise
ratio remains fairly constant. Thus effective compen-
sation can be achieved by feeding the signal from it
through a variable-gain audio amplifier. A suitable am-
plifier was designed to follow this spectrometer with 1
stage of audio amplification with a gain of roughly 15.
It is reported that the effective audio gain of the super-
regenerative spectrometer becomes quite small at the
higher quench frequencies. The spectra for 1 of the
Zeeman split lines in a single crystal of para-dichloro-
benzene is shown. Its quench frequency was 24 kc
whereas it was modulated from 32 to 15 kc using a
triangular wave from a Hewlett-Packard 202A low
frequency function generator.

1643

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

SIMPLE AMPLITUDE-STABILIZER TWIN-T AUDIO
OSCILLATOR, by C. Dean. [1959] [2]p. incl. diagrs.
(AFOSR-TN-59-1131) (AF 49(638)323)   Unclassified

Also published in Rev. Scient. Instr., v. 31: 213-214,
Feb. 1960.

Application is made of an amplitude stabilization of os-
cillators by means of nonlinear resistors. The result
is an oscillator which can be made by clipping a signal
from the output of a narrow-band tuned amplifier
against fixed reference voltages to form approximately
a square wave, and by using this wave form as the feed-
back signal at the input of the tuned circuit. The con-
struction is such that an excellent amplitude stability is
achieved without having to rely either on the inception
of nonlinearity in the frequency determining circuit or
on feedback gain controls to limit the oscillation level.
This type oscillator can be constructed around twin-T
feedback tuned circuits. Coupled to a commercial tuned
amplifier, it is shown that the external circuit need
only isolate the diodes from the amplifier output suffi-
ciently to avoid loading the amplifier unduly, and to pro-
vide the clipping at a low enough level to permit essen-
tially linear operation of the amplifier since the output
of these units at their center frequency is in phase with
the input and amplified to a higher level.

1644

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

RESEARCH STUDIES ON ANTIFERROMAGNETIC RES-
ONANCE, PARAMAGNETIC RESONANCE IN PHOS-
PHORS, FOREIGN ATOMS IN SILVER HALIDES AND
NUCLEAR RESONANCE. Mar. 1959 [25]p. incl. diagrs.
tables, refs. (AF 49(638)323) AD 228953
                                            Unclassified

This report is a compilation of publication reprints on
research done on Contracts AF 18(600)892 and AF 49-
(638)323. For abstracts see items PIT.02:012, 023;
05:001, 002, 005, Vol. II.

1645

Pittsburgh U. [Sarah Mellon Scafe] Radiation Lab., Pa.

TEMPERATURE MEASUREMENT BY NUCLEAR
QUADRUPOLE RESONANCE, by C. Dean. [1959] 6p.
[AF 49(638)323]   Unclassified

Presented at Nat'l. Conf. on Stratospheric Meteorology,
Minneapolis, Minn., Aug. 30-Sept. 3, 1959.

A nuclear quadrupole resonance (NQR) spectroscopic
system is described which is noted as the simplest one
that would be able to obtain and transmit the temperature

information with reliability and essentially automatically. This system consists of a conventional 1-tube self-quenched superregenerative spectrometer stage and 2 multivibrators for developing triangular modulating waveforms. The superregenerative circuit provides a tremendous amplification of the effect over the actual amount of power absorbed by the sample. The resonance frequency (rf) is measured by matching the occurrence of a resonance signal. The proper matching is assured when the apparent rf is not affected by the periodic alteration of the spectrometer pulse rate. In the laboratory the rf is usually detected in the plate circuit of the superregenerative tube, and the resulting audio frequency signal is amplified and viewed on an oscilloscope. The rf radiated by the spectrometer can be picked up by a radio receiver a short distance away, and all measurements made with that signal. For more distant direct transmission, an rf power amplifier could transmit 1 of the harmonics, or the rf could be used to modulate a microwave carrier.

1646

Plasmadyne Corp., Santa Ana, Calif.

HEATING AND CONFINEMENT OF A PLASMA BY A MAGNETIC FIELD OF EXTERNAL ORIGIN AND WITH A SHORT RISE TIME, by H. G. Loos. [1959] [2]p. incl. diagr. [AF 49(638)655]　　　Unclassified

Published in Phys. Rev. Ltrs., v. 2: 282-283, Apr. 1, 1959.

Results of experiments in which a fully ionized plasma is heated and confined by a magnetic field that is suddenly induced by a current in an external conductor are reported. A good separation between the magnetic field and the confined plasma is retained for a time interval small compared with the decay time $R^2 \mu \sigma$. It is shown that during such a small interval, the plasma may be manipulated using the "magnetic piston" effect at the plasma boundary, if the linear ion density N_i is large enough. The basic cylindrical configuration used in this experiment is described including the properties lost when magnetic mirrors are introduced at its ends to reduce excessive particle loss.

1647

Plasmadyne Corp., Santa Ana, Calif.

[INITIAL BREAKDOWN PROCESS OF GASEOUS CONDUCTORS] (Abstract), by H. G. Loos. [1959] [1]p (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)655)　　　Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif.

A study is planned of the initial breakdown of a gas in an electrodeless discharge in which the macroscopic parameters are uniform along the electric field lines, while these parameters may change in the direction normal to the electric field. An attempt will be made to formulate an analytical model of the governing processes occurring in the region where currents first build up, assuming that the gas is initially only slightly ionized. Since charged particles approaching the breakdown region may be turned back because of the gradient in magnetic pressure which is set up by the current, the breakdown region may be occupied by different particles at different times. Ionization is expected to occur both inside and outside the current region, since charged particles that encounter the current region may be reflected with increased energy and cause ionization at some distance from the current region. An analytical study will be made of the dynamics and the internal state of the breakdown region for the case of a cylindrical plasma and a longitudinal field. An experiment will be undertaken to observe the motion of the luminous region in a gas during the initial stages of breakdown under a high-transient magnetic field. A cylindrical configuration will be chosen that is long enough so that in a central portion the parameters remain uniform along the axial direction for time intervals long enough to permit observation of the initial breakdown processes.

1648

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

ARGON MOLLIER CHART, by G. L. Cann and A. C. Ducati. Feb. 27, 1959, 10p. incl. diagr. tables. (Technical note no. P-3TN029-54) (AFOSR-TN-59-247) (AF 49(638)54) AD 212227; PB 140223　　Unclassified

Argon was used extensively in shock-tube and arc plasma studies where the temperature is high enough to cause an appreciable % of ionization. Any analysis of the results then requires some extensive calculations to determine the state of the gas. In most cases the calculations neglect the effect of electronic excitation by using the Saha equation. In order to eliminate the errors introduced by this assumption and to have available the max amount of information about the gas properties, a Mollier Chart was constructed. The chart covers the temperature range from 1000 to 14,000°K and the pressure range from 10 to 10^{-4} atm. (Contractor's abstract)

1649

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

EQUILIBRIUM THERMODYNAMIC PROPERTIES OF HELIUM TO 60,000°K, by G. L. Cann and A. C. Ducati.

June 18, 1959, 1v. incl. diagrs. tables. (Technical note no. P-4TN069-54) (AFOSR-TN-59-633) (AF 49(638)-54) AD 228710; PB 144864   Unclassified

Helium was considered as a possible propellant for a plasma propulsion system because of its low molecular weight. To obtain reasonable exhaust velocities (greater than 10,000 m/sec) it is necessary to heat the gas to temperatures at which an appreciable % ionization occurs. In order to assess the potentially available exhaust velocities when ionization is present, it is necessary to have a Mollier chart to determine isentropic expansions, hence the thermodynamic properties of helium were computed over a temperature range of 6000-60,000°K and a pressure range of 10^{-4} -10^{-2} atm. A Mollier chart was constructed from this data. (Contractor's abstract)

1650

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

RESEARCH ON HIGH INTENSITY IONIC JETS, by G. L. Cann and A. C. Ducati. Final technical rept. Nov. 5, 1959, 36p. incl. illus. diagrs. (Rept. no. P-FR109-54) (AFOSR-TR-59-167) (AF 49(638)54) AD 229902; PB 144907   Unclassified

The various steps that have been completed in the development of a practical plasma jet propulsion unit are outlined, and detailed references to the work made. The steps that still need to be completed before a prototype unit can be constructed, are indicated. (Contractor's abstract)

1651

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

RESEARCH ON HIGH INTENSITY IONIC JETS (Abstract), by G. L. Cann and A. C. Ducati. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)54)   Unclassified

Presented at Second AFOSR Contractors me   Ion and Plasma Propulsion, North American ....ion, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

This program has encompassed the following studies: (1) A generalized rocket analysis was made to determine desirable specific impulse, ratio of propellant-to-powerplant mass, ratio of total rocket-to-payload mass, effect of propellant tank structure constant, and other relevant parameters as a function of the mission requirements; (2) Several substances that looked promising from preliminary considerations have been picked, and their thermodynamic properties have been computed and plotted on Mollier charts. To date, argon, heli-

um, lithium and lithium hydride have been completed. Hydrogen, water and ammonia are being worked on at present; and (3) A rather elaborate facility has been designed around a cantilever suspension of the plasma jet head, constructed, and put into operation for actually measuring the specific impulse, electric energy to jet energy, conversion efficiency, and other relevant parameters for plasma jets exhausting into an ambient pressure as low as 1 mm Hg. Specific impulses of 1100-1200 sec at efficiencies of 50-60 % for helium have been measured to date in this equipment. In order to obtain a more detailed knowledge of the jet, a total pressure probe has been designed and used to measure the radial distribution of total pressure. Thrusts have been computed from these measurements and correlated with the actual thrust measurements.

1652

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME VI. FUSION POWER, by E. J. Hellund. Apr. 24, 1959, 74p. incl. diagrs. tables. (Rept. no. E-6FR049-332) (AFOSR-TN-59-427) (AF 49(636)332) AD 214777; PB 144000 Unclassified

A report is made on the fusion fuels and some of the problems faced in starting a "fusion fire" which include validation of the existence of an actual thermonuclear fusion reaction and the confinement problems. New devices and techniques used in the field among which are the B65 Stellerator, the Oak Ridge DCX, and the Astron plus others are discussed. In addition an analysis is made on the maximum energy that can be expected from certain fuels and the problem of extracting the energy from the fuel.

1653

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME IV. NUCLEAR FISSION REACTORS, by E. J. Hellund. Apr. 24, 1959, 131p. incl. diagrs. tables. (Rept. no. E-4FR049-332) (AFOSR-TN-59-428) (AF 49(638)332) AD 214778; PB 143999   Unclassified

A discussion is given on the problems faced in the design of a nuclear-powered, electrically-driven space ships. The limitations of the engineering materials which require a temperature degradation in order to accommodate them is also discussed. Performance of certain different reactors is presented.

1654

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME III. DIRECT ELECTRICAL CONVERTERS, by E. J. Hellund. Apr. 24, 1959, 76p. incl. diagrs. tables. (Rept. no. E-3FR049-332) (AFOSR-TN-59-429) (AF 49(638)332) AD 214779; PB 143998   Unclassified

The criteria are discussed for building a photovoltage cell with pure material such as the silicon solar converter. In addition, an analysis of thermoelectric devices or thermopiles is given. Other direct electrical converters are also mentioned.

1655

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME II. BATTERIES, by E. J. Hellund. Apr. 24, 1959, 102p. incl. diagrs. tables. (Rept. no. E-2FR049-332) (AFOSR-TN-59-430) (AF 49-(638)332) AD 214780; PB 161262   Unclassified

A summary is presented of performance characteristics, e.g., structure, power weight ratios, and power volume ratios, whenever available of chemical batteries. Performance data include such items as whr/lb, whr/cu in., behavior at low temperatures, unactivated and activated shelf lives, rechargeability, reliability, open circuit voltage, average operating voltage, and adaptability for particular service. Fuel cells and nuclear batteries are discussed.

1656

Plasmadyne Corp [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOL. V. NUCLEAR AND SOLAR ENERGY SOURCES (Unclassified title), by D. Ragusa. Apr. 24, 1959, 33p. incl. illus. diagrs. tables. (AFOSR-TN 59-485) (AF 49(638)332) AD 307002
                                                         Secret

1657

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME I. MORPHOLOGY, by E. J. Hellund. Apr. 24, 1959 [30]p. incl. diagrs. (Rept. no. E-1FR049-332) (AFOSR-TR-59-103) (AF 49(638)-332) AD 227933; PB 144009   Unclassified

A survey and classification was made of various types of power sources which might possibly be used in conjunction with propulsion systems for space vehicles. Codification of these types was systematically developed with the objective in mind of providing a convenient classification by means of which a rapid evaluation on any new proposals can be made. A number of possible new power systems and propulsion systems were brought out. The primary goal in evaluation of all systems is to obtain an unambiguous upper limit to performance, equivalent to that derived for heat engines on the basis of Carnot cycle. (Contractor's abstract)

1658

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME VII. BIBLIOGRAPHIES, by H. Fife. Apr. 24, 1959, 42p. incl. diagrs. refs. (Rept. no. E-7FR049-332) (AFOSR-TR-59-104) (AF 49(638)332) AD 227934; PB 161117
                                                   Unclassified

An extensive bibliography is presented in order to take a fresh new look at the electric power sources that have been proposed from time to time which must operate in space. Briefly, this listing arranges possible sources according to whether they are (a) internal (wholly contained within the space vehicle) or external (utilize energy available outside the vehicle), (b) waste (utilize waste products from other functions) or direct storage, and (c) certain detailed categories.

1659

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

A CONTINUOUS HIGH TEMPERATURE GAS FLOW FACILITY FOR MAGNETOHYDRODYNAMIC STUDIES, by V. H. Blackman, J. Chambers, and C. Cobb. June 26, 1959, 39p. incl. illus. diagrs. (Rept. no. T-1TN069-334) (AFOSR-TN-59-681) (AF 49(638)334) AD 225412; PB 143163   Unclassified

In order to study phenomena which require both a long testing time and high temperature, it would be most desirable to combine the steady state flow characteristics of a wind tunnel with the high gas temperature capabilities of a shock tube. This plasma flow facility described was an attempt to accomplish such a union. The facility was set up in order to study the steady state Hall effect in an ionized gas flow and as a convenient arrangement to look at fluctuations introduced into a flow by means of an electric arc heater. It also proved to be useful for preliminary experimental studies of the steady acceleration of an ionized gas flow by means of crossed electric and magnetic fields. (Contractor's abstract)

1660

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

AN EXPERIMENTAL STUDY OF SPARK STABILIZA-
TION BY A GAS VORTEX, by C. Cobb and V. H.
Blackman. Aug. 28, 1959, 32p. incl. illus. diagrs.
(Rept. no. T-STN099-334) (AFOSR-TN-59-925)
(AF 49(638)334) AD 228775; PB 144768
                                                    Unclassified

An investigation was conducted to detect transient
electrical discharges along the axis of a vortex flow.
A time resolved photographic study of spark stabiliza-
tion and growth in a vortex channel might give informa-
tion on the stabilization of arcs by vortex motion.
Three separate experimental studies were conducted:
(1) The photographic demonstration of spark stabiliza-
tion by a gas vortex; (2) The investigation of radial
pressure distribution in the vortex; and (3) The gather-
ing of data on the expansion of a spark channel with
time.

1661

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana,
Calif.

FLEXURE OF A TWO-DIMENSIONAL ARC UNDER
FORCED CONVECTION, by P. G. Thiene. Aug. 25,
1959, 71p. incl. diagrs. (Rept. no. T 2TN089-334)
(AFOSR TN-59-947) (AF 49(638)334) AD 228540;
PB 144488   Unclassified

A rudimentary inquiry is conducted into the nature of
the physical mechanisms which maintain an arc in the
presence of forced convection. The basic fluid-
mechanical and electromagnetic equations are developed
for the case of a dilute, 3-component quasineutral arc
plasma. The basic equations, in particular the equa-
tion of energy balance, are then applied to a simple
model of a 2-dimensional arc in a low-Mach-number
subsonic flow. The proposed model is based on the
notion of a definite, localized zone of ohmic heating. An
analogy is qualitatively drawn between the convection-
loaded arc model and a structural beam with a dis-
turbed load. The equation of energy balance provides
the temperature distribution through the arc model from
which the curvature, flexural rigidity and deflection
curve are determined. Also included is a tentative cri-
terion for blowout. (Contractor's abstract)

1662

[Plasmadyne Corp.] Giannini Research Lab., Santa Ana,
Calif.

SPARK STABILIZATION BY A GAS VORTEX (Ab-
stract), by C. Cobb, J. Chambers, and V. [H.] Blackman.
[1958] [1]p. [AF 49(638)334]   Unclassified

Presented at meeting of the Amer. Phys. Soc., San
Diego Calif., Nov. 24-26, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
197, Mar. 30, 1959.

A rotating mirror camera and a Kerr cell camera have
been used to study photographically the buildup of a
spark channel in a gas vortex. The spark is initiated by
discharging either a low inductance capacitor or a length
of coaxial cable between electrodes at either end of a
cylindrical chamber which is 1/2 in. in diam. and from
1 in. to 1/8 in. in length. The coaxial cable can give a
square current pulse with a duration of up to 3 μsec.
The vortex is formed by injecting gas tangentially into
the cylindrical chamber through an orifice in the wall
and allowing the gas to escape through an axial orifice
in the electrodes. The pressure distribution has been
determined over a wide range of inlet and outlet condi-
tions by means of movable pressure taps. Radial pres-
sure gradients are as high as 4000 psi/in. with a mini-
mum pressure on the axis of 3 psia when the flow ex-
hausts into atmospheric pressure. Photographs will be
presented to illustrate the stabilizing influence of the
vortex. This arrangement is also being used to study
the propagation of a cylindrical shock into a known pres-
sure gradient.

1663

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana,
Calif.

SOME DYNAMICS PROBLEMS OF THE PUNCH METH-
OD OF HEATING AND ACCELERATION OF PLASMAS,
by H. G. Loos. Feb. 1959, 32p. incl. diagrs. (Techni-
cal note no. T-2TN029-335) (AFOSR-TN-59-256)
(AF 49(638)335) AD 212256; PB 140055 Unclassified

A few dynamics problems encountered in punch dis-
charges are discussed. The fully ionized plasma is
supposed to interact with the magnetic field only at the
plasma boundary; the analysis is limited to time inter-
vals in which the effect of ion-ion collisions may be
neglected. The type of discharge for the basic cylin-
drical punch geometry depends solely on 2 non-dimen-
sional parameters. A scaling law is derived for
changes for which these 2 parameters remain the
same. For compressions or expansions that take place
in a time short compared with the ion-ion collision
time, but which have a current sheet velocity that is
small compared with the mean ion speed, the discharge
coil with the moving plasma inside assumes a constant
inductance. An introduction is also given for the anal-
ysis of discharge dynamics for punch configurations
with a general axisymmetric geometry. (Contractor's
abstract)

1664

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

RELAXATION HEATING OF A PLASMA BY SURFACE INTERACTION WITH A MAGNETIC FIELD, by R. P. Treat. Oct. 15, 1959, 44p. incl. diagrs. (Rept. no. T-3TN109-335) (AFOSR-TN-59-1151) (AF 49(638)335) AD 230031; PB 144972   Unclassified

The heating of a fully ionized deuterium plasma by collisional relaxation for temperatures of the order of 1 kev is explored. The model used for the study consists of a long cylindrical plasma column confined and manipulated by an axial magnetic field that is induced by currents flowing in a 1-turn coil surrounding the plasma. Conditions are such that the field is excluded from the interior of the plasma: the interaction between plasma and field is essentially a surface phenomenon. The heating due to collisional relaxation is investigated for an idealized cycle. For given ion density and circuit parameters, i.e., the capacitance, inductance and voltage of the capacitor bank connected to the coil, initial plasma temperatures and initial radii are specified for which there is appreciable collisional relaxation while the plasma remains relatively homogeneous. Since initial temperatures are of the order of 10^{-1} kev and the initial radii, ion densities, and circuit parameters are realizable, the results are encouraging. (Contractor's abstract)

1665

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

PROBLEMS OF MAGNETIC PROPULSION OF PLASMA, by R. W. Waniek. [1959] [7]p. incl. illus. diagrs. refs. (AFOSR-TN 59-1335) (AF 49(638)335) AD 241130   Unclassified

Also published in Proc. Tenth Internat'l. Astronaut. Congress, London (Gt. Brit.) (Aug. 30-Sept. 5, 1959). Vienna, Springer-Verlag, v. 1: 131-137, 1960

Also published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass., (Oct. 7-8, 1959), Boston, v. 1: 141-148, 1959. (Title varies) (AFOSR-637)

Some of the basic approaches to intermittent magnetic plasma propulsion are summarized and reviewed in terms of the features deemed important for practical space applications. The class of inductively coupled devices is examined in detail and some of the requirements necessary for efficient magneto-kinetic energy transfer are outlined. Experimental results obtained with symmetric high field collapse thrustors are presented.

1666

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

HEATING AND CONFINEMENT OF A PLASMA BY A MAGNETIC FIELD OF EXTERNAL ORIGIN AND WITH A SHORT RISE TIME, by H. G. Loos. Feb. 1959, 6p. incl. diagr. (Rept. no. PLR-6) [AF 49(638)335] Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 282-283, Apr. 1, 1959.

The use of a basic cylindrical configuration to heat and confine a plasma, fully ionized by a magnetic field that is suddenly induced by a current in an external conduction is explored. During the small time interval that a good separation between the magnetic field and the confined plasma, the liquid may be manipulated using the "magnetic piston" effect at the plasma boundary, provided that the linear ion density is large enough. It is also shown that heating by translational relaxation requires that an additional lower limit condition on N_i be satisfied.

1667

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

STUDY OF THE ACCELERATION AND CHANNELING OF PLASMA BY MAGNETIC FIELDS (Abstract), by R. W. Waniek and H. G. Loos. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)335) Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

This presentation deals with experimental and theoretical results obtained during the course of a study aimed at accelerating and heating ionized gases by means of strong transient magnetic fields. Recently developed strong magnetic field techniques make available for experimentation field intensities up to 1,000,000 oersteds and hence field pressures well in excess of 10^4 atm. Preliminary experimental results on symmetric and asymmetric collapse geometries is discussed with particular emphasis on their characteristics as intermittent magneto-plasma thrustors. The theoretical work has been concentrated on "punch" discharges with a cylindrical geometry. A fully ionized plasma of cylindrical shape is compressed and heated by a high transient magnetic field induced by currents in an external cylindrical conductor. At present, collisional relaxation heating in the punch configuration is being studied. The motion of the plasma boundary is assumed to be slow compared with the mean ion speed. A generalized equation of state is derived.

1668

Politecnico di Torino. Laboratorio di Meccanica
Applicata (Italy).

ON THE EXISTENCE OF INFINITE ACCELERATION
POINTS IN TRANSONIC FLOWS AROUND AIRFOILS
WITH FINITE CURVATURE, by S. Nocilla. Dec. 1958
[17]p. incl. diagrs. (Technical note no. 11) (AFOSR-
TN-59-197) (AF 61(514)1124) AD 211474; PB 147445
Unclassified

The problem is investigated of the formation of shock
waves around airfoils with finite curvature in transonic
flow. As a suitable criterion for the theoretical inter-
pretation of the appearance of such a shock wave it is
assumed the appearing of a point with infinite accelera-
tion on the physical plane. The conditions which must be
fulfilled on the hodograph plane in order that such a
point exist, and the properties which the corresponding
stream function must possess are studied. The theory
is then applied to airfoils with constant curvature.
(Contractor's abstract)

1669

Politecnico di Torino. Laboratorio di Meccanica
Applicata (Italy).

ON THE STEADY AND NON-STEADY TRANSONIC
FLOW WITH ATTACHED SHOCK WAVE ($M_\infty < 1$): NEW
RESULTS AND CONJECTURES, by C. Ferrari. Feb.
1959, 31p. incl. diagrs. (Technical note no. 12)
(AFOSR-TN-59-338) (AF 61(514)1124) AD 213659;
PB 142261 Unclassified

The purpose of this work is to seek the singularity which
the potential function Φ of the field must exhibit in the
physical plane in the point A_f, and the stream function Ψ
must have in the hodograph plane in the point A_0 cor-
responding to A_f, in order that the tangent in A_f be con-
tinuous. There is also determined the wave form in
close proximity of A_f as well as demonstrated that the
curvature of the wave front exhibits a logarithmic infini-
ty in said point. The law obtained for the variation of
velocity along the profile, both before and after the shock
although not affording a true demonstration of the prop-
erty being enunciated herein - permits however to infer
that, if the maximum local Mach number is slightly in
excess of 1, the transonic flow is continuous, at least
if the curvature of the profile in A_f is not null or nega-
tive (convex profile). The research is carried out both
for the stationary and the non-stationary flow.

1670

Politecnico di Torino. Laboratorio di Meccanica
Applicata (Italy).

AERODYNAMIC FIELD NEAR THE STAGNATION

POINT OF A BLUNT SYMMETRICAL AIRFOIL IN
HYPERSONIC FLOW WITH γ NEAR UNITY, by A.
Muggia. Feb. 1959, 15p. incl. diagrs. (Technical
note no. 13) (AFOSR-TN-59-339) (AF 61(514)1124)
AD 213660; PB 142262 Unclassified

A blunt symmetrical airfoil in a steady axial hyper-
sonic flow is considered, in the limiting case of free-
stream Mach number infinite and ratio of specific
heats γ near unity. Viscosity dissociation and ioniza-
tion are neglected. A method is obtained to determine
the aerodynamic field in the neighborhood of the stag-
nation point. Very simple formulae are determined
for velocity and pressure distribution along the air-
foil, near the stagnation point. (Contractor's abstract)

1671

Politecnico di Torino. Laboratorio di Meccanica
Applicata (Italy).

EFFECTS OF AIR DISSOCIATION AND IONIZATION AT
HYPERSONIC SPEED, by G. Jarre. July 1959 [35]p.
incl. diagrs. tables. (Technical note no. 14) (AFOSR-
TR-59-119) (AF 61(514)1124) AD 225765; PB 143910
Unclassified

An analysis was conducted on the problem of dissocia-
tion and ionization of air components at the high temper-
atures produced by hypersonic speed, either behind a
strong normal shock wave or at the wall of an adiabatic
flat plate. The state of chemical equilibrium is studied
with the aid of a thermodynamic chart of atmospheric
air and using simplified schemes of real flows. The
dynamic problem of relaxation is also investigated but
only in the field of oxygen dissociation. Simplified
methods for calculating the length of the relaxation
processes are developed, discussed and applied to nu-
merical examples.

1672

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical
Engineering and Applied Mechanics] N. Y.

THE BLASIUS EQUATION WITH THREE-POINT
BOUNDARY CONDITIONS, by L. G Napolitano. [1959]
[12]p. incl. tables. (Sponsored jointly by Air Force
Office of Scientific Research under AF 18(600)693 and
National Advisory Committee for Aeronautics under
NAw 6480) Unclassified

Published in Quart. Appl. Math., v. 16: 397-408, Jan.
1959.

The Blasius equation subject to 3-point boundary
conditions, describing the interaction between 2 parallel
streams, is solved by way of a series in terms of as-
cending powers of the ratio $\lambda = (u_1 - u_2)/u_1$, where
the u_i's are the outer streams' velocities. The first 3
terms of the series are analytically expressed in terms

of the repeated integrals of the complementary error function (i^n erfc η) and of the repeated integrals of the square of the successive integrals of the complementary error function ($j^m i^n$ erfc η). These functions often appear in problems leading to extended heat-conduction type of equations. A recurrence formula for $j^m j^n$ erfc η is established and formulae relating the functions i^n erfc ($-\eta$) and $j^m j^n$ erfc ($\pm \eta$) to available tabulated values of the functions i^n erfc (η) are derived. The first 5 approximations to the Blasius function and to its first 2 derivatives are also presented in tabulated form with 4 significant figures. Test on the convergence of the series has been made by comparison with some exact solutions obtained by high speed computing machine. The comparison, extended to the physically essential quantities, shows that: (1) The Blasius function itself is slightly less accurate than its 2nd and 1st derivatives. (2) Two terms of the series for λ up to 0.5 and 3 terms for λ up to 0.7 yield extremely accurate results. The errors in the first 2 derivatives of the Blasius functions are always contained within less than 1%. (Contractor's abstract)

1673

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

A REVIEW OF THE WORK PERFORMED AT PIBAL UNDER CONTRACT AF 18(600)694. PART I. ANALYSIS AND ADVANTAGEOUS USE OF INTERFERENCE EFFECTS IN SUPERSONIC FLOWS (Unclassified title). PART II. (Classified title) n.a., Oct. 1958, 9p. incl. refs. (AFOSR-TR-59-8) (AF 18(600)694) AD 304431
Confidential

1674

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

EXPERIMENTAL PRESSURE DISTRIBUTIONS ON CONICAL ELLIPTICAL BODIES AT M_∞ = 3.09 AND 6.0, by V. Zakkay and M. Visich, Jr. Mar. 1959, 31p. incl. illus. diagrs. refs. (PIBAL rept. no. 467) (AFOSR-TN-59-10) (AF 49(638)217) AD 208591; PB 139907
Unclassified

Pressure distributions over two elliptical cones having a 16.7° equivalent circular cone, and a ratio of the major to the minor axis of a/b equal to 1.39 and 1.78 are presented for different angles of attack. A hypersonic approach similar to Newtonian is suggested for the determination of the pressure distribution. The resulting pressure distribution as determined by this method compares more favorably with the experimental results than the Newtonian theory. (Contractor's abstract)

1675

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

DISCONTINUITY SURFACES IN MAGNETOFLUIDY-NAMICS, by L. G. Napolitano. Dec. 1958, 38p. (PIBAL rept. no. 503) (AFOSR-TN-59-67) (AF 49(638)217) AD 209842; PB 140039
Unclassified

Presented at meeting of the Amer. Astronaut. Soc., Washington, D. C., Dec. 27-31, 1958.

Also published in Advances in Astronaut. Sci., v. 4: 51-73, 1958.

Investigation was concerned with the macroscopic study of magneto-fluid-dynamic discontinuities for negligible relativistics effects. Jump conditions relating the end states on the two sides of discontinuity surfaces of arbitrary geometry are derived for both the steady and unsteady cases. Applications are presented in connection with: (a) the magneto-fluid-dynamic counterpart of Truesdell-Lighthill-Hayes problem of determining the vorticity jump across a shock, and (b) the existence of magneto-fluid-dynamic slip and/or contact surfaces. (Contractor's abstract)

1676

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

ANALYSIS OF THE LAMINAR COMPRESSIBLE BOUNDARY LAYER CHARACTERISTICS OVER AN ISOTHERMAL FLAT PLATE WITH FINS, by A. Pallone. Feb. 1959, 56p. incl. diagrs. tables. (PIBAL rept. no. 468) (AFOSR-TN-59-275) (AF 49(638)217) AD 212709; PB 140459
Unclassified

A theoretical investigation is presented of the compressible laminar boundary layer characteristics of a flow over an isothermal flat plate with fins. The equations are reduced to a 2-dimensional form by replacing the variation of all quantities in the direction normal to the plane of the fins by average values. The resulting equation is integrated for various free stream Mach numbers, fin characteristics and wall to free stream temperature ratios. Results show that the wall shear stress and consequently the rate of heat transfer decreases with increasing fin height, decreasing fin spacing and increasing free stream Mach number. Reductions of wall shear and rates of heat transfer on the order of 1/3 the values given for a plate with no fins are possible. No marked change on the rate of decrease is noted when the wall temperature is varied. The fin shear and rate of heat transfer show a trend opposite to the one stated for the wall. Increases of drag and the rate of heat transfer are obtained on the order of twice the values given for a flat plate with no fins.

1677

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

TRANSONIC ROTATIONAL FLOW OVER A CONVEX
CORNER, by R. Vaglio-Laurin. Aug. 1959, 56p. incl.
diagrs. tables, refs. (PIBAL rept. no. 431) (AFOSR-
TN-59-355) (AF 49(638)217) AD 264409; PB 144381
Unclassified

Also published in Jour. Fluid Mech., v. 9: 81-103,
Sept. 1960.

A singularity is encountered in the flow field about 2-
dimensional and axisymmetric bodies characterized by
a sharp corner, where the fluid velocity becomes sonic.
Such is the case for several practical configurations in
transonic and hypersonic flow. An investigation of this
sonic singularity, and the application of results thereof
to the analysis of flow fields about blunt bodies in the
aforementioned category are presented. It is shown that
the problem in question, as many other discontinuity
problems, belongs to the family of asymptotic or bound-
ary layer phenomena of mathematical physics. The so-
lution of the 1st approximation equations is given by a
series in powers of a variable measuring the distance
from the corner with coefficients depending on an appro-
priate similarity variable. The leading coefficient of
the series is independent of 3-dimensional and rota-
tionality effects, in complete analogy to the well-known
solution of the corner problem in supersonic flow. De-
tailed results are presented for the leading singularity
and for the 1st 2 corrections due to rotationality and
axial symmetry of the flow. (Contractor's abstract)

1678

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

ON A NEW APPROACH FOR THE SOLUTION OF NON-
SIMILAR BOUNDARY LAYER PROBLEMS, by L. G.
Napolitano and A. Ferri. Mar. 1960, 32p. incl. table.
(PIBAL rept. no. 507) (AFOSR-TN-59-356) (AF 49-
(638)217) AD 238697; PB 148557 Unclassified

A new method of solution for non-similar dissipative
flow fields is proposed which is essentially based on the
description of such flow fields by means of "inner"
and "outer" profiles joined along a continuous "match-
ing" line lying within the field itself. The inner and outer
profiles are single-parameter profiles derived from the
solution of a total differential equation upon which not
all the pertinent physical conditions are necessarily im-
posed. The "inner" profiles are in fact the inner part of
solutions for which the conditions of boundness at infini-
ty have not been imposed. The "outer" profiles are the
outer part of solutions which do not satisfy the true phys-
ical similarity requirements at the wall. It is proved
that the basic equations for constant property dissipative
isobaric flows in the Prandtl approximation can always
be reduced to a total differential equation depending on a

single parameter β. It is also proved that when the simi-
larity conditions in the boundary conditions are not im-
posed simultaneously at the 2 points (0 and ∞), 6 classes
of single-parameter profiles can be generated corre-
sponding to the different types of homogeneous boundary
conditions at 0 and of boundness at ∞. Each class con-
tains infinite profiles for the infinite values of β. Some
additional general properties of the above-mentioned
equation are proved, and these relate the types of sin-
gularities of the solution at ∞ (and of the initial boundary
conditions at 0) to the values of β. The matching proce-
dure is derived and discussed, and the detailed applica-
tion of the method is illustrated for a particular case.
The attainment of the 6 classes of solutions is deferred
to future work. (Contractor's abstract)

1679

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

ON THE INTEGRAL OF MOMENT OF PRESSURE IN
SUPERSONIC FLOW, by L. Ting. May 1959 [14]p. incl.
diagrs. (PIBAL rept. no. 449) (AFOSR-TN-59-358)
(AF 49(638)217) AD 213684; PB 142238 Unclassified

Also published in Jour. Aero/Space Sci., v. 26: 758-759,
Nov. 1959.

The integral of the moment of the disturbance pressure
along the line of the interaction of a Mach plane with the
cylindrical surface, whose generator is parallel to the
undisturbed stream, is shown to be related to the inte-
gral of the moment of the prescribed normal velocity
along the same line. Its applications in problems of
planar systems and wing-body combinations at super-
sonic speed are presented. (Contractor's abstract)

1680

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

AN EXTENSION OF THE LINEARIZED CHARACTER-
ISTICS METHOD FOR CALCULATING THE SUPER-
SONIC FLOW AROUND ELLIPTIC CONES, by A.
Martellucci. June 1959, 51p. incl. illus. diagrs. tables,
refs. (PIBAL rept. no. 517) (AFOSR-TN-59-632)
(AF 49(638)217) AD 219219 Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 667-
674, Sept. 1960.

The method of linearized characteristics as applied by
Ferri to the flow about elliptic cones can be used to de-
termine the surface pressure distribution, even when
only linear terms are kept in the boundary conditions,
provided an area rule requirement is satisfied. In ad-
dition, the method can be applied for angles of attack
provided the elliptic body geometry is specified in a
manner so as not to distort the cross section. Experi-
mental results were obtained for several conical bodies

and the results are presented. The surface pressure distribution obtained by this modified method is in reasonable agreement with experiment over the range of Mach number and semidiameter ratio range considered. (Contractor's abstract)

1681

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

PRESSURE DISTRIBUTIONS FOR A TWO-DIMENSIONAL BLUNT-NOSED BODY AT DIFFERENT ANGLES OF AT-TACK, by A. Ferri and V. Zakkay. [1959] [2]p. incl. diagrs. (AF 49(638)217)   Unclassified

Published in Jour. Aero/Space Sci., v. 26: 395-396, June 1959.

A few of the more interesting results concerned with work on the boundary conditions near a sonic line are presented. It is pointed out that 2-dimensional body having a circular nose which is extended for an angle of 145° can, at appropriate values of the angle of the attack of the body, have tests performed on it where the elliptic region is limited to the circular part of the body and the sonic points are on the circular region. It is also possible to move one point outside of the circular region. In this case the flow at the nose is not symmetrical, and the stagnation point is not on the radial line parallel to the free-stream direction. The flow at the nose has an anti-symmetrical part which is equivalent to the presence of circulation. The measured pressure distribution and the velocity gradient at the stagnation point for both cases are shown.

1682

Polytechnic Inst. of Brooklyn [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

AN INVESTIGATION OF THE PRESSURE DISTRIBUTION ON CONICAL BODIES IN HYPERSONIC FLOWS by V. Zakkay. [1959] [1]p. incl. diagrs. (AF 49(638)217)
                                          Unclassified

Published in Jour. Aero/Space Sci., v. 26: 457, July 1959.

In this note, experimental data on 2 elliptical cones at $M_\infty = 6$ are presented and a hypersonic approach obtained from physical considerations is suggested. The method consists of determining at each point the local normal component of the free-stream velocity with respect to the surface of the body. Then, an equivalent circular cone at zero angle of attack is determined that has the same normal component of the free-stream velocity. The pressure distributions of 2 elliptical cones having a 16.7° equivalent circular cone, and ratios of the major to the minor axis of a/b equal to 1.39 and 1.87 are presented in diagrammatic form for the angles of

attack of 0, 10°, and 20°. The ratio of the height of the cones to the square root of the base area for both models is $H/(\pi ab)^{\frac{1}{2}} = 1.87$, where H is the height of the cone.

1683

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

AN INVESTIGATION OF A LOW-DRAG AUXILIARY BODY UTILIZING FAVORABLE INTERFERENCE, by A. Martellucci. [1959] [3]p. incl. illus. diagrs. table. (AF 49(638)217)   Unclassified

Published in Jour. Aero/Space Sci., v. 26: 538-540, Aug. 1959.

Interference principles utilizing linearized flow techniques have been employed for the optimum replacement of bodies to the underside of a configuration so that, for a given lift of the system, the drag changes in such a manner that the L/D increases. The present investigation considers the placement of a body of large volume to the underside of a wing or fuselage, flying at a Mach number of 3.09, such that for a constant lift of the system, the additional wave drag will theoretically be zero. Since the body ducts air internally, it could be used as a ramjet engine to be used during the acceleration phase of flight, then cut out at design speed and carried along with only a small penalty in drag.

1684

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

STRESS DISTRIBUTION IN BEAMS OF THIN-WALLED SECTIONS IN THE PRESENCE OF CREEP, by S. A. Patel and K. A. V. Pandalai. Feb. 1959 [36]p. incl. diagrs. tables. (PIBAL rept. no. 486) (AFOSR-TN-59-174) (AF 49(638)302) AD 211314; PB 140062
                                          Unclassified

The bending and shear stress distribution in beams of thin-walled sections in the presence of creep were investigated. The elastic analog is used to reduce the creep problem to a problem in non-linear elasticity. The cross-sections investigated are open sections with an axis of symmetry. As examples, channel sections, T-sections and lipped-angle sections are considered. Plots and tables indicating the effect of temperature on the location of the neutral axis and shear center for the channel section are presented. Thin-walled circular shells with and without stringer reinforcement are also treated and the effect of stringers on the bending and shear stress distribution is shown. (Contractor's abstract)

1685

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

A NOTE ON SHEAR CENTERS OF THIN-WALLED
CLOSED SECTIONS IN THE PRESENCE OF CREEP,
by K. A. V. Pandalai and S. A. Patel. Feb. 1959 [22]p.
incl. diagrs. tables. (PIBAL rept. no. 487) (AFOSR-
TN-59-190) (AF 49(638)302) AD 211311; PB 140060
Unclassified

This research has been concerned with the shift of shear
centers of beams of thin-walled closed sections sub-
jected to creep. The elastic analog helps reduce the
creep problem to one of nonlinear elasticity. The ex-
amples considered are D-section, triangular section
and an idealized airfoil section. All the cross sections
considered are assumed to have one axis of symmetry.
The results indicate that in the presence of creep the
shear center can shift significantly from its position
corresponding to the linear, elastic theory.

1686

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

HIGH ORDER CORRECT DIFFERENCE SCHEMES FOR
MULTI-DIMENSIONAL PARABOLIC EQUATIONS, by
J. R. M. Radok and K. Wang. Mar. 1959, 12p. (PIBAL
rept. no. 492) (AFOSR-TN-59-329) (AF 49(638)302)
AD 213676; PB 140532 Unclassified

A method of construction of high order correct differ-
ence schemes for multi-dimensional diffusion equations
is developed which represents a natural generalization
of a method, developed previously for the corresponding
1-dimensional equation. These difference formulas con-
tain weighting coefficients with the 1-dimensional divided
differences in several space dimensions which will en-
sure optimum truncation errors for a given number of
base points. It is shown that these coefficients can be
expressed in terms of their 1-dimensional counter parts.
The response of these and certain 1-dimensional schemes
to a certain mode of numerical solution is investigated
for which the values of the dependent variable at adjacent
points in space and time are of equal magnitude and of
opposite sign. It is shown that for explicit schemes in-
volving the mesh ratio $R = \frac{k}{h^2}$ linearly there is always a
real value of R for which the selected mode separates
the stable and unstable regime, while the 2nd-order ex-
plicit formulas involving R^2 are stable for all R. (Con-
tractor's abstract)

1687

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

CREEP BEHAVIOR OF COLUMNS, by S. A. Patel and

B. Venkatraman. May 1959 [84]p. incl. diagrs. tables,
refs. (PIBAL rept. no. 422) (AFOSR-TN-59-530)
(AF 49(638)302) AD 216537 Unclassified

Investigation of the creep behavior of pin-ended col-
umns is discussed. The analyses are carried out on
the basis of an assumed equivalent I-section. Viscous
and visco elastic columns are considered first. The
analysis is then carried out with the inclusion of a term
to account for plastic deformations. Next, short-time
buckling is investigated on the basis of a proposed tran-
sient creep law. Solutions for the critical time are pre-
sented in all cases. Finally, the validity of the assump-
tions made during the analysis is examined. It is shown
that results in good approximation may be obtained with
the use of an equivalent I-section and the neglect of
higher harmonic deflection components. (Contractor's
abstract)

1688

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

CREEP BUCKLING OF CYLINDRICAL SHELLS SUB-
JECTED TO UNIFORM AXIAL COMPRESSION, by F.
W. French and S. A. Patel. May 1959 [18]p. incl. diagrs.
(PIBAL rept. no. 489) (AFOSR-TN-59-538) (AF 49-
(638)302) AD 215555; PB 243007 Unclassified

The axially symmetric creep buckling of a circular
cylindrical shell is investigated. A sandwich shell
analogy and a biaxial creep law are used in the analysis.
Two simultaneous, nonlinear differential equations are
found to govern the stress distribution in and the dis-
placement of the cylinder. A numerical example using
these equations is carried out, and the results are pre-
sented in the form of curves. (Contractor's abstract)

1689

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

CREEP-STRESS ANALYSIS OF THIN-WALLED
STRUCTURES, b S. A Patel, K. A. V. Pandalai, and
B. Venkatraman. July 1959 [40]p. incl. diagrs. tables,
refs. (PIBAL rept. no. 497) (AFOSR-TN-59-665)
(AF 49(638)302) AD 220049 Unclassified

Also published in Jour. Roy. Aeronaut. Soc., v. 64: 673-
682, Nov. 1960.

A presentation is made of some methods of stress
analysis of thin-walled structures subject to creep.
It is assumed that the structures considered are main-
tained at a uniform temperature so that no thermal
stresses are present. It is also assumed that the elas-
tic deformations are negligible in comparison with
creep deformations. Under these assumptions, the
creep problems of thin-walled structures are 1st re-
duced to analogous problems of the same structures

made of nonlinear elastic materials. The stress ana-
lyses are then carried out with particular reference to
structures with closed and open cross sections and sub-
jected to pure torsion, bending, and shear. (Contrac-
tor's abstract)

1690

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

ON THE DIFFRACTION OF AN ARBITRARY PULSE
BY A WEDGE OR A CONE, by L. Ting. Feb. 1959 [12]p.
incl. diagrs. (PIBAL rept. no. 502) (AFOSR-TN-59-
127) (AF 49(638)445) AD 210615; PB 140643
Unclassified

Also published in Quart. Appl. Math., v. 18: 89-92,
Apr. 1960.

By virtue of Green's theorem, it is shown that for the
diffraction of an arbitrary 2-dimensional incident pulse
by a wedge of angle μ, the ratio of the resultant ve-
locity potential to the corresponding value of the inci-
dent pulse at the corner of the wedge at any instant is
equal to $2\pi/(2\pi - \mu)$; and that for the diffraction of a 3-
dimensional pulse by a cone of solid angle ω, the ratio
at the vertex of the cone is equal to $4\pi/(4\pi - \omega)$. (Con-
tractor's abstract)

1691

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

FAVORABLE INTERFERENCE OF A BODY AND
BIPLANE COMBINATION IN SUPERSONIC FLOW, by
L. Ting. Mar. 1959 [9]p. incl. diagrs. table. (PIBAL
rept. no. 510) (AFOSR TN-59-200) (AF 49(638)445)
AD 211526; PB 140026   Unclassified

An optimum contoured prismatic body mounted on a
triangular midwing is compared with the combination
of the same body with a biplane arrangement of a tri-
angular high wing and low wing. For the same lifting
surface, the span of the wings of the second combina-
tion is one-half of that of the midwing. The second
configuration is favorable from a structural point of
view and from the aerodynamic point of view. For the
special configurations considered in the numerical ex-
ample, a reduction of 8% in drag for the same lift is
found for the biplane-body combination as compared
with the monoplane-body combination. (Contractor's
abstract)

1692

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

INVESTIGATION OF THE HEAT TRANSFER AND

PRESSURE DISTRIBUTION FOR SEVERAL SHOCK
GENERATORS (Unclassified title), by V. Zakkay and
D. A. MacKenzie. Apr. 1959. 27p. incl. illus. diagrs.
table. (PIBAL rept. no. 460) (AFOSR-TN-59-328)
(AF 49(638)445) AD 306306   Confidential

1693

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

AN EXPERIMENTAL INVESTIGATION OF THE RE-
DUCTION OF AERODYNAMIC HEATING TO A 15° AND
20° BLUNTED CONE AT M_∞ = 6 AND 8, by V. Zakkay.
Feb. 1960, 39p. incl. illus. diagrs. (PIBAL rept. no.
469) (AFOSR-TN-59-350) (AF 49(638)445) AD 223662;
AD 315691   Declassified

Data for the laminar and turbulent heat transfer and
pressure distribution on a 15° and 20° blunted cone at
a Mach number of 6 and 8 with several ring body con-
figurations are presented. It is indicated that a larger
reduction in the laminar heat transfer may be obtained
as a result of increasing the Mach number. Effects of
shock generator transition is investigated experimen-
tally for a Mach number of 8 and a 15° blunted cone. It
is indicated that the transition Reynolds number is af-
fected by the presence of the shock generator. (Con-
tractor's abstract)

1694

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y

AN INVESTIGATION OF THE ADVANTAGEOUS USE OF
INTERFERENCE EFFECTS IN THE DESIGN OF SU-
PERSONIC INLETS. PART III. EXPERIMENTAL RE-
SULTS OF A SWEPT, RECTANGULAR WING-ROOT IN-
LET AT A MACH NUMBER OF 3.09 (Unclassified title),
by A. Martellucci. Apr. 1959, 44p. incl illus. diagrs.
tables. (PIBAL rept. no. 511) (AFOSR-TN-59-351)
(AF 49(638)445) AD 306305   Confidential

1695

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical
Engineering and Applied Mechanics] N. Y.

ON THE TURBULENT FLOW OF AN ELECTRICALLY
CONDUCTING STREAM IN THE PRESENCE OF A
MAGNETIC FIELD (Abstract), by L. G. Napolitano.
[1959] [1]p. (AFOSR-TN-59-357) [AF 49(638)445]
AD 213683   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
204, Mar. 30, 1959.

A study is reported of the turbulent boundary layer over a flat plate when the fluid is electrically conducting and a magnetic field is present. It is assumed that the fluid has constant properties and that linearization with respect to the magnetic Reynolds number is permissible. A suitable 2-layer model of the hydromagnetic turbulent boundary layer is then postulated and the energy transfer mechanism occurring therein is described. Solutions are obtained for 2-layers in terms of a "magnetic parameter" ξ, and are then joined by following an extension of the Clauser approach. Both the modified law of the wall and skin friction law are thus determined. The cases considered pertain to magnetic fields fixed relative to the plate and/or to the free stream. Solutions are $_{b}$ on to within a 1st approximation in the magnetic parameter ξ and the corresponding results are presented and discussed.

1696

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

INTERFERENCE OF BODY AND TRAILING EDGE VORTEX SHEET IN SUPERSONIC FLOW, by S. Kobayakawa and L. Ting. May 1959, 27p. incl. diagrs. (PIBAL rept. no. 516) (AFOSR-TN-59-453) (AF 49(638)-445) AD 215028; PB 142264   Unclassified

The interference of a wing with a circular cylindrical body is treated by the generalized integral relationship. It is shown that the integral equation is valid if the region ahead of the Mach plane contains a vortex sheet-like discontinuity surface. With this extension, the integral equation is applied to obtain an approximate solution to the pressure distribution on the body surface which lies in the domain of influence of the trailing edge in a manner similar to that employed for the dihedral and the wing-body interference problem. For the present problem, an alternate form of the integral relationship is derived so that the range of integration is substantially reduced. For the purpose of illustration, a triangular flat plate with a sonic leading edge and an unswept trailing edge is mounted as a high wing configuration on a prismatic body of rectangular cross section, and the pressure distribution on the body in the domain of influence of the trailing edge is obtained. (ASTIA abstract)

1697

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

SOME HEAT TRANSFER PROBLEMS IN HYPERSONIC FLOW, by A. Ferri. July 1959, 51p. incl. illus. diagrs. table, refs. (PIBAL rept. no. 473) (AFOSR-TN-59-806) (Sponsored jointly by Aeronautical Research Lab. and Air Force Ballistic Missile Div. under AF 33(616)6118 and Air Force Office of Scientific Research under AF 49(638)445) AD 237730; PB 143600   Unclassified

Also published in Proc. Durand Centennial Conf. on Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 5-8, 1959), N. Y., Pergamon Press, 1960, p. 344-377. (TR-59-108)

The curved shock waves associated with blunt bodies at hypersonic velocity produce large entropy gradients and therefore large shear flows which interact with the boundary layer. The effects of this shear flow are discussed for the case of axially symmetric and 2-dimensional flow fields and for low and high Reynolds number of flight. Approximate methods of heat transfer analysis are presented for the case of laminar boundary layer in the presence of a shear flow with a cold wall and in the case of zero pressure gradient. The effects of interaction between external flow and laminar turbulent heat transfer and/or the effect of shear flow on transition are presented. Results show that these are large effects and important for practical applications. (Contractor's abstract)

1698

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

AN EXPERIMENTAL INVESTIGATION AT M = 3.09 ON HEAT TRANSFER REDUCTION BY THE USE OF UP-STREAM PROBES, by A. Martellucci and M. Visich, Jr. Nov. 1959, 1v. incl. illus. diagrs. tables, refs. (PIBAL rept. no. 527) (AFOSR-TN-59-1167) (AF 49(638)445) AD 223659   Declassified

An experimental study of some aerodynamic effects of upstream probes on a tangent-ogive body of revolution is presented. In particular, the effect of the probes on the heat transfer to the body is considered. The spikes considered were blunted with a teardrop cross section. The length to spike-maximum diameter L/D_m ranged from 4.75 to 9.50. The tests were conducted at a Mach number of 3.09 with a corresponding test section Reynolds number per foot of 3.37×10^7. For a 10° angle of attack range, the static pressure over the ogive remained unchanged, independent of the spike configuration. A stagnation pressure level reduction of the fluid that wets the ogive surface was measured. This results in a lowered surface Mach number which corresponds to a heat transfer reduction. The spike with $L/D_m = 4.75$ produced the largest heat rate reduction. Results show that the presence of probes upstream of a tangent-ogive does not affect the drag of the body, but the skin friction and heat transfer to the ogive can be expected to diminish. (Contractor's abstract)

1699

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

A STUDY OF SIMILARITY TRANSFORMATIONS FOR

THE EQUATIONS OF A TWO-DIMENSIONAL INCOM-
PRESSIBLE VISCOUS FLUID FLOW, by K.-S. Wan.
Dec. 1959, 20p. (PIBAL rept. no. 537) (AFOSR-TN-
59-1257) (AF 49(638)445) AD 231852, PB 145773
Unclassified

Similarity transformations to a laminar flow equation
and the Navier-Stokes equation were obtained for 2-
dimensional unsteady and steady flows in both cartesian
and polar coordinates. These include those obtained
previously in the boundary layer theory as special
cases. The possibilities of applying these transforma-
tions to obtain solutions for unsteady and steady laminar
boundary layer problems with external accelerated or
decelerated, irrotational or rotational flows, and fixed
or moving boundaries, are indicated. (Contractor's
abstract)

1700

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical
Engineering and Applied Mechanics, N. Y.

SOME SIMILAR SOLUTIONS FOR INCOMPRESSIBLE
LAMINAR BOUNDARY LAYER PROBLEMS, by K.-S.
Wan. Dec. 1959, 28p. incl. refs. (PIBAL rept. no.
538) (AFOSR-TN-59-1303) (AF 49(638)445)
AD 235799   Unclassified

Similar solutions to 3 types of laminar boundary
layer problems are given in terms of known solutions.
The 1st problem pertains to unsteady laminar boundary
layer when the external irrotational flow is inversely
proportional to a linear function of time, and varies
linearly in the direction of the main flow. The related
heat transfer solution with isothermal heated surface
is indicated. The 2nd is the classical steady laminar
boundary layer problem, but with the external irrota-
tional flow given by $u_0(1 + \bar{b}x)^m$. The last problem is
concerned with similar solutions for the boundary layer
interacting with external inviscid rotational flow. A
similar solution is obtained when the external vorticity
is constant, large or small, and the external velocity
varies as $U_0(1 + \bar{b}x)^{1/3} + \omega y$ or $U_0\bar{x}^{1/3} + \omega y$. The
latter case may be considered as a simple shear flow
over a wedge with half wedge angle $\frac{\pi}{4}$. (Contractor's
abstract)

1701

Polytechnic Inst. of Brooklyn. Dept. of Chemistry, N. Y.

PHOTOREDUCTION OF DYES IN RIGID MEDIA. II.
PHOTOREDOX PROPERTIES OF THIAZINE DYES, by
B. Broyde and G. Oster. [1959] [5]p. incl. diagrs.
table, refs. (Sponsored jointly by Air Force Office of
Scientific Research under AF 49(638)293 and Atomic
Energy Commission under AT(30-1)2206)
Unclassified

Presented at meeting of the Phys. Chem. Div. of the
Amer. Chem. Soc., Boston, Mass., Apr. 5-10, 1959.

Abstract published in 135th meeting of the Amer. Chem.
Soc. Abstracts of papers, 1959, p. 58-R.

Thiazines undergo photoreduction to their leuco forms
when incorporated into high viscosity glasses of poly-
hydroxy compounds. The rate of photoreduction is
proportional to the square root of the diffusion coef-
ficient suggesting a diffusion-controlled process in
which stationary state conditions are not achieved.
Illumination of highly concentrated dye glasses con-
taining an added mild reducing agent yields an inter-
mediate color which reverts to the original dye on
softening the glass. This species is an entrapped dimer
of the original dye. Near ultraviolet light irradiation
of the leuco glass yields the normal dye and other
colored species. In acid glasses a red form is pro-
duced and in basic glasses a yellow form is the result,
both forms reverting to the leuco species on softening
the glass. The ratio of red to blue forms increases
when the viscosity of the medium is increased. These
intermediate species are believed to be a semiquinone
and a diradical, or a molecule in the triplet state en-
trapped in the rigid medium. (Contractor's abstract)

1702

Polytechnic Inst. of Brooklyn. Dept. of Mechanical
Engineering, N. Y.

NON-LINEAR THEORY OF COMBUSTION INSTABILITY.
LIQUID PROPELLANT ROCKET MOTORS, by T. P.
Torda and S. Z. Burstein. Dec. 1, 1958, 106p. incl.
diagrs. refs. (Technical note no. PRL-TN-58-1)
(AFOSR-TN-59-60) (AF 49(638)165) AD 209491;
PB 139653   Unclassified

The state of the art of combustion instability and seal-
ing of liquid propellant rocket motors is discussed. A
new non-linear theory is developed applicable to non-
steady, one-dimensional flows with mass and energy
addition. The resulting differential equations are
solved by the method of characteristics. The problem
has been completely coded for computations on an IBM
704 electronic data processing machine. (Contrac-
tor's abstract)

1703

Polytechnic Inst. of Brooklyn. Dept. of Mechanical
Engineering, N. Y.

SOME NUMERICAL METHODS OF SOLUTION OF
NON-LINEAR PARTIAL DIFFERENTIAL EQUATIONS
ARISING IN THE ANALYSIS OF SUBSONIC FLOW
SYSTEMS WITH MASS AND HEAT ADDITION, by W. A.
Beardsley and H. Berger. Dec. 1, 1958, 76p. incl.
diagrs. (Technical note no. PRL-58-2) (AFOSR-TN-
59-79) (AF 49(638)165) AD 210139; PB 140036
Unclassified

Four finite difference methods of solution are discussed for a system of three simultaneous partial differential equations which describe a one dimensional non-steady flow process with heat and mass addition which occurs in a rocket chamber. The partial differential equations are put into a finite difference form, and are used to calculate the variables (temperature, pressure, density, and velocity) throughout the x (position) - t (time) plane. (Contractor's abstract)

1704

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

AEROTHERMOCHEMISTRY OF JET PROPULSION LIQUID PROPELLANT ROCKET MOTORS, by T. P. Torda. Jan. 1959, 31p. incl. diagrs. refs. (Technical note no. PRL-59-3) (AFOSR-TN-59-80) (AF 49(638)-165) AD 210140; PB 139556   Unclassified

Discussion is presented on the following topics: aerothermochemistry of jet propulsion; combustion of liquid propellants; non-linear non-steady analysis of aerothermochemical phenomena in liquid propellant rocket motors; steady state operation - rocket chamber design; possible mechanisms for triggering instability; theories of rocket instability; and scaling of rocket motors.

1705

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

A NON-LINEAR NON-STEADY AEROTHERMO-CHEMICAL ANALYSIS OF COMBUSTION INSTABILITY IN A ROCKET CHAMBER, by H. Berger. May 1, 1959, 76p. incl. diagrs. tables, refs. (Technical note no. PRL-TN-59-5) (AFOSR-TN-59-703) (AF 49(638)-165) AD 228733; PB 144500   Unclassified

The mathematical relations for describing the non-steady flow of a non-viscous gas are developed. The assumptions necessary to obtain an approximate quasi-one-dimensional system of equatio s are explained; suitable boundary conditions are given. The characteristic net used in obtaining the numerical solution of hyperbolic partial differential equations that is standard in gas dynamics is outlined, and its limitations with respect to the requirements of this analysis is discussed. A rigorous method of numerical integration of the non-steady equations, differing from the standard characteristic method common in gas dynamics analyses is examined. Its advantages are considered, and sample numerical calculations are presented.

1706

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

FLEXURAL VIBRATIONS OF ELASTIC SANDWICH PLATES, by Y.-Y. Yu. Mar. 1959 [30]p. incl. diagr. (Technical note no. 3) (AFOSR-TN-59-188) (AF 49-(638)453) AD 211219; PB 140933   Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 272-282, Apr. 1960.

On the basis of the new flexural theory of elastic sandwich plates developed in two previous papers (PIB.15: 001, 002, Vol. II), which includes the effects of rotatory inertia and shear in the core and faces of the sandwich, and on the basis of the exact elasticity theory, flexural vibrations of infinite sandwich plates in plane strain are investigated. No limitations are imposed upon the magnitudes of the ratios between the thicknesses, material densities, and elastic constants of the core and faces of the sandwich. For ordinary sandwich plates that have relatively thin but heavy and rigid faces, the frequency equations may be reduced, and a numerical example is given. The results of the sandwich-plate theory show excellent agreement with those of the elasticity theory, and the former are shown to be applicable also to simply supported finite plates. It is concluded that the effects of rotatory inertia and shear play an even more important role in vibration studies of sandwich plates than in homogeneous plates. (Contractor's abstract)

1707

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

FORCED FLEXURAL VIBRATIONS OF SANDWICH PLATES IN PLANE STRAIN, by Y.-Y. Yu. July 1959, 22p. (Technical note no. 4) (AFOSR-TN-59-567) (AF 49(638)453) AD 235028; PB 146974 Unclassified

Published in Jour. Appl. Mech., v. 27: 535-540, Sept. 1960.

On the basis of newly-developed flexural theory of elastic sandwich plates, the problem of general forced flexural vibration of sandwich plates in the plane-strain case is solved. The classical method of separation of variables combined with the Mindlin-Goodman procedure (Jour. Appl. Mech., v. 17: 377-380, 1950) for treating time-dependent boundary conditions is used. As an example, the results are used in solving the problem of a simply supported sandwich plate in plane strain with 1 of the 2 end sections prescribed a transverse deflection varying with time. (Contractor's abstract)

1708

Polytechnic Inst. of Brooklyn. Dept. of Mechanical
Engineering, N. Y.

SIMPLIFIED VIBRATION ANALYSIS OF ELASTIC
SANDWICH PLATES, by Y.-Y. Yu. Aug. 1959, 24p. incl.
table. (Technical rept. no. 5) (AFOSR-TN-59-1062)
(AF 49(638)453) AD 234221; PB 146639
                                              Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 894-
900, Dec. 1960.

In a sequence of 3 recent papers a new flexural theo-
ry of elastic sandwich plates has been developed (see
item nos. PIB.15:001, 002, Vol. II), and, on the basis
of the theory, the flexural vibration of sandwich plates
has been analyzed (see item no. 1706, Vol. III). The
theory is good for a very wide frequency range that is
of practical interest, but vibration analysis on the basis
of the theory will in general be complicated due to the
high order of the equations. For low frequency ranges
simplified treatment of the vibration problem becomes
possible and is discussed in this paper. Simpler equa-
tions of motion of sandwich plates are introduced, and
their accuracy is determined by comparing them with
the previous more complete equations. (Contractor's
abstract)

1709

Polytechnic Inst. of Brooklyn. Dept. of Mechanical
Engineering, N. Y.

A NEW THEORY OF SANDWICH PLATES. GENERAL
CASE, by Y.-Y. Yu. Nov. 1959, 27p. (Technical note
no. 6) (AFOSR-TN-59-1163) (AF 49(638)453)
AD 234222; PB 146741   Unclassified

The 1-dimensional flexural case of a new theory of
elastic sandwich plates was developed in 2 previous
papers (Item nos. PIB.15:001, 002, Vol II). The gen-
eral 2-dimensional case of the theory is given in this
paper. Extension as well as flexure is considered,
and the core of the sandwich may be either isotropic
or orthotropic. As the 1-dimensional case, the general
theory is valid for any symmetrically arranged 3-
layered plate and for vibration analysis involving wide
frequency ranges. For sandwiches with very thin
faces simplified equations good for limited frequency
ranges are deduced. A brief discussion is given on
sandwiches with cores composed of Kelvin-Voigt ma-
terial. (Contractor's abstract)

1710

Polytechnic Inst. of Brooklyn. Microwave Research Inst.,
N. Y.

REFLEX MULTIPACTOR EFFECT, by B. Epsztein.

Sept. 22, 1959, 15p. incl. diagrs. (Rept. no. R-763-59;
PIB-691) (AFOSR-TN-59-1103) (AF 18(600)1505)
AD 228708; PB 149997   Unclassified

This paper is concerned with the theoretical study of
a new type of multipactor which can take place on a
single surface in the presence of a tangential dc mag-
netic field. The analysis shows that the presence of
this effect depends only on the ratio of the cyclotron
frequency corresponding to the applied magnetic field
to the operating frequency, once a threshold for the
r.f. field is reached. The value of this threshold de-
pends on the secondary emission properties of the sur-
face. Conditions for stable reflex multipactor are
given. (Contractor's abstract)

1711

Polytechnic Inst. of Brooklyn. Microwave Research Inst.,
N. Y.

INVESTIGATION OF A CIRCULAR WAVEGUIDE
PERIODICALLY LOADED WITH STRAIGHT WIRES,
by M. Ettenberg and T. Tamir. Oct. 15, 1959 [13]p.
incl. diagrs. refs. (Research rept. R-782-59; PIB-
710) (AFOSR-TN-59-1298) (AF 18(600)1505)
AD 230730; PB 152652   Unclassified

The investigation of the properties of a periodically
loaded line is described. The line, consisting of a cir-
cular guide with straight wires loading, is shown to be
suitable for linear accelerators and traveling-wave
tubes. The determination of the propagation character-
istic and other pertinent measurements is described.
The results show that the structure exhibits a fundamen-
tal slow backward harmonic, similar to the properties
of an anti-Karp line. A discussion on the influence of
various parameters indicates how an appropriate propa-
gation curve may be designed by suitable proportioning
the geometrical dimensions of the structure. (Contrac-
tor's abstract)

1712

Polytechnic Inst. of Brooklyn. Microwave Research Inst.,
N. Y.

REALIZATION OF BOOLEAN POLYNOMIALS BASED
ON INCIDENCE MATRICES, by S. Okada, Y. Moriwaki,
and K. P. Young. Nov. 16, 1959 [37]p. incl. diagrs.
tables, refs. (Research rept. R-790-59; PIB-718)
(AFOSR-TN-59-1299) (AF 18(600)1505) AD 230765;
PB 153234   Unclassified

An algebraic method for finding minimum switching 2-
terminal networks for any given Boolean polynomial S
is established by adopting node-branch incidence ma-
trices as unknown quantities. Generators of invariant
transformation group of S are determined. Prime im-
plicant S_1, or any other equivalent polynomial S_i, are
expressed by loops passing the relay branch and by a

set of vectors $C_g(i)$ modulo 2 in a branch-number-dimensional affine space. Dually open circuit conditions R_i are expressed by a set of hyperplane covectors $B^f(i)$ of cut-sets. $B^f(i)$ and $C_g(i)$ give realizable range of number of nodes, branches, and degree of freedom for each R_i and S_i. Base vectors $C_p(i)$ of subspace $C_g(i)$ and all vectors $C_k(i)$ which express loops passing the relay branch are determined based on linear dependency. Dually $B^f(i)$ gives base covectors $B^a(i)$ and all covectors $B^h(i)$ of cut-sets cutting the relay branch. Sneak paths or barriers in $B^h(i)$ or $C_k(i)$ are eliminated by increase of contacts. Networks of solution are obtained from either $B^a(i)$ or $C_q(i)$ by a new graphical or algebraic ambit-method, generally with addition of some pseudo-ties $C_n(i)$ which are loops including make and break contact of a relay in series. Dually, pseudo-cuts $B^m(i)$ can be added to $B^a(i)$ for realization. (Contractor's abstract)

1713

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

PRELIMINARY DESIGN CONSIDERATIONS OF A MICROWAVE FLYWHEEL, by J. Griemsmann. Mar. 13, 1959, 13~. (Rept. no. 722; PIB-650) (AF 18(600)-1505)   Unclassified

As a means of obtaining magnitudes of design parameters and indicating directions for future developments, preliminary designs of microwave "flywheels" are presented for ideal power magnifications of 5, 10 and 20 times, and for the standard rectangular copper waveguide in S, C, and X bands. An example of a realizable S-band design of final 4-fold power magnification is found to have a length of 135 ft, a build up time of 1.673 μsec and a discharge time of .230 μsec with an energy conversion efficiency of 44%. The inherent limiting factor, particularly for higher frequency designs, is found to be the attenuation of the waveguide used for the ring. A projected design using an oversized guide at C-band shows a power multiplication of 6.4 for a 537 ft ring, a build up time of 8.74 μsec and a discharge time of .546 μsec with an energy conversion efficiency of 41.3%. The length of the ring is, of course, directly associated with the desired duration of the output pulse and in addition specifies the requirements on the speed of switching required to discharge the ring. An appendix gives the analytical basis for the design including an heretofore unpublished solution for the transient build up of power in the ring. (Contractor's abstract)

1714

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

ON A CERTAIN PROBLEM IN QUEUING THEORY WITH ARBITRARY PROBABILITY DISTRIBUTIONS OF THE NUMBER OF ARRIVALS AND SERVICING TIMES, by E. Mishkin. May 22, 1959, 7p. (Rept. no. 744; PIB-672) (AF 18(600)1505)   Unclassified

The average queuing lengths and weighting times are derived for arbitrary probability distributions of the number of arrivals and of the processing times. The final expressions given are derived under certain conditions which govern the double integrations involved. (Contractor's abstract)

1715

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

NETWORK REPRESENTATIONS FOR MULTI-PATH LINE FILTERS, by E. N. Torgow. July 16, 1959, 13p. (Rept. no. 760; PIB-688) (AF 18(600)1505)
Unclassified

Multi-path transmission line structures were investigated with a view toward the development of the necessary and sufficient conditions for network functions to be realized by the use of these structures. Cauer representation for the single line section was obtained. It was shown that the impedance matrix for the n-path transmission line network where all the path lengths are commensurate has a canonical Cauer network representation which consists of 2-port series connection of networks. The filter parameters, however, can be more readily observed from an examination of the image parameters of the n-path structure. Accordingly, the image parameters were derived and the characteristics of several 2-path line structures were examined. (Contractor's abstract)

1716

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

A FEEDBACK SYSTEM WITH CERTAIN UNUSUAL CHARACTERISTICS, by J. G. Truxal. Sept. 22, 1959, 6p. (Rept. no. 780; PIB-708) (AF 18(600)1505)
Unclassified

The difficulty associated with the satisfactory design of even relatively simple feedback configurations on the basis of the theories so extensively developed for the single-loop system is illustrated by consideration of the characteristics of the system whose configuration involves only 3 simple negative feedback paths and 2 frequency-sensitive transfer functions. (Contractor's abstract)

1717

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

GENERAL N-PORT SYNTHESIS WITH NEGATIVE RESISTORS, by H. J. Carlin. Nov. 20, 1959, 4p. (Rept. no. 791: PIB-719) (AF 18(600)1505)
Unclassified

Also published in Proc. Inst. Radio Engineers, v. 48: 1174-1175, June 1960.

An n-port synthesis is presented for any n x n admittance $[Y(p)]$, impedance $[Z(p)]$, or scattering $[S(p)]$, matrix, in which the matrix elements are general rational functions with real coefficients containing zeros and poles of arbitrary multiplicity anywhere in the complex frequency (p) plane. It is shown that the synthesis can always be performed with passive elements (R, L, C, gyrators, ideal transformers) and negative resistors.

1718

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

A STABILITY CHARACTERIZATION OF THE GENERAL LINEAR, PASSIVE, RECIPROCAL, TIME-INVARIANT N-PORT, by D. C. Youla. Jan. 9, 1959, 15p. (Rept. no. 709; PIB-637) (AFOSR-4208) (AF 18-(603)105)
Unclassified

Also published in Proc. Inst. Radio Engineers, v. 47: 1150-1151, June 1959.

The fact that a 2 port which is reciprocal and stable under all passive terminations is passive has been known for quite some time. In the present work, it is shown that the theorem remains valid for arbitrary n-ports, i.e., a reciprocal n-port stable under all passive terminations is passive. The technique employed makes use of induction and the properties of mappings which transform the closed right half-plane into the open right half-plane. In addition, the scattering matrix $S(p)$ of the structure is assumed to be analytic and of "limited growth" in Re $p > 0$, no assumptions being made regarding its boundary behavior on $p = j\omega$. Thus, non-lumped networks fall within the scope of the theorem. (Contractor's abstract)

1719

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

BOUNDED REAL SCATTERING MATRICES AND THE FOUNDATIONS OF LINEAR PASSIVE NETWORK THEORY, by D. C. Youla, L. J. Castriota, and H. J. Carlin. [1959] [23]p. incl. refs. (AFOSR-4210) (AF 18-(603)105 and AF 18(600)1505)
Unclassified

Also published in I.R.E. Trans. on Circuit Theory, v. CT-6: 102-124, Mar. 1959.

The most general linear, passive, time-invariant n-port is studied from an axiomatic point of view, and a completely rigorous theory is constructed by the systematic use of theorems of Bochner and Wiener. An n-port Φ is defined to be an operator in H_n, the space of all n-vectors whose components are measurable functions of a real variable t, $(-\infty < t < \infty)$. Under very weak conditions on the domain of Φ, it is shown that linearity and passivity imply causality. In every case, Φ_a, the n-port corresponding to φ augmented by n series resistors is always causal. Under the further assumptions that the domain of Φ_a is dense in Hilbert space and φ is time-invariant, it is proved that Φ possesses a frequency response and defines an n x n matrix $S(z)$ of a complete variable $z = \omega + i\beta$ with the following properties: (1) $S(z)$ is analytic in Im $z > 0$; and (2) $Q(z) = 1_n - S^*(z)S(z)$ is the matrix of a non-negative quadratic form for all z in the strict upper half-plane and almost all ω. Conversely, it is also established that any such matrix represents the scattering description of a linear, passive time-invariant n-port Φ such that the domain of Φ_a contains all of Hilbert space. Such matrices are termed "bounded real scattering matrices" and are a generalization of the familiar positive-real immittance matrices. When Φ and Φ^{-1} are single-valued, it is possible to define 2 auxiliary positive-real matrices $Y(z)$ and $Z(z)$, the admittance and impedance matrices of Φ, respectively, which either exist for all z in Im $z > 0$ and almost all ω or nowhere. The necessary and sufficient conditions for an n x n matrix $A_n(z)$ to represent either the scattering or immittance description of a linear, passive, time-invariant n-port Φ are derived in terms of the real frequency behavior of $A_n(\omega)$. Necessary and sufficient conditions for Φ_a to admit the representation

$$i(t) = \int_{-\infty}^{\infty} dW_n(\tau) e(t - \tau)$$

for all integrable e(t) in its domain are given in terms of $S(z)$.

1720

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

GENERAL ELECTRONIC WAVEGUIDES, by N. Marcuvitz. Oct. 28, 1958, 25p. incl. illus. (Rept. no. R-692-58; PIB-620) (AFOSR-TN-59-115) (AF 49(638)-340) AD 210400
Unclassified

Published in Proc. Symposium on Electronic Waveguides, Polytechnic Inst. of Brooklyn, N. Y. (Apr. 8-10, 1958), N. Y., Interscience Publishers, 1958, p. 63-87.

For abstract see item no. PIB.09:029, Vol. II.

1721

Pomona Coll. [Dept. of Physics] Claremont, Calif.

ULTRASOFT X-RAY INTERACTION COEFFICIENTS, by B. L. Henke and J. C. Miller. Aug. 1959, 1v. incl. diagrs. tables. (Technical rept. no. 3) (AFOSR-TN-59-895) (AF 49(638)394) AD 229780   Unclassified

Also published in Proc. Second Internat'l. Symposium on X-ray Microscopy and X-ray Microanalysis, Stockholm (Sweden) (1959), New York, Elsevier, 1960, p. 10-29.

Ultrasoft x-radiations (10-100A in wavelength) are highly absorbed by matter so as to be particularly useful in microanalysis. Photoelectric cross-sections may be interpolated from universal absorption functions and used to deduce the transitional probabilities for a particular atom which in turn allow the evaluation of the quantum dispersion equations for the atomic scattering factors. Universal tabulated functions have been obtained in this manner for the atomic scattering factors. It is noted that this approach is particularly appropriate and precise for the ultrasoft region for which the ratio of the atomic diam to the wavelength is very small and thus only dipole interactions are effective. Atomic scattering factors have been tabulated for O, Al and Si; refractive indices have been obtained for Al, Al_2O_3, and SiO_2; and the reflected intensities from surfaces of Al, Al_2O_3 and SiO_2 and from layered combinations of these surfaces have been tabulated as a function of both wavelength and angle of reflection. These results have been used to illustrate the potentiality of ultrasoft x-radiations for application to the microanalysis for mass, chemical and surface structure information. (Contractor's abstract)

1722

Princeton U. Dept. of Aeronautical Engineering, N. J.

RESEARCH ON LAMINAR AND TURBULENT BOUNDARY LAYERS AND TRANSITION AT SUPERSONIC SPEEDS. Final rept. Nov. 14, 1952-Sept. 15, 1958, 9p. incl. refs. (AFOSR-TR-59-17) (AF 18(600)498) AD 264408   Unclassified

A summary is given of the major programs which have been carried out and some notes on unfinished work which did not show sufficient results for publication. A list of reports and published papers are included.

1723

Princeton U. [Dept. of Aeronautical Engineering] N. J.

NOTE ON THE SHOCK-INDUCED UNSTEADY LAMINAR

BOUNDARY LAYER ON A SEMI-INFINITE FLAT PLATE, by S. H. Lam and L. Crocco. [195] [3]p. incl. diagr. (AF 18(600)498)   Unclassified

Published in Jour. Aero/Space Sci., v. 26: 54-56, Jan. 1959.

Let a semi-infinite flat plate be immersed in a quiescent gas of infinite extent and let its leading edge be the origin of a coordinate system (x, y) with the plate occupying the positive x-axis. A plane shock wave perpendicular to the x-axis, advancing in the positive x direction with constant velocity U_s, reaches the leading edge of the plate at the instant $t = 0$. For $t \geq 0$, the shock travels over the plate. A boundary layer will develop on the plate between the leading edge and the moving shock. The gas velocity behind the shock is denoted by u_0, and the strength of the shock is characterized by the number A which is the ratio of the shock velocity U_s to u_0. The purpose of this note is to study this unsteady boundary layer under the following assumptions: (1) The boundary layer is laminar, (2) the boundary-layer approximations are valid, (3) the plane shock remains plane, (4) $\rho\mu$ = constant, and (5) $P_r = \mu c_p/k$ = constant.

1724

Princeton U. Dept. of Aeronautical Engineering, N. J.

A STUDY OF HYPERSONIC WINGS AND CONTROL, by S. M. Bogdonoff and I. E. Vas. [1959] [26]p. incl. refs. [IAS rept. no. 59-112] (AF 18(600)498) Unclassified

To facilitate study of hypersonic gliding and re-entry flight, experiments were made on single wings at Mach numbers between 11 and 19 in the Princeton Helium Hypersonic Tunnel, with emphasis on effect of sweep angle and angle of attack on pressure distribution. No correlation was found with geometrical theories (normal Mach numbers) but simple empirical relations were derived. Lift and moment of such wings deviate widely from such simple approximations as Newtonian flow.

1725

Princeton U. Dept. of Aeronautical Engineering, N. J.

THE STABILITY OF PROPELLANTS AND THE THEORY OF THERMAL IGNITION, by I. Glassman. May 1959, 19p. incl. diagrs. refs. (Rept. no. 460) (AFOSR-TN-59-586) (AF 18(600)1527) AD 217185; PB 142016 Unclassified

The concept of stability is investigated by considering the fundamentals of the stability process in light of the theory of thermal ignition. The stationary and

non-stationary theories of thermal explosion are analyzed mathematically. From the conditions described, a propellant may be less stable than another for one test, but this relative stability rating may be reversed completely for another test where a different time-temperature domain exists. For 2 propellant systems having the same activation energy, the more energetic system will be the more unstable when all other factors are kept the same. However, it is not necessarily true that all propellant systems have the same activation energy. A very energetic system with a high activation energy can be more stable in the low-temperature regions than a low-energetic system with a low activation energy. One single test cannot be used to rule out a propellant on stability grounds. A propellant should be evaluated on the basis of many different tests and on the consideration for the over-all system in which the propellant is to be used. Thus, if hydrodynamic shock cannot exist in a given system, but long term small temperature rises can, a propellant which is very poor by card gap standards may be better than a propellant excellent in all tests except thermal stability.

1726

Princeton U. Dept. of Aeronautical Engineering, N. J.

FURTHER STUDIES ON THE LIGHT SCATTERING TECHNIQUE FOR DETERMINATION OF SIZE DISTRIBUTIONS IN BURNING SPRAYS, I, by R. A. Dobbins, L. Crocco, and I. Glassman. Apr. 10, 1959, 37p. incl. diagrs. table, refs. (Rept. no. 463) (AFOSR-TN-59-700) (AF 18(600)1527) AD 220496; PB 143022
Unclassified

The importance of measuring the droplet size distribution in rocket motors in order to determine the effect of the significant physical and chemical parameters on the combustion process has long been evident. To date no satisfactory technique has been developed for the direct measurement of droplet size distributions of a burning or evaporating stream. The light scattering technique appears to offer the possibility of accomplishing this purpose and the development of this technique could be a major contribution to the combustion field in its own right. Early theoretical and experimental work in light scattering by spherical particles is re-examined and inconsistencies are pointed out. A revised no-multiple-scattering theory is offered which correctly predicts various limiting cases and repetition of earlier experimental work is in order. The experimental considerations limiting the size of the particles which can be measured are discussed and it estimated that the technique can be extended to include particles of the sizes formed in combustion chambers by injectors and atomizers. The possible adverse effects of scattering due o presence of thermal gradients present in combustors is considered. Experimental equipment which has been built to measure small-angle scattering is described. (Contractor's abstract)

1727

Princeton U. Dept. of Aeronautical Engineering, N. J.

METAL COMBUSTION PROCESSES, by I. Glassman. Aug. 1959, 37p. incl. diagrs. tables, refs. (Rept. no. 473) (AFOSR-TN-59-1093) (AF 18(600)1527) AD 228566; PB 145531
Unclassified

Presented at Fourteenth annual meeting of the Amer. Rocket Soc., Washington, D. C., Nov. 16-20, 1959.

Since the light metallic elements undoubtedly will play a greater and greater role as propellants in advanced chemical and nuclear-chemical propulsion systems, interest in their burning characteristic is increasing. Some preliminary conclusions on burning characteristics are presented. These conclusions are based on fundamental physical considerations and not on experimental results. An analytical approach to calculate the burning rate of metals is also suggested. This approach differs from the diffusion-droplet approach in that it includes radiation feed-back and loss terms. Such terms can be important at the high temperatures of the diffusion film surrounding a burning metal. The verification of many of the postulates given in this report can be carried out ideally at some later date on the high pressure double rocket motor flow reactor developed under the subject contract. (Contractor's abstract)

1728

Princeton U. [Dept. of Aeronautical Engineering] N. J.

NEWTONIAN FLOW THEORY IN HYPERSONIC AERODYNAMICS, by W. D. Hayes. [1958] [7]p. incl. diagrs. tables. [AF 49(638)465]
Unclassified

Presented at First Internat'l. Cong. for the Aeronaut. Sciences, Madrid (Spain), Sept. 8-13, 1958.

Also published in Advances in Aeronaut. Sciences, v. 1: 113-119, 1959.

A brief description is given of the body of theory known as Newtonian flow theory, the theory based on the assumption that the shock layer in a hypersonic flow is infinitesimally thin. The reasons why the study of this theory is essential to an understanding of hypersonic aerodynamics are emphasized. The accomplishments of Sir Issac Newton in gas dynamics are discussed, together with the development of the pressure laws referred to as Newtonian. Some of the features of the general theory are discussed, including optimum shapes for minimum drag and solutions with cross flow. (Contractor's abstract)

1729

Princeton U. Dept. of Aeronautical Engineering, N. J.

INTERACTION OF A TWO-DIMENSIONAL INVISCID INCOMPRESSIBLE JET FACING A HYPERSONIC STREAM, by S. H. Lam. Mar. 1959 [31]p. incl. diagrs. (Rept. no. 447) (AFOSR-TN-59-274) (AF 49(638)465) AD 212708; PB 146018   Unclassified

A modified Newtonian pressure formula on the jet-shock layer interface is adopted in this report, and several assumptions are made regarding this formula as follows: (1) it is valid only for steady flow; (2) the jet flow is inviscid incompressible, and irrotational (the Laplace equation is established as the governing equation); (3) the problem is 2-dimensional; and (4) the total pressure of the jet equals the P_s when the jet is direct-

ly opposed to the oncoming stream. Within the framework of the above assumptions, it is demonstrated that any potential flow – hypersonic flow interaction problem may be treated if the stream lines of the potential flow can readily be drawn on the hodograph plane.

1730

Princeton U. Dept. of Aeronautical Engineering, N. J.

APPROXIMATE SOLUTIONS FOR SUPERSONIC FLOW OVER WEDGES AND CONES, by A. G. Hammitt and K. R. A. Murthy. Apr. 1959 [19]p. incl. diagrs. (Rept. no. 449) (AFOSR-TN-59-304) (AF 49(638)465) AD 213088; PB 146007   Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 71-73, Jan. 1960.

Approximate solutions for the supersonic flow of a gas at relatively high Mach numbers over wedges and cones are presented. These methods provide simple and accurate results over a wide range of Mach number and specific heat ratios. (Contractor's abstract)

1731

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON THE NEWTONIAN THEORY OF HYPERSONIC FLOW FOR A BLUNT BODY, by N. C. Freeman. May 1959, 13p. (Rept. no. 467) (AFOSR-TN-59-634) (AF 49(638)465) AD 220140   Unclassified

The Hayes-Serbin theory of Newtonian hypersonic inviscid flow past blunt bodies is derived by a formal expansion procedure in powers of $(\gamma-1)/(\gamma+1)$. The theory is shown to be a uniformly valid extension of the Newtonian hypersonic flow past blunt bodies. Particular attention is given to the solution to the flow past a sphere where the original bluff body result is shown to be valid in the neighborhood of the stagnation point. (Contractor's abstract)

1732

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON A SINGULAR POINT IN THE NEWTONIAN THEORY OF HYPERSONIC FLOW, by N. C. Freeman. May 1959 [28]p. incl. diagrs. tables, refs. (Rept. no. 466) (AFOSR-TN-59-635) (AF 49(638)465) AD 220139   Unclassified

Also published in Jour. Fluid Mech., v. 8: 109-122, May 1960.

An examination of the Newtonian inviscid theory of hypersonic flow past a sphere is made in the neighborhood of the singular point which occurs at $\Theta = 60°$. A uniformly valid theory is developed in this neighborhood which exhibits the limiting detached "free layer" behavior postulated by Hayes and Lighthill in the limit as $\gamma \to 1$. A complete solution is obtained which gives details of streamline and shock wave shape, pressure distribution, etc., for $(\gamma-1)$ small. Reasons are given why this theory suggests that the empirical "modified" Newtonian theory of Lees. (Hypersonic Flow, IAS Preprint no. 554, 1955) proves to be good approximation to experimentally determined pressure distributions. A novel check to the theory is provided by a simple power law relation between the pressure on the sphere surface and the distance of the shock wave away from sphere at the same point. (Contractor's abstract)

1733

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON THE LIMITING STRUCTURE OF THE EDGE OF A HYPERSONIC BOUNDARY LAYER WITH VERY COLD FREE STREAMS, by N. C. Freeman and S. H. Lam. May 1959 [23]p. incl. diagr. tables. (Rept. no. 468) (AFOSR-TN-59-690) (AF 49(638)465) AD 240233; PB 149753   Unclassified

The structure of the edge of a hypersonic boundary layer in the limit of zero free stream temperature is analyzed with conventional boundary layer approximations for a gas with arbitrary Prandtl number Pr and

and viscosity law $\mu \propto T^s$. It is shown that for certain combinations of Pr and s the velocity profile has a discontinuity in slope at the edge of the boundary layer. The boundary layer thickness in this limit is always finite for S > -1. For S < -1 no limiting solution exists for any Pr. (Contractor's abstract)

1734

Princeton U. Dept. of Aeronautical Engineering, N. J.

HEAT TRANSFER THROUGH A REGION OF CLOSED-STREAMLINE, by S. H. Lam. May 1959, 22p. (Rept. no. 469) (AFOSR-TN-59-727) (AF 49(638)465)   Unclassified

It has been shown that the pertinent parameter in this class of problem is the Peclet number $\lambda = R_e P_r$. Since this number contains a characteristic length, the solution is not invariant with respect to a scale transformation. When λ is small, the solution tends to the simple conduction solution, which is invariant with respect to a scale transformation. For any $\lambda > 0$ and for any steady flow pattern, the gross heat transfer rate through the region is always higher than Q_0. For small λ, the increase of gross heat transfer rate is proportional to λ^2. For large λ, the gross heat transfer rate is proportional to $\lambda^{1/3}$. Both results are for $\Phi = 0$ only. Dissipation in the region will, in general, increase the heat transfer rate through the cold boundary and decrease the heat transfer rate through the hot boundary. (Contractor's abstract)

1735

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON THE MACH NUMBER INDEPENDENCE PRINCIPLE FOR A HYPERSONIC BOUNDARY LAYER, by N. C. Freeman and S. H. Lam. July 1959, 13p. (Rept. no. 471) (AFOSR-TN-59-728) (AF 49(638)465) AD 233046; PB 157732   Unclassified

The Mach number independence principle for a hypersonic viscous boundary layer postualted by Hayes and Probstein is considered for the case of a flat plate with no heat transfer. The structure of the boundary layer is given, and the transition solution in the neighborhood of the edge of the boundary layer is constructed. This transition layer, in which the boundary layer adjusts to the free stream conditions, is shown to have a thickness scale proportional to $(M_\infty)^{-1-S}$ as originally suggested. The values of density, temperature and velocity across this layer are determined explicitly in terms of velocity and implicitly in terms of velocity and implicity as functions of boundary layer coordinates. (Contractor's abstract)

1736

Princeton U. Dept. of Aeronautical Engineering, N. J.

NUMERICAL SOLUTIONS OF SHOCK-INDUCED UN-STEADY BOUNDARY LAYERS, by S. H. Lam. Aug. 1959 [37]p. incl. diagrs. tables. (Rept. no. 480) (AFOSR-TN-59-926) (AF 49(638)465) PB 147265   Unclassified

This report is a supplement to PRI.04:023, Vol. II. Numerical solutions for the shear function $\Phi(\alpha, \beta)$ and the Reynolds analogy coefficient (Ra) are presented. The calculations were performed on the Wright Field Univac Scientific 1103 digital computer using the Wright Field "CHIP" interpretive system. It was found that the iteration procedure suggested in the above report was suc-

cessful in generating solutions of good accuracy for the shear function $\Phi(\sigma, \beta)$. However, because of the lack of a suitable "momentum integral correction" procedure, the iteration for the enthalpy function $H(\sigma, \beta)$ was found to be unsatisfactory. (Contractor's abstract)

1737

Princeton U. [Dept. of Aeronautical Engineering] N. J.

COMBUSTION INSTABILITY IN SOLID ROCKETS USING PROPELLANTS WITH SUSPENDED METALLIC POWDERS, by S.-I. Cheng. Sept. 1959 [32]p. (Rept. no. 482) (AFOSR-TN-59-1002) (AF 49(638)465) AD 231172; PB 157720   Unclassified

Also published in Proc. First Internat'l. Symposium on Rockets and Astronautics, Tokyo (Japan) (May 25-28, 1959), Tokyo, Yokendo, 1960, p. 62-73.

The stability of the acoustic oscillations in the chamber of a solid propellant rocket is analyzed to reveal the effect of the addition of the metallic powders to a basic solid propellant. The dissipative action of the oscillation of the particles in the condensed phases is neglected. The oxidation of the metallic powders is considered as distributed heat sources to the gas system. The heat addition distorts the acoustic field through the variation of the speed of sound over the chamber volume. This modifies the non-dissipative damping action of the supercritical nozzle. The rate of heat release from the metallic powders may fluctuate but lag behind the local gas oscillation. This oscillatory heat source from the oxidation of the metallic powders, like the oscillatory mass source from the combustion of the basic propellant, can excite unstable oscillations of the gas system. The 2 exciting forces are, however, out of phase, in general, and may or may not counteract each other. (Contractor's abstract)

1738

Princeton U. Dept. of Aeronautical Engineering, N. J.

THE BOUNDARY LAYER IN A CORNER, by S.-I. Cheng and R. H. Levy. Nov. 1959 [45]p. incl. diagrs. tables, refs. (Rept. no. 485) (AFOSR-TN-59-1165) (AF 49-(638)465) AD 232955; PB 157741   Unclassified

The problem of the incompressible boundary layer between 2 semi-infinite flat plates whose line of intersection is parallel to the incoming flow and whose leading edges are perpendicular to it is treated for arbitrary angle between the plates. A series expansion valid at small distances from the corner is developed; the 1st term is derived from consideration of the creeping flow in which convective forces are negligible compared to pressure and viscous forces. An asymptotic solution is obtained for the case when the angle between the plates is less than π; it is based upon an estimate of the form of the flow in the transverse plane far from the corner which is generally non-vanishing

in the boundary layer approximation. This solution is matched to the series solution for various values of the angle between the plates, and consistent numerical results are obtained. (Contractor's abstract)

1739

Princeton U. [Dept. of Aeronautical Engineering] N. J.

ON THE FLOW PAST A SPHERE AT HYPERSONIC SPEED WITH A MAGNETIC FIELD, by N. C. Freeman. [1959] [3]p. (AFOSR-4159) (AF 49(638)465)
Unclassified

Also published in Jour. Aero/Space Sci., v. 26: 670-672, Oct. 1959.

An explanation is given on the anomalies between the constant density solution to the hypersonic inviscid flow past a sphere with a radial magnetic field in a conducting fluid obtained by Kemp and the author's extension of the Newtonian theory of hypersonic flow to magnetic field problems. It is found that Kemp's result is incorrect as the 1st approximation in some expansion procedure vanishes, causing a singular behavior in the higher order terms. A scheme outlined by Lighthill for making such approximations uniformly valid is then developed. The result obtained is in agreement with that obtained from the Newtonian theory when a magnetic field and a conducting fluid are introduced.

1740

Princeton U. [Dept. of Aeronautical Engineering] N. J.

A NOTE ON THE EXPLOSION SOLUTION OF SEDOV WITH APPLICATION TO THE NEWTONIAN THEORY OF UNSTEADY HYPERSONIC FLOW, by N. C. Freeman. [1959] [2]p. (AFOSR-4160) (AF 49(638)465)
Unclassified

Published in Jour. Aero/Space Sci., v. 27: 77-78, Jan. 1960.

The Sedov solution of the equations of inviscid compressible unsteady flow is analyzed in the limiting form where the ratio of specific heats approaches zero. The Newtonian theory of unsteady flow is then developed and it is shown that the assumption of Newtonian theory that breaks down in the derivation of the constant-energy similarity solution of Sedov is that of isothermal conditions along particle paths. The Newtonian theory is able, by modification of this assumption alone, to give the correct non-uniform dependence in the limit as $\gamma \to 1$.

1741

Princeton U. [Dept. of Aeronautical Engineering] N. J.

VISCOUS HYPERSONIC SIMILITUDE, by W. D. Hayes

and R. F. Probstein. [1959] [23]p. incl. diagrs. [IAS rept. no. 59-63] (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)... and Wright Air Development Center under AF 33(616)5442)
Unclassified

Presented at Twenty-Seventh annual meeting of the Inst. of Aeronaut. Sciences, New York, Jan. 26-29, 1959.

An extension of classical hypersonic similitude is developed which takes into account the interaction effect of the displacement thickness of the boundary layer. A basic result of this viscous similitude is that the total drag including frictional drag obeys the classical similarity law for the pressure drag. Additional similarity conditions governing viscous effects must be imposed in this similitude. Underlying the similitude is a new hypersonic boundary layer independence principle. According to this principle, the principal part of a hypersonic boundary layer with given pressure and wall temperature distributions and free stream total enthalpy is independent of the (high) external Mach number distribution outside the boundary layer. Various features of viscous hypersonic similitudes are discussed. It is found, for example, that it applies to three-dimensional boundary layer interaction effects on flat bodies provided the concepts of strip theory may be applied and provided the aspect ratio is an invariant. (Contractor's abstract)

1742

Princeton U. Dept. of Chemistry, N. J.

CHEMICALLY INDUCED VIBRATIONAL EXCITATION: HYDROXYL RADICAL EMISSION IN THE 1-3 MICRON REGION PRODUCED BY THE H + O_3 ATOMIC FLAME,

by D. Garvin, H. P. Broida and H. J. Kostkowski. Aug. 24, 1959 [23]p. incl. diagrs. tables, refs. (Technical note no. 5) (AFOSR-TN-59-746) (In cooperation with National Bureau of Standards, Washington, D. C. CSO-680-56-30) (AF 18(603)134) AD 226573
Unclassified

Also published in Jour. Chem. Phys., v. 32: 880-887, Mar. 1960.

A detailed investigation was performed in the 1 to 3 u wavelength region on the radiation emitted by the hydroxyl radical from a low pressure flame of ozonized oxygen and atomized hydrogen. Wavelengths and photon intensities were obtained for about 300 lines in the OH vibration-rotation bands V → V -ΔV where ΔV = 3, V = 9 to 5 and for ΔV = 2, V = 9 to 2. Relative photon band intensities were determined from the overdetermined set of data by a method of successive approximations using an IBM-650 computer. Dipole moment parameters were calculated using the above data and Morse Oscillator transition probabilities. Approximate rotational and vibrational Boltzmann distributions exist with an average rotational "temperature" of 560°K for the P branches, 460°K for the R and Q branches and a vibrational "temperature" of 9250°K for the ΔV = 2 and 3 bands. The

absence of radiation from levels V > 9 confirms the non-thermal character of the excitation and its dependence on the energetics of the reaction $O_3 + H \rightarrow OH + O_2$.

Moreover, flux calculations based on the assumption that in this case collisional deactivation transition probabilities are proportional to the radiation probabilities show that there is an appreciable OH production in all levels V ≤ 9, and the main flux of OH through any population level is via $\Delta V = 1$ transitions. Possible causes for the large changes in line intensity with pressure and smaller but significant changes with flows or concentrations are discussed. (Contractor's abstract)

1743

Princeton U. Dept. of Chemistry, N. J.

THE THERMAL OZONE-HYDROGEN REACTION, by T. P. Williams and D. Garvin. Sept. 15, 1959 [35]p. incl. diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-59-979) (AF 18(603)134) AD 228326; PB 144019   Unclassified

The kinetics of the reaction between dilute ozone and molecular hydrogen has been studied in the temperature range 400-500°K using a flow technique. Water is the principal product, small amounts of hydrogen peroxide also are formed. The reaction competes with the thermal decomposition of ozone. It is concluded that the oxidation of hydrogen is initiated by oxygen atoms formed in the thermal decomposition of ozone, and that a short chain sequence occurs. Mechanisms involving either OH or both OH and HO_2 are presented. (Contractor's abstract)

1744

Princeton U. [Dept. of Mathematics] N. J.

THE THEORY OF CHARACTERISTIC CLASSES, by J. Milnor. [1959] 144p. incl. diagrs. refs. (AFOSR-TN-59-9) (AF 18(600)1494) AD 208281; PB 139634
                                            Unclassified

Lectures are presented on the following topics: n-plane bundles; Stiefel-Whitney classes; Applications; Stiefel-Whitney numbers; Paracompactness; The cohomology ring $H^*(G_n, Z_2)$; Existence of Stiefel-Whitney classes; Oriented bundles; Computations in differentiable manifolds; Obstructions; Complex n-plane bundles; Pontrjagin classes; Pontrjagin numbers; Corbordism; The index theorem; Combinatorial Pontrjagin classes.

1745

[Princeton U. Dept. of Mathematics, N. J.]

ON SEMISIMPLICIAL FIBRE-BUNDLES, by M. G. Barratt, V. K. A. M. Gugenheim, and J. C. Moore.

[1959] [19]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)-1494 and Office of Ordnance Research under DA 36-034-ORD-2588RD)   Unclassified

Published in Amer. Jour. Math., v. 81: 639-657, July 1959.

A study is made of semisimplicial fibre bundles and in order to show how general fibre bundles are. It is shown that a minimal fibre map is, in fact, the map of the total complex of a semisimplicial fibre bundle into the base complex. In the description of a semisimplicial fibre-bundle with fibre Y there occurs a certain group-complex A(Y) or, more generally, one of its subgroups Γ; the consequential notion "Γ-bundle" is the semisimplicial analogue of a Steenrod fibre bundle with structural group Γ. In particular the classical notions of the associated principal bundle and the classifying space reappear in theory.

1746

Princeton U. [Dept. of Mathematics] N. J.

OBSTRUCTIONS TO THE SMOOTHING OF PIECE-WISE-DIFFERENTIABLE HOMEOMORPHISMS, by J. Munkres. [1959] [3]p. (AF 18(600)1494)
                                            Unclassified

Published in Bull. Amer. Math. Soc., v. 65: 332-334, Sept. 1959.

A unification and extension within the framework of an obstruction theory of some of the results concerning Milnor and Thom's differentiable structures are presented. If M and N are diffeomorphic, then they are combinatorially equivalent; a partial converse of this is sought. An attempt is made to redefine f in neighborhoods of the open simplices of M. Thus f is no longer a linear isomorphism between C^2 triangulations. If f:M → N is a diffeomorphism mod L^{m-1}, an approximate f by a map g:M → N which is a diffeomorphism mod L^{m-1} can be sought. This method permits, among others, the demonstration of known results for the differentiable structures.

1747

Princeton U. [Dept. of Mathematics] N. J.

GENERAL ANALYTICAL SETTING FOR THE CENTRAL LIMIT THEORY OF PROBABILITY, by S. Bochner. [1959] [18]p. [AF 49(636)578]   Unclassified

Published in Bull. Calcutta Math. Soc. (Golden Jubilee Commemorative Volume), pt. 1: 111-128, 1958-1959.

Some first observations are presented on possibilities that can occur when the positive-definiteness is either

relaxed or modified in a Fourier transform of a probability distribution. It is pointed out that the control limit theory is concerned with the behavior of a product of sufficiently many products each of which is sufficiently near to the unity function.

1748

Princeton U. Dept. of Mathematics, N. J.

GENERALIZED CONJUGATE AND ANALYTIC FUNCTIONS WITHOUT EXPANSIONS, by S. Bochner. [1959] [3]p. [AF 49(638)578]   Unclassified

Published in Proc. Nat'l. Acad. Sci., v. 45: 855-857, June 1959.

Complex-valued measurable functions are considered on a Lebesgue measure space with total measure finite or infinite. A theorem is presented which is an axiomatic generalization of a basic theorem of M. Riesz for functions on 1 variable, and the existence of finite bounds of the operator over the functions is established. A related Hausdorff space with a Borel measure is also considered and a theorem presented which is an axiomatization of a multi-variable version. Other theorems of these 2 are also discussed under the new assumptions.

1749

Princeton U. [Dept. of Mathematics] N. J.

ALGEBRAS OF HOLOMORPHIC FUNCTIONS ON ONE-DIMENSIONAL VARIETIES, by H. Rossi. Oct. 1959, 37p. incl. refs. (AFOSR-TN-59-1179) (AF 49(638)692) AD 231970; PB 145771   Unclassified

Also published in Trans. Amer. Math. Soc., v. 100: 439-458, Sept. 1961.

One-dimensional analytic spaces are studied with emphasis on the maximality problem of the algebra of holomorphic functions on a compact subset, first considered for Riemann surfaces by John Wermer (IAS.05:-021, Vol. II). It is proven that this is the only case where such an algebra is maximal. Representations of subalgebras of holomorphic functions on Riemann surfaces as algebras on an analytic is also considered. (Contractor's abstract)

1750

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXIX. DIELECTRIC RELAXATION AND GROUP ROTATION IN SOME AROMATIC METHOXY COMPOUNDS, by D. M. Roberti and C. P. Smyth. [1959] [5]p. incl. diagr. tables, refs. (AFOSR-TN-59-689) [AF 18(600)1331]   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 2105-2110, May 5, 1960.

The effect on dielectric relaxation of rotation of the methoxy group has been studied by a series of measurements on anisole, o-dimethoxybenzene, m-dimethoxybenzene, p-dimethoxybenzene, 1-methoxynaphthalene, 2-methoxynaphthalene and p-chloroanisole. Comparison of these values with those for the analogs, where a methyl group has been substituted for each methoxy group, shows that the presence of a methoxy group causes a lowering of the relaxation time below the expected value. Two distinct dispersion regions were indicated for o-dimethoxybenzene, as might be expected for a molecular rotation and a methoxy group rotation. The value for 1-methoxynaphthalene is higher than that for 2-methoxynaphthalene because of the hindrance to rotation of the methoxy group of the 1-isomer by the hydrogen on the 8-carbon. Mutual viscosities have been determined for benzene solutions of o-dimethoxybenzene, p-dimethoxybenzene, 1-methoxynaphthalene, 2-methoxynaphthalene, p-chloroanisole and 1-nitronaphthalene. Reduced relaxation times of the liquids have been compared with the solution values reduced by the solvent viscosity and by the mutual viscosity. (Contractor's abstract)

1751

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXVIII. THE DIELECTRIC RELAXATION OF SOME RIGID MOLECULES IN VISCOUS SOLUTIONS, by O. F. Kalman and C. P. Smyth. [1959] [5]p. incl. diagrs. tables, refs. (AFOSR-TN-59-729) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1331] and Office of Ordnance Research) AD 245262   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 783-787, Feb. 20, 1960.

The dielectric constants and losses at wave lengths of 1.25, 3.22, 10, 25 and 50 cm, and 300 m have been measured for d,l-camphor, isoquinoline and 4-bromobiphenyl in solution in a viscous oil, and for acridine in the oil and in decalin at 20, 40 and 60°. The Cole-Cole arc plots have been used to calculate the most probable dielectric relaxation times for the solutions and their distribution parameters. The effect of viscosity on relaxation time increases from the slight viscosity dependence for the nearly spherical camphor molecule to a considerable dependence for the elongated molecules. Over this same range of molecular shape the activation energy for dielectric relaxation increases from a small value for the nearly spherical molecule to a value close to that for viscous flow for the elongated molecules. Where there is a possibility of more than 1 relaxation time for a molecule, the highly viscous solvent tends to increase the separation or distribution of the times. (Contractor's abstract)

1752

Princeton . Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUC-
TURE IN LIQUIDS. XXX. THE ANOMALOUS DIELEC-
TRIC RELAXATION OF DIPHENYL ETHER AND SOME
SIMILAR MOLECULES, by D. M. Roberti, O. F.
Kalman, and C. P. Smyth. [1959] [4]p. incl. tables,
refs. (AFOSR-TN-59-1224) (Sponsored jointly by Air
Force Office of Scientific Research under [AF 18(600)-
1331] and Office of Ordnance Research) AD 245263
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 3523-
3526, July 20, 1960.

Dielectric relaxation times have been determined for
diphenylmethane, benzyl ether, bibenzyl and dibenzyl
ether, as pure liquids, to be compared with previous
values for diphenyl ether and benzophenone. All the
measured compounds have relaxation times comparable
to that for diphenyl ether, very low in comparison to
that for benzophenone. In addition, the relaxation time
of diphenyl ether measured in Nujol has been found to
be relatively insensitive to viscosity and temperature.
The results indicate that some form of intramolecular
motion is responsible for the small relaxation time.
Several previously proposed mechanisms are dis-
cussed. (Contractor's abstract)

1753

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUC-
TURE IN LIQUIDS. XXXI. ANALYSIS IN TERMS OF
TWO RELAXATION TIMES FOR SOME AROMATIC
ETHERS, by K. Bergmann, D. M. Roberti, and C. P.
Smyth. [1959] [3]p. incl. diagr. tables, refs. (AFOSR-
TN-59-1319) (AF 18(600)1331) Unclassified

Also published in Jour. Phys. Chem., v. 64: 665-667,
May 1960.

Dielectric measurements on diphenyl ether, dibenzyl
ether, anisole and o-dimethoxybenzene have been anal-
yzed in terms of 2 relaxation times. The results are
consistent with the interpretation of a large relaxation
time due to molecular rotation and a smaller relaxation
time due to intramolecular motion, notably methoxy
group rotation for anisole and o-dimethoxybenzene. The
data for dibenzyl ether have also been analyzed in
terms of a distribution of relaxation times between 2
limiting values. (Contractor's abstract)

1754

Princeton U. Frick Chemical Lab., N. J.

DIELECTRIC INVESTIGATION OF POLAR MOLE-
CULES IN LIQUIDS AND SOLIDS, by C. P. Smyth.

Final rept. Nov. 1, 1954-Dec. 31, 1958, 11p. incl. refs.
(AFOSR-TR-59-22) (AF 18(600)1331) AD 211668,
PB 139904 Unclassified

The limitations of the equations for the effect of the in-
ternal field upon molecular relaxation time have been
established and the relation of the molecular to the
macroscopic relaxation time has been found to depend
on the shape of the molecule as well as on the dielec-
tric constant of the liquid. An approximate proportion-
ality between the relaxation time and the volume of a
rigid molecule has been observed but the orientation of
the dipole in a non-spherical molecule influences the
relaxation time by determining the most probable axis
about which the molecule may rotate, thus complicating
the relationship. In pure polar liquids, the relaxation
time is often roughly proportional to the viscosity but
some increases in molecular volume which increase the
relaxation times have little effect on the viscosities. In
solutions, increase in solvent viscosity with increase in
molecular size does not generally bring about a propor-
tionate increase in the relaxation time of the polar solute
molecule, although some increase is usually observed.
This complexity of behavior prevents any of the several
equations so far advanced for these phenomena from be-
ing generally valid. However, the observation of the de-
viations as well as the regularities provides valuable evi-
dence of the mechanism of molecular behavior in liquids.
The measurement of the dielectric constants and losses
of liquids at 3.1 mm. wavelength extended such measure-
ments to a higher frequency than any previously attained.

1755

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR
STRUCTURE IN LIQUIDS. XXVII. THE MUTUAL VIS-
COSITIES AND DIELECTRIC RELAXATION TIMES OF
SEVERAL POLAR AROMATIC COMPOUNDS IN SOLU-
TION, by D. A. Pitt and C. P. Smyth. [1959] [4]p. incl.
diagrs. tables, refs. (Sponsored jointly by [Air Force
Office of Scientific Research under AF 18(600)1331]
and Office of Naval Research) AD 248758
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 783-
786, Feb. 20, 1959.

The viscosities of dilute solutions of 7 polar solutes in
2 non-polar solvents have been measured at 20, 40 and
60°C, and the slopes of the viscosity-concentration
plots have been used to calculate the mutual viscosities.
The use of these values in an equation developed by
Hill for the calculation of the relaxation times of the
solutions gives values considerably higher than the ob-
served. (Contractor's abstract)

1756

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR

STRUCTURE IN LIQUIDS. XXVI. THE DIELECTRIC
RELAXATION TIMES OF TWO LARGE OBLATE
ELLIPSOIDAL MOLECULES IN BENZENE SOLUTION,
by D. A. Pitt and C. P. Smyth. [1959] [6]p. incl. diagrs.
tables, refs. (Sponsored jointly by [Air Force Office
of Scientific Research under AF 18(600)1331] and
Office of Naval Research) AD 248759   Unclassified

Also published in Jour. Phys. Chem., v. 63: 582-587,
Apr. 1959.

The dielectric relaxation times of metal-free hepta-
phenylchlorophenyl-porphyrazine (I) and of ferric octa-
phenylporphyrazine chloride (II) have been determined
in benzene solution, based on dielectric constant data
at 1.25, 3.22, 10.0, 25.0 and 50.0 cm wave lengths at
temperatures of 20, 40 and 60°. The dipole moment of
I lies in the plane of the great ring, while that of II is
perpendicular to the molecular plane. The relaxation
time of the former is close to that calculated by equa-
tions taking into account the microscopic viscosity. The
ferric complex, with a relaxation time 5/2 that of I is
better described by a relation involving the macroscopic
solvent viscosity. It is evident that relaxation occurs
through 2 different modes of orientation. A new dielec-
tric measuring apparatus is described, consisting of a
coaxial line resonant cavity. The transmission-line
equations provide a simple derivation of the transmis-
sion of power through the cavity as a function of the
cavity dimensions and of the dielectric properties of
the liquid filling the cavity. The apparatus is usable
over a wide frequency range and is especially applica-
ble to measurements of the dielectric constant and loss
of dilute solutions. (Contractor's abstract)

1757

Princeton U. James Forrestal Research Center, N. J.

SOME EFFECTS OF INTRAMOLECULAR VIBRA-
TIONAL ENERGY TRANSFER IN COMPLEX FLUOR-
ESCENT MOLECULES, by B. Stevens. [1958] [6]p.
incl. diagrs. refs. (AF 33(038)23976)   Unclassified

Published in Canadian Jour. Chem., v. 36: 96-101,
Jan. 1958.

The effects of intramolecular redistribution of vibra-
tional energy on both the fate of an excited complex
molecule and the appearance of its electronic spectra
are discussed in terms of a 3-dimensional energy sur-
face. It is suggested that continuous absorption be
used as a criterion for the application of classical
methods to intra- and inter-molecular vibrational
energy transfer in those cases where fluorescence
emission is observed. (Contractor's abstract)

1758

Princeton U. James Forrestal Research Center, N. J.

BASIC RESEARCH IN PHYSICAL AND CHEMICAL KI-

NETICS RELATED TO PROBLEMS OF COMBUSTION
AND PROPULSION, by R. H. Wilhelm. Final rept.
Nov. 4, 1959, 14p. incl. refs. (AFOSR-TR-59-174)
(AF 33(038)23976) AD 231830; PB 145685
Unclassified

A summary of the research in physical and chemical
kinetics conducted under this contract is presented.
The work was concerned with the following topics:
(1) High temperature flow kinetics of the hydrogen-
bromine and/or hydrogen iodine reaction. (2) Ki-
netics and mechanisms of the decomposition of ammo-
nium nitrate and various amine nitrates. (3) Energy ex-
change processes in molecular collisions. (4) Kinetics
and mechanism of the reactions between nitric acid and
saturated hydrocarbons. (5) Kinetics of the carbon mon-
oxide-ozone system. (6) Flame stabilization at sur-
faces. A brief recapitulation is presented on each of the
above.

1759

Princeton U. James Forrestal Research Center, N. J.

DETERMINATION OF DIFFUSION COEFFICIENTS IN
SOLIDS BY THE RESIDUAL ACTIVITY METHOD, by
R. H. Condit. Feb. 1959 [17]p. incl. diagrs. tables.
(Metallurgy rept. no. 19) (AFOSR-TN-59-150) (AF 18-
(600)967) AD 210984; PB 140812   Unclassified

The determination of diffusion coefficients in solids
with radioactive tracers is discussed with special ref-
erence to the frequently used, residual activity method.
In this method the profile of tracer concentration after
diffusion into the solid from a flat, plated surface is
determined from measurements of the activity remain-
ing in the solid following removal of successive layers
from the surface. The proper procedure for relating
the count of activity after each cut to the actual concen-
tration of tracer is presented, necessary correction
factors which were computed are given graphically,
and their use is illustrated by application to an actual
experimental case. (Contractor's abstract)

1760

Princeton U. [James Forrestal Research Center] N. J.

ATOMIC DIFFUSION IN IRON SULFIDE STUDIED AS
PART OF A PROGRAM OF RESEARCH ON THE HIGH
TEMPERATURE CORROSION OF METALS, by R. H.
Condit. [1959] [11]p. incl. diagrs. (AFOSR-TN-59-
1180) (AF 18(600)967)   Unclassified

Presented at meeting of the Sixth annual ARDC Science
and Engineering Symposium, Washington, D. C., Oct.
1-2, 1959.

Some factors controlling atomic diffusion were studied
using ferrous sulfide as a medium. Diffusion measure-
ments were carried out with conventional radioactive
tracer technique. In ferrous sulfide at about 300°C,

compositions near that of Fe_7S_8 were observed. Dis-
cussion of the obtained results showed that metal dif-
fusion was controlled by crystal structure, the concen-
tration of vacancies in Fe-lattice sites and the mobility
of these vacancies as they become reduced by ordering
forces at low temperatures.

1761

Princeton U. James Forrestal Research Center, N. J.

THE OXIDATION OF METALS AND ALLOYS. Final
rept. Sept. 1, 1953-Dec. 31, 1958 [39]p. incl. illus.
diagrs. tables, refs. (AFOSR-TR-59-43) (AF 18(600)-
967) AD 214525   Unclassified

Contributions of this project are classified under the
following topics: (1) The absorption of non-collimated
radiation in the experimental measurement of diffusion
coefficients by tracer techniques; (2) The plasticity of
oxidizers and the effect of pores and cracks on the ki-
netics of oxidation of metals; (3) The role of defects in
oxide and sulfide crystals on conductivity, diffusion,
and scale growth; (4) Metal-sulfide equilibria for the
PbS-Pb, WS_2-W, and Rh_8S_7-Rh pairs; (5) The Fe-Ni-O
equilibria and the course of the oxidation reaction of
iron-nickel alloys; and (6) The variation of self-diffu-
sivity in the Curie point of alpha iron. See Vols. I and
II for reports completed under this contract.

1762

Princeton U. James Forrestal Research Center, N. J.

THE ROLE OF SPINEL OXIDES IN THE OXIDATION
OF IRON AND ITS ALLOYS, by C. E. Birchenall.
[1959] [4]p. incl. refs. (AFOSR-3561) (AF 18(600)-
967)   Unclassified

Published in Zeitschr. Elektrochem., v. 63: 790-793,
1959.

Alloying elements in iron may decrease the rate of
oxidation by lowering the composition range of wüstite
or by eliminating it as a stable phase in the presence
of the alloy and spinel phases. Additional protection
may be obtained if the alloying element lowers the
range of defect concentration in the spinel phase or de-
creases the ion mobilities. A sufficiently great de-
crease in mobilities of the cations may lead to anion
control of the spinel growth rates. A working hypothe-
sis to be used as a guide to diffusion studies in spinels
is presented. (Contractor's abstract)

1763

Princeton U. James Forrestal Research Center, N. J.

A REDETERMINATION OF THE LEAD-LEAD SULFIDE

EQUILIBRIUM BETWEEN 585° AND 920°C, by J. R.
Stubbles and C. E. Birchenall. [1959] [4]p. incl. diagr.
table. (AFOSR-3563) (AF 18(600)967)   Unclassified

Also published in Trans. Metall. Soc. AIME, v. 215:
535-538, June 1959.

The equilibrium between lead, lead sulfide, and circu-
lating atmospheres of hydrogen and hydrogen sulfide
was measured between 585° and 920°C. The equilibrium
atmospheres were analyzed by an iodometric method.
The data may be represented by a linear free-energy
equation, whose enthalpy and entropy terms have asso-
ciated errors of ∓ 1 kcal and ∓ 1 e.u. Reasons are
given for accepting the new data in preference to that
which already exists. (Contractor's abstract)

1764

Princeton U. James Forrestal Research Center, N. J.

SELF-DIFFUSION IN ALPHA IRON, by C. E. Birchenall
and R. J. Borg. Oct. 1959 [18]p. incl. diagrs. refs.
(Metallurgy rept. no. 20) (AFOSR-TN-59-1085) (AF 49-
(638)533) AD 227069; PB 144006   Unclassified

Also published in Trans. Metall. Soc. AIME, v. 218:
980-984, Dec. 1960.

The self-diffusion coefficients for α-iron have been
determined between 980°C to 1167°K using Fe^{55} as the
tracer. With decreasing temperature the diffusivity
was found to decrease more rapidly than predicted by
the Arrhenius equation in the region of the Curie tem-
perature. The diffusion coefficients obtained well
above the temperature of the magnetic transformation
are more precise and differ substantially from all the
previously reported values. In the temperature region
beginning at least 50°C above T_c the diffusion coeffi-
cient is given by $D = 118 (\pm 2) \exp (-67240/RT)$ sq cm
sec^{-1}. This is the 1st known clearcut demonstration
that the diffusivities in solids may depend on tempera-
ture in a clearly non-exponential fashion over a con-
siderable range of temperature without the known in-
tervention of impurity control of the defect population.
The phenomenological characteristics of the results
strongly support short range spin ordering as the
source of the effect, but the theory so far developed is
very crude and of qualitative value only. A short range
order treatment of a ternary system - spins up, spins
down and spins missing - is required. (Contractor's
abstract)

1765

Princeton U. Palmer   vsical Lab.. N. J.

THE PHYSICAL NUC.   N IN STATIC SOURCE
MESON THEORY, by F.   Halpern, L. Sartori and
others. [1959] [20]p. incl. tables, refs. (Sponsored

jointly by Air Force Office of Scientific Research under [AF 49(638)304], Atomic Energy Commission, and Office of Naval Research)   Unclassified

Published in Ann. Phys., v. 7: 154-173, June 1959.

A wave function for the physical nucleon in static source meson theory was constructed by the method of moments. The wave function includes contributions from states containing as many as 5 mesons, and is shown to be a good approximation to the ground state of the Hamiltonian. Because of the restrictive nature of the static model, the probability that the meson cloud have a particular angular momentum or isotopic spin turns out to be almost independent of the dynamics of the system. Since the matrix elements of the nucleon spin and isotopic spin operators can be expressed in terms of these probabilities, such matrix elements are determined essentially by the kinematics of the meson cloud. This fact renders unreliable any predictions of the static model which depend on matrix elements of the nucleon operators. The consistent failure of the static model to explain satisfactorily the scalar part of the magnetic moment may be ascribed to this cause. The quantities which depend on meson operators are more closely related to the dynamics of the system. The vector part of the magnetic moment is in agreement with experiment, and the electron-neutron interaction turns out much too large; these results differ little from those obtained by the Chew-Low 1-meson approximation. However, the contributions of the many meson states are not negligible, and the mean number of mesons is found to be closer to 2 than to 1. Evaluation of the charge renormalization enables the scattering amplitudes predicted to be tested by the static model against the sum rules of Cini and Fubini. It is found that, for the conventional value of renormalized coupling constant, the sum rules are strongly violated. This result, together with the substantial many meson component of the wave function, casts doubt on the validity of the 1-meson approximation in the static model. (Contractor's abstract)

1766

Princeton U. Palmer Physical Lab., N. Y.

ON THE POSITIVE DEFINITE MASS OF THE BONDI-WEBER-WHEELER TIME-SYMMETRIC GRAVITA-TIONAL WAVES, by D. R. Brill. [1959] [18]p. incl. table. [AF 49(638)304]   Unclassified

Published in Ann. Phys., v. 7: 466-483, Aug. 1959.

The total mass-energy can be given an unambiguous value for any gravitational disturbance which is sufficiently concentrated that its asymptotic behavior is Schwarzschildian in character. It is sufficient to consider such a disturbance on an initial surface to determine the energy, since it is conserved in time. For the case of time- and axial-symmetry the initial value equations reduce to a single equation involving 2 undetermined functions. It was shown here that solutions exist which are everywhere regular and asymptotically

flat. Such solutions are to be regarded as "snapshots" of pure gravitational waves. It was shown without approximation that the total mass-energy is positive definite for pure gravitational waves, as well as for combined electromagnetic and gravitational waves, which are time and axially symmetric. The mass-energy of these waves exhibits a complete spectrum from zero to infinity. Using the method of solution described 1 can obtain "snapshots" of gravitational waves at the moment of time-symmetry with any desired value of the mass-energy, by varying the parameter ω^2 between 0 and its critical value. At the critical value the solution represents a universe which is closed by its own content of gravitational energy. Computations of exact solutions representing such waves and universes are being programmed on an electronic computer. (Contractor's abstract)

1767

Princeton U. Palmer Physical Lab., N. J.

INTERFERENCE EFFECTS IN NEUTRAL K-PARTI-CLE DECAY, by S. B. Treiman and S. Weinberg. [1959] [2]p. incl. tables. [AF 49(638)304]
Unclassified

Published in Phys. Rev., v. 116: 239-240, Oct. 1, 1959.

An analysis is made of interference effects between the K_1° and K_2° components of a neutral K beam for decay in the channel $\pi^+ + \pi^- + \pi^\circ$. The effects discussed, though expected to be small, may just be detectable. If so, they would serve as a test of the proposed $|\Delta T| = 1/2$ rule. (Contractor's abstract)

1768

Princeton U. Palmer Physical Lab., N. J.

ELECTROMAGNETIC CORRECTIONS TO ISOTOPIC SPIN CONSERVATION, by S. Weinberg and S. B. Treiman. [1959] [4]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(   )304] and Atomic Energy Commission)   Unclassified

Published in Phys. Rev., v. 116: 465-468, Oct. 15, 1959.

If electromagnetic interactions are wholly responsible for all departures from isotopic spin invariance, then the strict conservation law $\Delta T = 0$ may be replaced, to order e^2, by the rule $|\Delta T| < 2$. Consequences of this weaker restriction are discussed for elementary particle masses, scattering processes, and weak-interaction decay processes. The apparent absence in nature of particles with isotopic spins greater than one makes it difficult to find very practical experimental tests of this rule. (Contractor's abstract)

1769

Princeton U. Palmer Physical Lab., N. J.

ACTIVE GRAVITATIONAL MASS, by C. W. Misner
and P. Putnam. [1959] [2]p. incl. table. [AF 49(638)-
304]   Unclassified

Published in Phys. Rev., v. 116: 1045-1046, Nov. 15,
1959.

Tolman states that "... disordered radiation in the
interior of a fluid sphere contributes roughly speaking
twice as much to the gravitational field of the sphere
as the same amount of energy in the form of matter."
The gravitational pull exerted by a system on a distant
test particle might therefore at first sight be expected
to increase if within the system a pair of oppositely
charged electrons annihilate to produce radiation.
This apparent paradox is analyzed here in the case
where gravitational effects internal to the system are
unimportant. It is shown that tensions in the wall of
the container compensate the effect mentioned by
Tolman so that the net gravitational pull exerted by the
system does not change. (Contractor's abstract)

1770

Princeton U. Palmer Physical Lab., N. J.

EXACT THREE-VARIABLE SOLUTIONS OF THE
FIELD EQUATIONS OF GENERAL RELATIVITY, by
B. K. Harrison. [1959] [12]p. incl. diagrs. refs.
[AF 49(638)304]   Unclassified

Published in Phys. Rev., v. 116: 1285-1296, Dec. 1,
1959.

In order to trace out with more understanding the con-
sequences of general relativity it is advantageous to
have exact solutions of Einstein's field equations which
show more detail than the familiar solutions with their
high symmetry. In the present investigation, based on
the method of separation of variables, all solutions of
the field equations for empty space have been found

which (1) have the "linked pair" form $g_{ij} = \pm \delta_{ij} A_i^2$
$(x^0, x^1) B_i^2 (x^0, x^2)$, and which (2) are nondegenerate-so
far as could be determined-in the sense that all the g_{ij}

cannot be reduced to functions of only 2 variables.
Other solutions have been obtained from the solutions
of the above form by interchange of variables. Explicit
expressions are given for all 20 nondegenerate solutions,
all apparently mev. Of degenerate solutions, 10 are
presented, not all of them mev. All 30 solutions are ex-
amined with respect to possible physical and geometri-
cal interpretations.

1771

Princeton U. Palmer Physical Lab., N. J.

A CONTRACTION RULE FOR COMPOSITE PARTICLES,
by R. Blankenbecler. [1959] [9]p. incl. refs. (Spon-
sored jointly by Air Force Office of Scientific Research
under [AF 49(638)304] and National Science Foundation)
                                              Unclassified

Published in Nuclear Phys., v. 14: 97-105, Dec. 1959.

A contraction rule for an arbitrary composite particle is
derived, based on results due to Nishijima, and Klein and
Zemach. This relation between this contraction rule and
the analogous problem in potential scattering is demon-
strated by an explicit reduction to the nonrelativistic
limit. Applications of these rules are briefly discussed.
(Contractor's abstract)

1772

Puerto Rico U. Dept. of Electrical Engineering, Mayaguez.

CHARACTERISTIC OF A PECULIAR BACK-SCATTER
ECHO OBSERVED AT A FREQUENCY OF 21.6 MC.
P.S., by B. Dueño. [1959] 24p. incl. illus. diagrs.
tables. (Research rept. no. 1) (AFOSR-TN-59-40)
(AF 49(638)172) AD 209212; PB 139212 Unclassified

Inspection of records of a backscatter experiment per-
formed at Puerto Rico U. at Mayaguez has revealed a
very interesting echo which as yet, has not been ob-
served at back-scatter stations located on higher lati-
tude sites. This echo takes the form of a narrow thin
line reflection extending in all directions with its slant
range practically independent of its azimuthal bearing.
The bottom edge of the line is believed to be due to a
focusing effect of the minimal time delay type proposed
by A. M. Peterson in 1951 while the upper edge is due
to a focusing effect between the skip distance rays and
rays at greater angles of incidence having the same
time delays as the skip distance rays. At the frequency
of operation, 21.6 mc it is observed by itself at times
when the attenuation of the radio waves is at its highest.
The range assumes values between 1000 and 2000 km
depending on time of the day and season. The lowest
value of range, 1000 km, occurs during the winter
months. Since, in addition, the thin line echo disappears
during the summer months, when it is observed only
sporadically, the echo is assumed to be an F-2 layer
echo. There are reasons to believe that for a given
parabolic distribution, that with the greatest half thick-
ness should produce the strongest focusing effect. An
opportunity to test the validity of this statement if af-
forded by the sporadic appearances of the thin line dur-
ing the summer. An estimation of the half thickness of
the F-2 layer deduced from ionograms for two consec-
utive days of appearance and nonappearance of the thin
line seems to confirm the aforementioned statement.

1773

Puerto Rico U. Dept. of Electrical Engineering, Mayaguez.

PECULIARITIES AND SEASONAL VARIATIONS OF
T. E. BACKSCATTER ECHOES OBSERVED AT
MAYAGUEZ, PUERTO RICO, by B. Dueño. [1959]
[14]p. incl. diagrs. (Research rept. no. 2) (AFOSR-
TN-59-889) (AF 49(633)172) AD 225968; PB 144658
Unclassified

As a result of a backscatter experiment on 21.6 mcs
and 40.68 mcs it has been observed that long range
transequatorial echoes (T. E.), which are most preva-
lent during the equinoxial periods, also exhibit a mini-
mum of T. E. activity during the solstitial periods
June - July and December - January. The minimum dur-
ing December and January can be adscribed to the small
horizontal gradient prevailing at the time. During
June - July the horizontal gradient is not as small as
during December - January. This coincides with the
observation that T. E. activity is not as low in June -
July as it is in December - January. Due to the com-
bined action of the equatorial bulge and sizable horizon-
tal gradients in the neighborhood of the geomagnetic
equator, radio waves of sufficiently high frequencies
will be launched into the ionosphere in directions along
the maximum of electron density of the elevated layer.
To produce focussing by a bundle of rays, a shallow
distribution of electron density in the layer is necessa-
ry. This is in agreement with the postulated decrease
in electron density as the geomagnetic equator is ap-
proached. (Contractor's abstract)

1774

Puget Sound Coll. [Tacoma, Wash.].

THE PREPARATION, STRUCTURE AND PROPERTIES
OF CERTAIN METHYLENE PEROXIDES, by R. D.
Sprenger. Final rept. Sept. 1952-Sept. 1959. Nov.
1959, 4p. incl. diagrs. (AFOSR-TR-59-171) (AF 18-
(600)544) Unclassified

A summary of results reached under this contract are
presented. This research has been concerned with the
formation, structure and properties of isochroman
peroxide of which 2 forms have been obtained by the air
oxidation of isochroman. Existence as dimorphic forms
seems most likely, but efforts to interconvert the 2
forms have been unsuccessful. The studies of peroxi-
dation of these 2 forms is reported on also, and they
indicate that small amounts of impurities are present
which influence the peroxidation rate. A mechanism
for peroxidation is suggested. It is pointed out that the
lower melting from (m. p. 128.9-130.4°C) and the higher
melting form (m. p. 152.9-154.4°C) have been found to
give identical ultra violet and infrared spectra. Efforts
to differentiate them have been unsuccessful also.

1775

Purdue Research Foundation, Lafayette, Ind.

EXTENSION PROBLEM FOR QUASI ADDITIVE SET
FUNCTIONS AND RADON-NIKODYM DERIVATIVES, by
L. Cesari. Apr. 1959, 44p. incl. refs. (Technical note
no. 17) (AFOSR-TN-59-477) (AF 18(600)1484)
AD 215720; PB 142230 Unclassified

A discussion is presented of the problem of extension of
quasi additive set functions Φ, Φ_r, $|\Phi|$, $|\Phi_r|$, Φ_r^+, Φ_r^-

into measures ν, ν_r, μ, μ_r, μ_r^+, μ_r^- in A, and consequent
representation theorem for the integral I.

1776

Purdue Research Foundation, Lafayette, Ind.

QUASI ADDITIVE SET FUNCTIONS AND THE CON-
CEPT OF INTEGRAL OVER A VARIETY, by L. Cesari.
Apr. 1959, 32p. (Technical note no. 16) (AFOSR-TN-59-
47d) (AF 18(600)1484) AD 264037; PB 142231
Unclassified

A topological treatment of quasi additive set functions is
presented and the application of surface area theory is
made through the use of the calculus of variations by
various authors. Theorems, proofs, and examples of
several integrals are given. (ASTIA abstract)

1777

Purdue Research Foundation, Lafayette, Ind.

ANALYTICAL THEORY OF CONTINUOUS TRANS-
FORMATIONS I, by T. Nishiura. Aug. 1959 [70]p. incl.
refs. (Technical note no. 20) (AFOSR-TN-59-496)
(AF 18(600)1484) AD 263800; PB 143179
Unclassified

An analysis of the theory of continuous transforma-
tions is made. It concerns the analog of the Geöcze
area of mappings from specific subsets of Euclidean
k-space, E_k, and Euclidean N-space, E_n. By use of
combinatorial topology and algebraic topology the notion
of polyhedral regions is defined. Theorems and proofs
of constructions of certain polyhedral regions are pre-
sented. (ASTIA abstract)

1778

Purdue Research Foundation, Lafayette, Ind.

ANALYTIC THEORY OF CONTINUOUS TRANSFOR-
MATIONS II, by T. Nishiura. Aug. 1959 [131]p. incl.
refs. (Technical note no. 21) (AFOSR-TN-59-496a)
(AF 18(600)1484) AD 263801; PB 143180
Unclassified

The present work is a continuation of the extension of the theory of the Geőcze "k-area" which was started in item no. 1777, Vol. III.

1779

Purdue Research Foundation, Lafayette, Ind.

ANALYTIC THEORY OF CONTINUOUS TRANSFOR-MATIONS III, by T. Nishiura. Aug. 1959 [17]p. incl. refs. (Technical note no. 22) (AFOSR-TN-59-496b) (AF 18(600)1484) AD 263803; PB 144071
Unclassified

This analysis deals with the generalized length of a contour and the Cavalieri inequality for continuous mappings defined on admissible sets in the plane. (Contractor's abstract)

1780

Purdue Research Foundation, Lafayette, Ind.

A CHARACTERIZATION OF MULTICOHERENT PEANO SPACES, by A. Lauria and C. J. Neugebauer. Nov. 1959, 14p. incl. refs. (Technical note no. 19) (AFOSR-TN-59-801) (AF 18(600)1484) PB 144750
Unclassified

Let P be a Peano Space, and denote by τ the collection of all continuous mappings $T : P \to [0, 1]$. For each $T \in \tau$ let $1m \to T$, $m : P \to M_T$, $1 : M_T \to [0, 1]$ be a monotone-light factorization of T. In this paper the above theorem is generalized to Peano spaces of finite degree of multicoherence r(P). A number a(P) will be associated with P which measures roughly the maxi-mum number of distinct arcs with self-intersections joining any two points in any M_T. The theorem states that r(P) = n if and only if $a(P) = 2^n$.

1781

Purdue Research Foundation, Lafayette, Ind.

RETRACTIONS ONTO DENDRITES, by A. Lauria and C. J. Neugebauer. Nov. 1959, 13p. (Technical note no. 18) (AFOSR-TN-59-802) (AF 18(600)1484) PB 144214
Unclassified

Let X be a normal Hausdorff space and α be any simple arc contained in X. Then α is a retract of X, that is, there exists a continuous function F taking X onto α such that the restriction of F to α is the identity mapping. This is a simple consequence of the Tietze Extension Theorem. If X is a unicoherent Peano space then the re-traction F can be chosen to be a monotone mapping. In this paper both of these results are generalized and the following is obtaind: Theorem. If X is any normal Hausdorff space and Δ is a dendrite in X, then Δ is a retract of X. Corollary. If X is a unicoherent Peano

space and Δ is a dendrite in X, then Δ is a monotone retract of X. The theorem and corollary are proved, but it is shown that the corollary is no longer true if X is not locally connected or unicoherent.

1782

Purdue [Research Foundation] Lafayette, Ind.

RECENT RESULTS IN SURFACE AREA THEORY, by L. Cesari. [1959] [20]p. incl. diagrs. [AF 18(600)1484]
Unclassified

Published in Amer. Math. Monthly, v. 66: 173-192, Mar. 1959.

An approach to surfaces is discussed which entails a much deeper connection with topology and measure theory than with curves. The concept of surfaces is re-viewed followed by a discussion of Lebesque area and its lower semicontinuity property. A discussion is also presented on Peano and Geőcze areas and the relation between area and integral. The Weierstrass-type inte-gral and fine-cyclic elements are also discussed.

1783

[Purdue Research Foundation, Lafayette, Ind.]

MEASURES INDUCED ON A σ-ALGEBRA BY A SUR-FACE, by L. H. Turner. [1959] [7]p. (AF 18(600)1484)
Unclassified

Published in Duke Math. Jour., v. 26: 501-509, Sept. 1959.

Let (T, A) be a continuous a c.Bv mapping from an ad-missible set A into E_3 and $T_r = P_r oT$ where P_r is a perpendicular projection on the rth coordinate plane for r = 1, 2, 3. For A compact, regular measures φ, φ_r, φ_r^+, φ_r^-, r = 1, 2, 3, on the middle space which agrees for open sets with area and the corresponding variations of the plane transformations T_r, respectively. The re-striction that A be compact is removed. It is also shown that φ_r^+ and φ_r^- are mutually singular. (Math. Rev. ab-stract)

1784

Purdue Research Foundation, Lafayette, Ind.

LEBESGUE AREA OF MAPS FROM HAUSDORFF SPACES, by R. F. Williams. [1959] [14]p. incl. diagrs. [AF 18(600)1484]
Unclassified

Published in Acta Math., v. 102: 33-46, 1959.

Let X be a compact m-dimensional Hausdorff space

and f a map from X into Euclidean n-space. Using nerves of open coverings of X 2 functions L_m^p and L_m^* are introduced and compared with the Lebesgue m-dimensional area L_m of the surface represented by f. From the definitions it follows that $L_m^p \le L_m^*$. Moreover, $L_m^* \le L_m$ if X is finitely triangular. If X is a compact 2-manifold it is shown that $L_2^* = L_2$. For light maps it is proved that L_m^* does not exceed the lower Riemann integral of the crude multiplicity M_f. An example is given of a light map f from a finitely triangular space X onto the unit square for which L_2 exceeds both L_2^* and the Riemann integral of M_f. (Math. Rev. abstract)

1785

Purdue Research Foundation, Lafayette, Ind.

ON DIFFERENCES OF UNITARILY EQUIVALENT SELF-ADJOINT OPERATORS, by C. R. Putnam. May 1959, 9p. (Technical note no. 9) (AFOSR-TN-59-413) (AF 18(603)139) AD 214530   Unclassified

Suppose that A and B are bounded self-adjoint operators satisfying $H = A - B \ge 0$. In case B is unitarily equivalent to A, that is if $B = U^*AU$ and if $H \ge 0, \ne 0$, then the spectral resolution of U must have an absolutely continuous component. In particular, the spectrum of U has a positive measure. If $H = DD^* - D^*D$ and if D is nonsingular with a polar factorization $D = PU$ ($P > 0$, U unitary) then U must have a spectrum with a positive measure. It is shown that P must have at least 2 points in its cluster spectrum. (Contractor's abstract)

1786

Purdue Research Foundation, Lafayette, Ind.

A NOTE ON NON-NEGATIVE MATRICES, by C. R. Putnam. Mar. 1960, 6p. (Technical note no. 10) (AFOSR-TN-59-692) (AF 18(603)139) AD 233512; PB 146377   Unclassified

Also published in Canad. Jour. Math., v. 13: 59-62, 1961.

Results on non-negative matrices previously obtained (PRF.02:008, Vol. II) are extended. (Contractor's abstract)

1787

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE THERMODYNAMIC PROPERTIES OF TECHNETIUM AND RHENIUM COMPOUNDS. VII. HEATS OF

FORMATION OF RHENIUM TRICHLORIDE AND RHENIUM TRIBROMIDE. FREE ENERGIES AND ENTROPIES, by J. P. King and J. W. Cobble. Oct. 1959, 10p. incl. tables, refs. (AFOSR-TN-59-968) (AF 18(600)-1525) AD 227327; PB 145532   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 2111-2113, May 5, 1960.

The heats of oxidation of $ReCl_3(c)$ and $ReBr_3(c)$ by basic hypochlorite have been determined. From these data the heats of formation at 25°C have been calculated to be: $ReCl_3(c)$, $-63.1 + 0.8$ kcal mol^{-1} and $ReBr_3(c)$, -39.9 ± 0.09 kcal mol. Free energy and entropy estimates are also given. (Contractor's abstract)

1788

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE HEAT OF FORMATION OF THE HYPOCHLORITE ION, by J. E. McDonald, J. P. King, and J. W. Cobble. [1959] [2]p. incl. table, refs. (AFOSR-TN-59-1042) (AF 18(600)1525)   Unclassified

Also published in Jour. Phys. Chem., v. 64: 1345-1346, Oct. 28, 1960.

The heat of formation of the hypochlorite ion has been redetermined calorimetrically at 25° by measuring the heat of hydrolysis of chlorine in basic solutions. The value obtained was $\Delta H° = -26.2 \pm 0.1$ kcal/mol (item no. 1790, Vol. III). Using this value in conjunction with that for the free energy of formation, $\Delta F° - 8.858$ kcal/mol, the entropy is calculated to be 8.6 ± 0.3 entropy units. (Contractor's abstract)

1789

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE THERMOCHEMISTRY OF RHENIUM COMPOUNDS, by J. P. King. Oct. 1959, 96p. incl. diagrs. tables, refs. (AFOSR-TN-59-1164) (AF 18(600)1525) AD 228839; PB 144741   Unclassified

The potential and temperature coefficient of the ReO_3/ReO_4^- couple at 25°C obtained from cell measurements was found to be -0.768 ± 0.005 v and 0.00121 ± 0.00011 v deg^{-1}, respectively. The thermodynamic functions of rhenium trioxide at 25°C were calculated to be -146.9 ± 0.8 kcal mol^{-1}, -128.1 ± 0.8 kcal mol^{-1} and $19.3 + 2.5$ cal mol^{-1} deg^{-1} for the heat of formation, the free energy of formation and the entropy, respectively. The heats of oxidation of $ReCl_3(c)$ and $ReBr(c)$ by basic hypochlorite were determined by solution calorimetry. From these data the heats of formation at 25°C were

calculated to be: $ReCl_3$(c), -63.6 ± 0.8 kcal mol^{-1} and $ReBr_3$(c), -39.9 ± 0.8 kcal mol^{-1}. The potential of Re/Re^- couple obtained from both acidic and basic cells was found to be 0.136 ± 0.02 v at 0°C. The heat of formation of aqueous rhenide ion obtained from calorimetric measurements at 25°C is 11.4 ± 3 kcal mol^{-1}. From entropy considerations, the simple halide-like structure of rhenide ion was shown to be very improbable. A new calorimetric oxidant, basic hypochlorite, was investigated and its application for the calorimetric measurements of certain halides of 2nd and 3rd row transition elements was proposed. The heat of formation of the hypochlorite ion at 25°C is determined calorimetrically to be -25.90 ± 0.05 kcal mol^{-1} by measuring the heat of hydrolysis of aqueous chlorine in basic solutions. (Contractor's abstract)

1790

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE HEAT OF FORMATION OF THE HYPOCHLORITE ION, by J. P. King and J. W. Cobble. [1959] [4]p. incl. table, refs. (Bound with its AFOSR-TN-59-1164; AD 228839) (AF 18(600)1525) Unclassified

The heat of formation of the hypochlorite ion at 25°C has been redetermined calorimetrically by measuring the heat of hydrolysis of aqueous chlorine in basic solutions. The value obtained was $\Delta H^\circ = -25.90 \pm 0.05$ kcal mol^{-1}. (Contractor's abstract)

1791

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE STRUCTURE AND ENTROPY OF AQUEOUS RHENIDE ION, by J. P. King and J. W. Cobble. [1959] [12]p. incl. tables, refs. (Bound with its AFOSR-TN-59-1164; AD 228839) (AF 18(600)1525) Unclassified

The potential of Re/Re^- couple was measured in both acidic and basic solutions at 0°C and the standard electrode potentials of the rhenide electrode was found to be 0.136 ± 0.020 v at 0°C and 0.101 ± 0.020 v at 25°C; the free energy of formation of aqueous rhenide ion was calculated from latter value to be 2.3 ± 0.5 kcal mol^{-1} at 25°C. The heat of formation of aqueous rhenide ion was calorimetrically determined to be $+ 11.4 \pm 3$ kcal mol^{-1}. The entropy of the species at 25°C is 55 ± 10 entropy units. (Contractor's abstract)

1792

Purdue U. Dept. of Chemistry, Lafayette, Ind.

A MODIFIED URRY TOEPLER PUMP, by F. Vratny

and B. Graves. Apr. 22, 1958, 4p. incl. diagr. (AFOSR-TN-59-302) (AF 18(603)45) AD 213086; PB 140536
Unclassified

Also published in Rev. Sci. Instrs., v. 30: 597-598, July 1959.

At moderate pressure (0-5 cm Hg), splashing occurred in the downstroke cycle of an Urry Toepler pump which was being employed for the pumping and circulating of gas. At high pressure, violent splashing destroyed the pump. Entrapped gas in the upper portion of the pump was troublesome in the pumping to very low pressures or in the quantitative transfer of a given gas. The modification of the Urry Toepler pump to eliminate these deficiencies is discussed. (ASTIA abstract)

1793

Purdue U. Dept. of Chemistry, Lafayette, Ind.

REFLECTANCE SPECTRA OF PRASEODYMIUM OXIDES IN THE RANGE Pr_2O_3 TO Pr_6O_{11}, by F. Vratny, M. Tsai, and J. M. Honig. Mar. 1958, 10p. incl. diagrs. r.is. (AFOSR-TN-59-404) (AF 18(603)45) AD 214524; PB 140805 Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 16: 263-267, Feb. 1961.

The spectra of praseodymium oxides (PrO_x) has been studied in the composition range $1.5 < X < 1.83$ from 200 to 2000 mμ. An ultraviolet cut-off was observed at about 320 mμ, exciton interaction was observed in the spectral range of 400-650 mμ, and a band observed in the near infrared which begins at about 900 mμ. The spectra are discussed in terms of known changes in the crystalline structure of the material. (Contractor's abstract)

1794

Purdue U. Dept. of Chemistry, Lafayette, Ind.

A SYSTEM FOR THE ANALYSIS OF NITRATES AND OXIDES OF NITROGEN, by F. Vratny. May 1959 [11]p. incl. diagrs. tables. (AFOSR-TN-59-602) (AF 18(603)-45) AD 217175; PB 142733 Unclassified

Also published in Anal. Chim. Acta, v. 21: 579-583, Dec. 1959.

A system was constructed for determining absolute amounts of NO_2, N_2O_3, NO, and of either N_2O or a mixture of N_2 and O_2 simultaneously present in the gas phase. The system consists of a reaction chamber, a Ni-NiO tube, a pumping and manometering section, and 2 purification sections. The entire system is evacuated to a pressure of 10^{-6} mm of Hg; this eliminates the possibility of analyzing compounds that are volatile at room

temperature. The decomposition products pass a cold trap which separates the NO_2-N_2O_3 components from the more volatile NO and the N_2O or N_2-O_2 mixture. An Ni-asbestos mixture is heated to 800°C to remove the O components from the nitrogeneous gas phase. NiO is reduced by H to yield water vapor; the excess H is metered. The mol quantities of N_2 and H_2 are computed, and the mol quantity of O is deduced. The procedure is repeated for nitrogen oxides that are condensed in the trap. The decompositions of $Ba(NO_3)_2$, $Pb(NO_3)_2$, and NH_4NO_3 were studied. Results indicated that the analytical procedure yields correct data under carefully controlled conditions and may be applied with confidence.

1795

Purdue U. Dept. of Chemistry, Lafayette, Ind.

GROWTH AND CRYSTAL STRUCTURE OF SINGLE CRYSTALS OF $Pr(NO_3)_3 \cdot 6H_2O$, by J. W. Richardson, Q. W. Choi and others. July 1959, 4p. incl. table. (AFOSR-TN-59-638) (AF 18(603)45) AD 218018
Unclassified

Single crystals of $Pr(NO_3)_3 \cdot 6H_2O$ were grown by dissolving Pr_6O_{11} in HCl solution and evaporating the solution almost to dryness. The resulting chloride was treated 3 times with HNO_3 and evaporated almost to dryness in a steam bath. The residue was placed in a desiccator together with a 15% NaOH solution in another beaker. The $Pr(NO_3)_3$ dissolved in H_2O withdrawn from the NaOH solution. A 40 to 45% aqueous NaOH solution was placed in the desiccator. The higher vapor pressure of the $Pr(NO_3)_3$ solution caused a slow transfer of H_2O to the NaOH reservoir. This resulted in the growth of a single crystal of $Pr(NO_3)_3 \cdot 6H_2O$, with dimensions of 2 x 1.5 x 0.5 cm. The crystal exhibited a marked spiral dislocation pattern on the top surface. X-ray diffraction studies were made on the crystal using a Weissenberg camera and Ni-filtered CuK_α radiation. The crystal was monoclinic and had the foliowing cell constants: $a_0 = 8.64 \pm 0.05$ A, $b_0 = 11.75 \pm 0.05$ A, $c_0 = 6.78 \pm 0.05$ A, and $\gamma = 112 \pm 3°$. The calculated density for 2 formula units per unit cell was 2.42 g/cc compared to 2.48 g/cc observed by displacement of ethylacetate. Indexing the Weissenberg data revealed that all hkO reflections were present. The lattice constants were computed assuming that the lattice was primitive and that no glide planes occurred.

1796

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE THERMAL DECOMPOSITION OF PRASEODYMIUM NITRATE, by F. Vratny and J. M. Honig. Nov. 1959 [29]p. incl. diagrs. refs. (AFOSR-TN-59-1153) (AF 18(603)45) AD 228959; PB 144944
Unclassified

Also published in Trans. Faraday Soc., v. 56: 1051-1058, July 1960.

The thermal decomposition of $Pr(NO_3)_3$ has been measured in the temperature range $285 < T \le 465°C$. In conjunction with infrared spectra of the solid decomposition products it is postulated that the reaction proceeds via an intermediate nitrite structure. The composition of the final nonstoichiometric oxide varied with the temperature at which the reaction was allowed to proceed. Various characteristic features of this decomposition reaction are discussed. (Contractor's abstract)

1797

[Purdue U. Dept. of Chemistry, Lafayette, Ind.]

SYMPOSIUM ON THE CHEMISTRY OF LESS FAMILIAR ELEMENTS, San Francisco, Calif., Apr. 14-16, 1959, by J. W. Cobble. Final rept. Aug. 1959, 44p. (AFOSR-TR-59-101) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)233 and American Chemical Society) AD 226190; PB 143887
Unclassified

Presented at meeting of the Inorg. Chem. Div. of the Amer. Chem. Soc., San Francisco, Calif., Apr. 13-18, 1958.

Also published in 133rd meeting of the Amer. Chem. Soc., Abstracts of Papers, 1958, p. 10-L-12-L; 16-L-18-L; 20-L-24-L; 29-L-31-L.

On April 14 - 16, 1959, the Air Force Office of Scientific Research and the American Chemical Society Division of Inorganic Chemistry held a joint symposium at the National American Chemical Society Meeting in San Francisco, California. Twenty-nine papers, including those by eight foreign speakers from five countries were presented. Because of the preliminary nature of many of the papers, the authors and co-chairmen agreed not to attempt to publish the symposium as a separate collection. This final report includes, therefore, a program, list of speakers, list of foreign participants, and copies of the abstracts of the papers.

1798

Purdue U. [Dept. of Chemistry] Lafayette, Ind.

AN APPLICATION OF THE HAMMETT EQUATION TO SUBSTITUTED FERROCENE CARBOXYLIC ACIDS, by

R. A. Benkeser and L. W. Hall, Jr. [1959] 7p. incl. diagrs. table, refs. (AFOSR-TN-59-450) (AF 49(638)-297) AD 225119; PB 140775   Unclassified

A series of substituted ferrocene carboxylic acids were prepared and their ionization constants measured. Rather poor correlation was noted when the ionization constants of the ferrocene acids were plotted against Hammett sigma values. On the other hand, excellent correlation with Taft's σ^* was obtained. These results would indicate that the electrical effects operative between the rings of ferrocene are essentially inductive in nature. Further tests of this hypothesis are presently underway. (Contractor's abstract)

1799

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

[TWO DIMENSIONAL PROBLEMS OF THE CALCULUS OF VARIATIONS], by W. H. Fleming. Final rept. [1959] 2p. (AFOSR-TR-59-113) (AF 49(638)18)   Unclassified

A review of the research conducted under this contract is presented. One paper (PUR.11:003, Vol. II) discusses the most general existence theorem for double integral variational problems in parametric form known to date. It uses the method of generalized surfaces which applies to both regular and non-regular problems. Two others (PRF.01:004, Vol. I and PUR.11:002, Vol. II) deal with surfaces in the more general sense. These 3 papers thus, deal with a phase of surface area theory which is drawing to a close, namely, the study of 2-dimensional surfaces of finite genus situated in ordinary finite dimensional space. The other paper submitted under this contract, (PUR.11:001, Vol. II) is concerned with generalized surfaces of arbitrary finite dimension k situated in (k + 1)-dimensional space. This paper appears to be one of the first in a new phase of surface area theory which deals with surfaces of arbitrary dimension k, and which seems to offer hope of general existence theorems for multiple integral problems in calculus of variations of any dimensions.

1800

Purdue U. Dept. of Mathematics, Lafayette, Ind.

A SPACE OF MULTIPLIERS OF TYPE L^p $(-\infty, \infty)$, by G. L. Krabbe. Nov. 20, 1959, 13p. incl. refs. (AFOSR-TN-59-170) (AF 49(638)505) AD 232457; PB 146009   Unclassified

Also published in Pacific Jour. Math., v. 9: 729-737, 1959.

Let $V(G)$ denote the set of all functions having finite variation on G. Set $G = (-\infty, \infty) = \hat{G}$, and let $V_\infty(G)$ be the Banach space of all functions in $V(G)$ which vanish at infinity. If $f \in V_\infty(G)$, then there exists a bounded

linear operator $(t_p f)$ on $L^p(\hat{G})$ such that (Fourier transform of $(t_p f)x$) = f. (Fourier transform of x) for all x in $L^p(\hat{G})$. Suppose $1 < p < \infty$. When $f \in L^1(G) \cap V(G) \subset V_\infty(G)$, then $(t_p f)$ is a singular integral operator. For all x in $L^p(\hat{G})$, $(t_p f)x$ is found to have the form

$$[(t_p f)x]_\lambda = \frac{1}{2\pi i} \int_{-\infty}^{\infty} x(\Theta) \frac{F(\Theta - \lambda)}{\Theta - \lambda} d\Theta, \quad (\lambda \in \hat{G}), \text{ where}$$

the integral is taken in the Cauchy principal value sense. A set $\Delta(L^p(\hat{G})$ which contains all factor functions for Fourier transforms of type (L_p, L_p) is defined. A number N_p is found such that if $f \in V_\infty(G)$, then $f \in \Delta(L^p(\hat{G}))$ and $\|(t_p f)\| < N_p \|f\|_v$, where $\|f\|_v$ denotes the total variation on G of the function f. Let F_* be the mapping $[x \to x*F]$, where $x*F$ is the convolution of the functions x and F. Let (Yf) denote the Fourier transform of the function f. If $f \in L^1(G) \cap V(G)$, then the transformation $(YF)_*$ is a densely defined bounded operator, and $(t_p f)$ is its continuous linear extension to the whole space $L^p(\hat{G})$. (Contractor's abstract)

1801

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

NORMAL OPERATORS ON THE BANACH SPACE L^p $(-\infty, \infty)$. PART I. BOUNDED OPERATORS, by G. L. Krabbe. Nov. 20, 1959, 4p. [Technical note no. 2] (AFOSR-TN-59-579) (AF 49(638)505) AD 232458; PB 146006   Unclassified

Also published in Bull. Amer. Math. Soc., v. 65: 270-272, July 1959.

Let B denote the Boolean ring generated by the semi-closed intervals of the plane. Denote by E_p the algebra of all linear bounded transformations of L^p $(-\infty, \infty)$ into itself. Suppose that p = 2, and let A_p be an involutive Abelian subalgebra of E_p. If A_p is also a Banach space and if $T_p \in A_p$, then the family of all homomorphic mappings of the ring B into the algebra E_p contains a member of E_p^T such that $T_p = \int \lambda, E_p^T(d\lambda)$. Suppose that $1 < p < \infty$. Let D be the class of all bounded functions whose real and imaginary parts are piecewise monotone. An isomorphism $f \to A(f)_p$ whose domain includes D and whose range $(t)_p$ is a normed involutive abelian subalgebra of E is defined. The main theorem shows that a member T_p of $(t)_p$ has the family of homomorphic mapping property whenever $T_p = A(f)_p$ for some f in D. The relation (T_p) involves a Stieltjes integral defined in the strong operator-topology whenever $p \geq 2$. (Contractor's abstract)

1802

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

NORMAL OPERATORS ON THE BANACH SPACE L^p $(-\infty, \infty)$. Part I, by G. L. Krabbe. Nov. 20, 1959, 21p. incl. refs. [Technical note no. 3] (AFOSR-TN-59-1115) (AF 49(638)505) AD 232459; PB 146385   Unclassified

Also published in Canad. Jour. Math., v. 13: 505-518, 1961.

Let $B\bar{R}^2$ be the Boolean algebra of all finite unions of sub-cells of the plane. Denote by E_p the algebra of all linear bounded transformations of L^p $(-\infty, \infty)$ into itself. Suppose that $p = 2$, and let R_p be an involutive Abelian sub-algebra of E_p. If R_p is also a Banach space and if $T_p \in R_p$, then the family of all homomorphic mappings of $B\bar{R}^2$ into the algebra R_p contains a member E_p^T such that $T_p = \int \lambda \cdot E_p^T(d\lambda)$. Suppose that $1 < p < \infty$. Let D be the class of all bounded functions whose real and imaginary parts are piecewise monotone. An isomorphism $f \to [\lambda f]_p$ whose domain includes D and whose range $(t)_p$ is a normed involutive abelian sub-algebra of E_p is detained. A theorem shows that a member T_p of $(t)_p$ has the homomorphic mapping property whenever $T_p = [\lambda f]_p$ for some f in D. The relation T_p involves a Stieltjes integral defined in the strong operator-topology whenever $p \geq 2$. The set-function E_p^T need not be countably additive. The values of E_p^T are self-adjoint idempotent members of $(t)_p$. (Contractor's abstract)

1803

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

NORMAL OPERATORS ON THE BANACH SPACE L^p $(-\infty, \infty)$. PART II, UNBOUNDED TRANSFORMATIONS, by G. L. Krabbe. Nov. 20, 1959, 7p. [Technical note no. 4] (AFOSR-TN-59-1116) (AF 49(638)505) AD 232460; PB 146384   Unclassified

Also published in Bull. Amer. Math. Soc., v. 66: 86-90, Mar. 1960.

Suppose $1 < p < \infty$. The transformation D_p is defined by $D_p x =$ derivative of x for all functions x in the set $D(D_p)$ of all locally absolutely continuous members of $L^p = L^p$ $(-\infty, \infty)$ whose derivative belongs to L^p. The following result is prototypic: $(1/2\pi)D_p$ is a transformation (denoted P_p) that satisfies the spectral theorem. Let L_p denote the norm-topology of L^p when $p \geq 2$. For $p < 2$, L_p denotes the weak topology of L^p. Suppose that E is a spectral resolution in L^p, and let f be a function on $(-\infty, \infty)$. If T is a transformation of L^p with domain $D(T)$, then the relation $T \subseteq \int f(\lambda) \cdot E(d\lambda)$ means that, for all functions x in $D(T)$, the Riemann-Stieltjes integral $\int_{-\infty}^{\infty} f(\lambda) \cdot E(d\lambda)x$ converges to Tx in the topology L_p. Let O_p be the class of all linear transformations Q of L^p which give rise to a spectral resolution E^Q in L^p. Then $P_p \in O_p$. In the case $p = 2$, the relation $P_2 \in O_2$ comes from the spectral theorem (O_2 contains all self-adjoint linear transformations of L^2). Differential transformations of a more general sort also belong to O_p.

1804

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

NORMAL OPERATORS ON THE BANACH L^p $(-\infty, \infty)$. PART II. UNBOUNDED OPERATORS, by G. L. Krabbe. Nov. 20, 1959, 36p. incl. refs. (AFOSR-TN-59-1212) (AF 49(638)505) AD 231841; PB 145933   Unclassified

Also published in Jour. Math. and Mech., v. 10: 111-133, Jan. 1961.

Let $1 < p < \infty$. The differentiation operator D_p is defined by $D_p x =$ derivative of x for all functions x in the set $d(D_p)$ of locally absolutely continuous members of $L^p = L^p$ $(-\infty, \infty)$ whose derivative lies in L^p. Let O_p be the class of all linear operators T_p on L^p which have a spectral resolution E_p^T such that the relation $T_p x = \int \theta \cdot E_p^T(d\theta)x$ holds for all x in the domain $d(T_p)$ of T_p. O_p is shown to contain the operator $\nabla_p = (1/2\pi)D_p$. A class $\mathcal{T}_p$ is defined such that $\nabla_p \in \mathcal{T}_p \subset O_p$. The class $\mathcal{T}_p$ contains an algebra of different operators and the operator $D_p H_p$, where H_p is the Hilbert transformation. (Contractor's abstract)

1805

Purdue U. [Dept. of Physics] Lafayette, Ind.

MUON CAPTURE IN CERTAIN LIGHT NUCLEI, by A. Fujii and H. Primakoff. Mar. 1959 [29]p. incl. refs. (Technical rept. no. 20) (AFOSR-TN-59-28) (In cooperation with Washington U., St. Louis, Mo., AF 18(603)-108) (AF 18(600)1579) AD 208873   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 39, Jan. 28, 1959.

Also published in Nuovo Cimento, Series X, v. 12: 327-355, May 1, 1959.

The partial transition rate of the muon-capture reactions $He^3 - H^3$, $Li^6 - He^6$, and $C^{12} - B^{12}$ in which the daughter nucleus is found in its ground state is calculated by making use of the comparison with the beta-decay transition rate of the daughter nucleus from the ground state back to the ground state of the parent nucleus. Also the universality in coupling constants and coupling schemes, V-A between beta decay and muon capture is assumed. The "induced" pseudoscalar interaction and the correction due to "divergenceless" current are both included in the basic Hamiltonian. The nuclear matrix element is evaluated using a variational trial wave function for He^3 and an oscillator potential wave function in LS and jj coupling shell theory for Li^6 and C^{12}, respectively. The calculated partial capture rate is in agreement with experiment which exists only for C^{12} at present. (Same as item no. 2174).

1806

Purdue U. [Dept. of Physics] Lafayette, Ind.

ON THE EVALUATION OF DISPERSION RELATIONS, by R. Blankenbecler and S. Gartenhaus. [1959] 30p. incl. refs. (AFOSR-TN-59-534) (AF 18(600)1579) AD 216551; PB 142403   Unclassified

Also published in Phys. Rev., v. 116: 1297-1305, Dec. 1, 1959.

A new evaluation of the dispersion relations for mesonic phenomena is proposed. The method, which utilizes the comparison function procedure, makes explicit use of crossing symmetry and allows for an exact treatment of nuclear recoils. For the case of meson nucleon scattering at low energies an expansion of a first order solution is made in inverse powers of the nucleon mass and agreement with the results of a previous evaluation is obtained. The extension of the method to other processes is briefly discussed. (Contractor's abstract)

1807

Purdue U. [Dept. of Physics] Lafayette, Ind.

PHOTOPRODUCTION OF PI-MESONS, by S. Gartenhaus and R. Blankenbecler. [1959] [23]p incl. diagrs. (AFOSR-TN-59-1027) (AF 18(600)1579) AD 250976   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 49, Jan. 28, 1959. (Title varies)

Also published in Phys. Rev., v. 116 :1305-1311, Dec. 1, 1959.

The dispersion relations for meson photoproduction at moderately low energies are examined by means of the comparison function method which was proposed in an earlier paper. Assuming that only the (3,3) state is appreciably modified by rescattering effects, an approximate solution is obtained. Nucleon recoil and crossing symmetry are treated exactly. The static limit of this solution yields substantial agreement with the results of Chew, Goldberger, Low, and Nambu (Phys. Rev., v. 106: 1345, 1957). It is hoped that an evaluation including effects of nucleon recoil will improve the agreement in the resonance region. (Contractor's abstract)

1808

Purdue U. [Dept. of Physics] Lafayette, Ind.

ELECTRON-(ANTI)NEUTRINO SCATTERING, by R. W. King, D. C. Peaslee, and J. F. Perkins. [1959] [5]p. incl. diagr. (AFOSR-TN-59-1243) (AF 18(600)1579) AD 241632   Unclassified

Also published in Phys. Rev., v. 117: 1614-1615, Mar. 15, 1960. (Title varies)

Cross sections for electron-neutrino and electron-anti-neutrino scattering are given as a function of recoil electron energy, averaged over a reactor spectrum of anti-neutrinos. (Contractor's abstract)

1809

Purdue U. Dept. of Physics, Lafayette, Ind.

MUON CAPTURE IN He^3, by A. Fujii. [1959] [1]p. (AFOSR-TN-59-1320) ([Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1579] and Atomic Energy Commission)   Unclassified

Also published in Phys. Rev., v. 118: 870, May 1, 1960.

The hard core wavefunction for a 3-nucleon system is used to calculate the capture rate of the reaction $\mu^- + He^3 - H^3$ (ground state) + ν. It is found to be 1.66 x 10^3 sec^{-1}. (Contractor's abstract)

1810

Purdue U. [Dept. of Physics] Lafayette, Ind.

Σ-MIXING EFFECTS IN THE HYPERTRITON (Abstract), by M. T. Vaughn. [1959] [1]p. [AF 18(600)1579]   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 26-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
37, Jan. 28, 1959.

A variational calculation has been made to estimate
the contribution of the off-diagonal (Σ mixing) terms of
the Λ-nucleon potential to the binding of the hypertriton.
Two terms were used in the semiphenomenological po-
tential tried here: the 1st was a Σ-mixing term of
Yukawa shape and range 1 pion Compton wavelength
corresponding to the 2nd-order potential calculated by
Lichtenberg and Ross; the 2nd term was a Yukawa
potential containing both diagonal and off-diagonal terms
of range ~$\frac{1}{2}$ pion Compton wavelength (0.6f and 0.8f were
used), corresponding roughly to the 4th-order potential
of Lichtenberg and Ross. Tensor forces were replaced
by "equivalent" central potentials throughout. For var-
ious strengths of the 2nd-order term, the strength of the
4th-order term necessary to produce the observed hy-
pertriton binding energy was determined by a varia-
tional calculation. It was found that the Σ-mixing terms
contribute 20-40% of the effective Λ-deuteron potential
for reasonable choices of the strength of the 2nd-order
potential.

1811

Purdue U. [Dept. of Physics] Lafayette, Ind.

ANGULAR MOMENTUM OF THE ELECTRON-NEU-
TRINO IN FIRST FORBIDDEN BETA DECAY (Abstract),
by C. E. Johnson and R. W. King. [1959] [1]p. (Spon-
sored jointly by Air Force Office of Scientific Research
under [AF 18(600)1579] and Atomic Energy Commis-
sion)   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
58, Jan. 28, 1959.

The nuclear shell model and the collective model are
employed to predict the presence of sizable unique
($\Delta I = 2$) components in particular classes of what are
usually assumed to be non-unique first forbidden beta
transitions ($\Delta I = 0 \pm 1$). The shell model argument de-
pends only on the plausible assumption that c figura-
tion admixing is restricted primarily to con'   ations
in the same major shell. The collective mod   ru-
ment depends only on the validity of the K-quantum num-
ber. Experimental evidence is surveyed to support each
of these effects imposed on beta decay by the structure
of the nucleus. It is proposed that first forbidden beta
decay be used to explore the degree of configuration
mixing in the shell model and the validity of the K-quan-
tum number in the collective region. The analysis of
several kinds of experiments will be strongly affected
by the presence of the usually neglected unique compo-
nents (e.g., experiments with oriented nuclei, β-γ angu-
lar correlation experiments, etc.).

1812

Purdue U. [Dept. of Physics] Lafayette, Ind.

APPLICATION OF THE QUASI-α MODEL TO BETA
DECAY AND NUCLEAR MAGNETIC MOMENTS (Ab-
stract), by D. W. Dorn and R. W. King. [1959] [1]p.
[AF 18(600)1579]   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
59, Jan. 28, 1959.

The quasi-α model in j-j coupling previously presented
has been applied to the calculation of beta-decay matrix
elements and magnetic moments in the nuclear $d_{5/2}$ and

$f_{7/2}$ shells. The model (in the j-j coupling limit) need
only be imposed to obtain non-unique wave functions,
i.e., those wave functions for which the requirements
that the total-angular momentum I and the isotopic spin
T be good quantum numbers are insufficient to determine
the angular parts of the wave function. Twenty-three
beta transition probabilities for which experimental com-
parison is possible have been calculated. The degree of
agreement is just that found for the cases where only
unique wave functions are required. This agreement is
far superior to that obtained when the criterion of seni-
ority is imposed. The symmetry properties of the quasi-
α structure are also more in accord with our knowledge
of the nucleon-nucleon interaction than those implied by
making seniority a good quantum number. In 10 cases
comparisons were made with the calculated magnetic
moments with experiment. While the agreement is good,
no great improvement over other models can be claimed
since magnetic moments appear rather insensitive to the
choice of model.

1813

Purdue U. [Dept. of Physics] Lafayette, Ind.

LOWEST ORDER VELOCITY DEPENDENT NUCLEAR
FORCE FROM PION FIELD THEORY (Abstract), by M.
Sugawara, M. T. Vaughn, and S. Okubo. [1959] [1]p.
[AF 18(600)1579]   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
266, Apr. 30, 1959.

Velocity dependent 2-nucleon potential has been derived
from relativistic ps-ps pion field theory up to the lowest
order of both coupling and pion-nucleon mass ratio, us-
ing Tamm-Dancoff formalism. The result obtained is not
the same, but of similar general feature, as the 1 ob-
tained from ps-pv pion field theory using the same

procedure. The detail of the derived potential will be reported, with particular emphasis on comparison of this potential with the L · S potential thus far proposed.

1814

Purdue U. [Dept. of Physics] Lafayette, Ind.

SEVEN-DIMENSIONAL CHARGE SPACE, by D. C. Peaslee. [1959] [14]p. incl. diagrs. tables, refs. [AF 18(600)1579]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 230, Apr. 30, 1959. (Title varies)

Also published in Phys. Rev., v. 117: 873-886, Feb. 1, 1960.

Some implications of a charge space of 7 (rotational) dimensions are considered for (I) particle classification, (II) strong interactions, and (III) weak interactions. The principal conclusions from the point of view are that (I) all particles except the photon and graviton can be incorporated in 7 dimensional charge space; lepton conservation must be abandoned, which automatically introduces parity nonconservation into β decay; (II) the one boson, two fermion interaction is predominantly pseudovector in form and induces no mass differences; the Σ - Λ mass difference arises from interference with a fundamental two boson, two fermion interaction of lower symmetry; the Ξ-N mass difference has an "intrinsic" basis and is not due entirely to strong interactions; (III) the weak universal Fermi interaction has signature-1 under time reversal; the strangeness change $\Delta S = \pm 1$ is associated with 256 independent (in principle) terms; the rule $\Delta I \pm \frac{1}{2}$ needs further qualification because $I = T + U$, where T and U are independent operators. (Contractor's abstract)

1815

Radio Corp. of America. Astro-Electronics Div.,
Princeton, N. J.

NON-UNIFORM R.F. FIELD ACCELERATION METH-
ODS FOR PLASMA ROCKETS (Abstract), by E. C.
Hutter and G. A. Swartz. [1959] [2]p. (Bound with its
AFOSR-TN-59-770; AD 241053) (AF 49(638)658)
Unclassified

Presented at Second AFOSR Contractors meeting on
Ion and Plasma Propulsion, North American Aviation,
Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9,
1959.

Investigations are being made of non-uniform RF field
acceleration methods and the feasibility of such methods
for use in plasma rockets for satellite and space vehicle
applications. A laboratory model of a non-uniform RF
field accelerator has been constructed and will be used
to test general principles of 1 particular method. The
model consists of a continuously pumped tube containing
electrode configurations to develop a grad E which is
approx linear over a distance of 10 cm. Plasma will
be generated by a 5 kv vacuum arc between metallic
electrodes located within the alternating field gradient.

1816

Rand Corp., Santa Monica, Calif.

AVAILABILITY OF UPPER ATMOSPHERIC AND
OTHER SELECTED DATA FROM THE I. G. Y., by S.
M. Greenfield. Jan. 7, 1959, 52p. incl. diagrs. refs.
(Research memo. no. 2309-ARPA; Quick key rept. no.
3) (AF 49(638)500) Unclassified

This memorandum describes the U. S. I.G.Y. data ar-
chives pertaining to the geophysics of the upper atmos-
phere. It then reviews the general state of knowledge
and the major lines of investigation of the U. S. I.G.Y.
programs in the interrelated fields of the ionosphere,
aurora, cosmic rays, solar activity, and geomagnetism.
The program for using rockets and satellites as scien-
tific tools in these I.G.Y. studies is also discussed.
Thorough analysis of the I.G.Y. data is necessary in or-
der to gain better understanding of the geophysical prob-
lems investigated — in short, to realize on the invest-
ment in the I.G.Y. program. Except for one modest
study, American workers are not carrying out extensive
analyses of the accumulated I.G.Y. data. However,
Russian and other foreign workers are performing exten-
sive world-wide analyses of the data contributed by all
nations, including the United States. (Contractor's
abstract)

1817

Rand Corp., Santa Monica, Calif.

A SURVEY OF CURRENT RESEARCH IN GASEOUS

ELECTRONICS IN THE UNITED STATES, by W. H.
Culver. R. Geballe, and P. Tamarkin. Jan. 7, 1959, 98p.
incl. refs. (Research memo. no. 2310-ARPA; Quick
key rept. no. 4) (AF 49(638)500) AD 243952
Unclassified

This memorandum outlines the relation of atomic and
ionic impact phenomena to the propagation of electro-
magnetic waves in the upper atmosphere. Several group
efforts are described which are aimed at stimulating
research on impact phenomena and related fields in gas-
eous electronics. Descriptions are given of current and
projected research in principal laboratories in the
United States. The status of the research is summarized
and suggestions for further research are presented.
(Contractor's abstract)

Reaction Motors, Inc., Denville, N. J. see
Thiokol Chemical Corp. Reaction Motors, Inc.,
Denville, N. J.

1818

Rensselaer Polytechnic Inst. Dept. of Aeronautical
Engineering, Troy, N. Y.

NONEQUILIBRIUM FLOW IN GAS DYNAMICS, by T.-Y.
Li. May 1959, 68p. incl. diagrs. refs. (Rept. no. TR-
AE-5901) (AFOSR-TN-59-389) (AF 18(600)1591)
AD 213893; PB 143516 Unclassified

General concepts are given which include: (1) the funda-
mental equations and boundary conditions in problems
of steady adiabatic inviscid flow of a reacting mixture
of perfect gases and (2) a general study of the chemical
relaxation in a gaseous system. The steady 1-dimen-
sional nozzle flow with nonequilibrium chemical reac-
tions is next considered. An important nondimensional
parameter is used to classify the nozzle flow into equi-
librium flow, nonequilibrium flow, and frozen flow. Sig-
nificant departure from equilibrium flow in a hypersonic
shock tunnel nozzle would lead to frozen flow further
downstream. Also presented is a numerical method
whereby the inviscid adiabatic flow of a reacting mix-
ture of perfect gases past a blunt body may be calcu-
lated. Numerical examples show that significant changes
in the flow conditions of the shock layer region can be at-
tributed to the chemical nonequilibrium effects.

1819

Rensselaer Polytechnic Inst. Dept. of Aeronautical
Engineering, Troy, N. Y.

EXPLORATORY EXPERIMENTAL STUDY OF A NEW
METHOD OF ENERGY EXCHANGE BETWEEN STEADY
FLOWS, by W. J. Guman. May 1958, 56p. incl. illus.
diagrs. tables. (Rept. no. TR-AE-5811) (AFOSR-TN-
59-14) (AF 18(603)37) AD 208595; PB 140152
Unclassified

A summary is given of an experimental investigation of
a new energy transfer mode set forth by an exploratory

study of radial-flow air-to-air induction by pseudo-blades in free-rotor models. Test results showing the effects of various gasdynamic and geometrical parameters are presented. Results of limited flow visualization studies are also discussed. (Contractor's abstract)

1820

Rensselaer Polytechnic Inst. [Dept. of Aeronautical Engineering] Troy, N. Y.

[METHOD AND APPARATUS FOR INDUCING FLUID FLOW]. Final rept. 1959 [3]p. (AFOSR-TR-59-140) (AF 18(600)37)   Unclassified

The purpose of this project was to design and build an experimental model to demonstrate the flow induction phenomena predicted for the energy exchange between flows. The model was constructed and instrumented to permit (1) measurements leading to an estimation of the rate and amount of mixing of the flow inducing blades, and (2) a determination of the blade shape, size, and flow induction capability. The difficulties encountered allowed only 2 rotor passages to be built and tested. Although they performed differently, the interacting flows of each maintained their separate identities over an appreciable distance. It soon became evident that secondary-flow patterns were generated in the driving flow by a succession of bends to which this flow was subjected within the rotor. An attempt was made to circumvent these difficulties by studying, in parallel with the main effort, the possibility of generating a pattern of primary pseudo-blades by utilization of a modified and controlled form of rotating stall through stationary cascades. No significant results have yet been made public of these efforts.

1821

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

A STUDY OF THE USE OF OPTIMAL COORDINATES FOR SOME VISCOUS FLOW PROBLEMS, by K. T. Yen. Apr. 1958, 43p. incl. diagr. (Rept. no. TR-AE-5805) (AFOSR-TN-59-11) (AF 49(638)23) AD 208592   Unclassified

A study of the use of optimal coordinates for (a) boundary layer flows of the wedge type and (b) a simple shear flow over a flat plate is made. It is shown that, for these problems, optimal coordinates can be found to achieve smooth transition from the inner viscous flow to the "outer" free stream flow. The significance of these coordinates and some features of the physical problems are discussed. In particular, the boundary layer problem of a flat plate is considered in some detail: a new definition of boundary layer thickness is proposed and some points concerning the properties of the Blasius solution and the boundary layer solution in parabolic coordinates are discussed. For the simple

shear flow it is shown that parabolic coordinates can be used as the optimal coordinates. Two methods of solution for this problem with vorticity index $\omega_0 \sim 1$ and $\omega_0 << 1$, respectively, are given. (Contractor's abstract)

1822

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

ON THE THRUST HYPOTHESIS FOR THE JET FLAP INCLUDING MIXING EFFECTS, by K. T. Yen. June 1959, 47p. incl. diagrs. refs. (Rept. no. TR-AE-5902) (AFOSR-TN-59-737) (AF 49(638)23) AD 225014; PB 143159   Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 607-614, Aug. 1960.

An investigation of thrust generated by a jet flap shows that a linear thrust hypothesis can be obtained, provided linearized potential flow is assumed. In fact, the linearized problem of a jet flap system is found to be the linear combination of a lift problem and a thrust problem. The lift problem gives all the lift generated, but it is of interest to note that the thrust problem would yield all the thrust developed by the jet flap within the limitation of the linearized theory. The mixing of the jet flap with the surrounding fluid is analyzed by the momentum integral method. The analysis substantiates Stratford's suggestion (Aeronaut. Quart., v. 7: 85-105, May 1956) for obtaining an increase of thrust by causing the jet to mix with the main stream in a region of high suction. Finally, some approximate formulas, relating the thrust and the jet angle are derived. (Contractor's abstract)

1823

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

STRUCTURE OF MOLTEN MERCURIC HALIDES, by J. D. E. McIntyre and G. J. Janz. Mar. 1959 [27]p. incl. diagrs. tables, refs. (Technical note no. 10) (AFOSR-TN-59-310) (AF 49(638)50) AD 213242; PB 140582   Unclassified

Presented at Symposium on Molten Salts, New York Acad. Sci., Apr. 1959.

Also published in Ann. New York Acad. Sci., v. 79: 790-802, Jan. 30, 1960.

The physical properties and structures of the mercuric halides for the solid, gaseous, and liquid states are reviewed. Two models for the liquid state are proposed, 1 due to complete self-dissociation with the formation of the complex ions, Hg X+ and Hg X_3^-, as the predominant species, and the 2nd in which the molten salt consists primarily of the molecular

species, $Hg\ X_2$. The evidence of electrical conductance and viscosity is examined in the light of both models, using $HgBr_2$ as example. The percentage of ions free to conduct on this melt is shown to be 2×10^{-2}. The conditions under which calculations of the degree of ionic dissociation by the concept of reduced conductance for molten salts are discussed. (Contractor's abstract)

1824

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

FUSED SALT CHEMISTRY, by G. J. Janz. Aug. 1959 [23]p. incl. diagrs. tables, refs. (Technical note no. 11) (AFOSR-TN-59-880) (AF 49(638)50) AD 226418; PB 143924   Unclassified

Also published in Proc. Internat'l. Symposium on High Temperature Tech., Asilomar, Calif. (Oct. 6-9, 1959), New York, McGraw-Hill, 1960, p. 278-295.

Molten salts form systems which are liquid at temperatures up to 3000°C at atmospheric pressure. They form the largest class of non-aqueous inorganic solvents. The present communication develops some aspects of the structure of molten salts which are of current interest among both theoretical and experimental research workers. The models for molten salts based on liquid state theories and on the electro-chemical properties of these systems are considered. Experimental methods, the information to be gained, and current problems in the fields of pure molten salts, and mixtures are surveyed. (Contractor's abstract)

1825

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

AN ELECTRONIC RECORDING DIFFERENTIAL POTENTIOMETER, by C. Solomons and G. J. Janz. [1959] [1]p. incl. diagr. (AFOSR-3801) (AF 49(638)50)   Unclassified

Also published in Anal. Chem., v. 31: 623, Apr. 1959.

This paper reports on the construction of a thermometric device, capable of accurately measuring small changes of temperature over a wide temperature range (0° to 600°C), and of automatically recording the temperature-time changes. The component units of the present design include a potentiometer, a microvolt amplifier, and a strip-chart recorder. A detailed explanation of the principles of operation is given. The advantages of this design include its simplicity, sensitivity, and versatility over earlier designs.

1826

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

STRUCTURE OF MOLTEN MECURIC HALIDES. II. HEAT AND ENTROPY OF FUSION OF MERCURIC BROMIDE, by G. J. Janz and J. Goodkin. [1959] [2]p. incl. table, refs. (AF 49(638)50)   Unclassified

Published in Jour. Phys. Chem., v. 63: 1975-1976, Nov. 1959.

It is shown that the heat of fusion of $HgBr_2$ at $238.1°$ = 4280 ± 80 cal/mol by drop calorimetry. It is also shown that $\Delta S_{238.1} = 8.4$ eu.

1827

Rensselaer Polytechnic Inst. Dept. of Mathematics, Troy, N. Y.

PROBLEMS IN THE DYNAMICS OF ELASTIC SYSTEMS UNDER INITIAL STRESS, by Y.-O. Tu and G. Handleman. May 8, 1959, 74p. incl. diagr. tables, refs. (Math. rept. no. 25) (AFOSR-TN-59-406) (AF 18(600)-1586) AD 214503; PB 142229   Unclassified

The eigenvalue problems associated with vibration and stability of beams under initial axial stress and flat plates under initial plane stress are formulated from variational principles for general structural members. These eigenvalue problems can be studied by means of variational principles or through the solution of appropriate differential equations with corresponding boundary conditions. Approximate solutions for small γ^2 can be obtained by the perturbation theory of Rellich for which the perturbed differential operator is of lower order than the unperturbed problem. If, however, the beam is everywhere under tension, no critical load exists. Consequently, γ^2 could be very large, and β^4 increases monotonically with respect to γ^2. By writing the differential equation in the form $[\psi(x)u']' + (1/\gamma^2)u^{iv} = (\beta^4/\gamma^2)u$, an approximate solution can be found for large γ by the method of singular perturbation for which the perturbed differential operator is of higher order than the unperturbed one. Perturbation solutions have been carried out for another example of a thin, but long, flat plate simply supported on all edges and subjected to parabolic temperature distribution along its width. Numerical results do indicate the existence of critical loads. (Contractor's abstract)

1828

Rensselaer Polytechnic Inst. Dept. of Mathematics, Troy, N. Y.

LINEAR DIFFERENTIAL EQUATIONS WITH RANDOM

NONHOMOGENEITIES, by W. E. Boyce. Dec. 17, 1959
[11]p. incl. diagr. (Math. rept. no. 29) (AFOSR-TN-59-
1260) (AF 18(600)1586) AD 230946; PB 153382
Unclassified

A method is proposed for dealing with the effects of
certain types of random perturbations in systems
governed by linear differential equations. When these
perturbations occur as a nonhomogeneous term in the
differential equation, the solution can be represented by
means of an integral involving the random nonhomoge-
neity, both for boundary and initial value problems. This
integral can be commuted with the integrals represent-
ing statistical moments, and several consequences of
this fact are discussed. (Contractor's abstract)

1829

Rensselaer Polytechnic Inst. [Dept. of Mathematics]
Troy, N. Y.

A NOTE ON STRAIN HARDENING CIRCULAR PLATES,
by W. E. Boyce. [1959] [12]p. incl. diagrs. (AF 18-
(600)1566) Unclassified

Published in Jour. Mech. and Phys. Solids, v. 7: 114-
125, Mar. 1959.

Previous solutions for unifo ... ily loaded simply sup-
ported circular plates are c ... ended to plates which are
partially clamped. A piecewise linear theory using
Prager's hardening law is employed. The effect of
perturbations in the initial yield stress on the post-
yield stresses and displacements is also examined.
(Contractor's abstract)

1830

Rensselaer Poly echnic Inst. Dept. of Mathematics,
Troy, N. Y.

HARMONIC AND SUBHARMONIC RESPONSE OF AN
ON-OFF CONTROL SYSTEM TO SINUSOIDAL INPUTS,
by B. A. Fleishman. May 7, 1959 [29]p. incl. diagrs.
(Math. rept. no. 24) (AFOSR-TN-59-360) (AF 49(638)-
514) AD 213670 Unclassified

Also published in Jour. Franklin Inst., v. 270: 99-113,
Aug. 1960.

Periodic solutions are derived, of harmonic and sub-
harmonic type, of a differential equation governing the
operation of a relay servomechanism which is subjected
to a sinusoidal input $y_0 \sin \omega t$. Each solution is a "for-
mal" solution in the sense that it is constructed under an
a priori assumption about the manner in which it changes
sign, and this assumption can be verified only after one
has the solution. A significant part of the analysis, then,
is devoted to the determination of suitable conditions on
the parameters y_0 and ω which insure the validity of the
formal solution. (Contractor's abstract)

1831

Rensselaer Polytechnic Inst. Dept. of Mathematics,
Troy, N. Y.

A GENERALIZATION OF THE PHASE RELATIONS
IN A FORCED HARMONIC OSCILLATOR, by B. A.
Fleishman. Dec. 18, 1959 [11]p. incl. diagrs. (Math.
rept. no. 30) (AFOSR-TN-59-1178) (AF 49(638)514)
AD 232437; PB 145999 Unclassified

Also published in Jour. Franklin Inst., v. 272: 360-
365, Nov. 1961.

When a simple harmonic oscillator is subjected to a
sinusoidally varying external force whose frequency is
different from the natural frequency of the oscillator,
there is a simple and wellknown phase relation be-
tween the purely forced response and the forcing func-
tion. They will have the same or opposite signs (ex-
cept when both functions vanish) according as the forc-
ing frequency is less or greater than the natural fre-
quency. It is shown here that when the sinusoidal forc-
ing function is replaced by any member of a wide class
of periodic functions, the relation between the signs of
the forcing function and the forced response continues
to hold when the forcing frequency is greater than the
natural frequency, but no longer holds in the other
case. (Contractor's abstract)

1832

Rensselaer Polytechnic Inst. [Dept. of Mathematics]
Troy, N. Y.

A COMPUTATIONAL PROOF PROCEDURE. AXIOMS
FOR NUMBER THEORY. RESEARCH ON HILBERT'S
TENTH PROBLEM, by M. Davis and H. Putnam. Oct.
1959, 1v. incl. refs. (AFOSR-TR-59-124) (AF 49-
(638)527) AD 240066; PB 144296 Unclassified

A computing procedure for quantification theory: A
refutation algorithm is described whereby, given an
inconsistent formula, a proof of inconsistency is ob-
tained which may also be regarded as a proof of validity
for the negation of the given formula. A finitely axio-
matizable system for elementary number theory: Let
Z be the formalization of elementary number theory,
using Peano's postulates and the recursive equations
for addition and multiplication. A system EZ, formal-
ized within quantification theory, is constructed. On
Hilbert's tenth problem: Hilbert's tenth problem is the
problem of finding an algorithm for determining, given
a diophantine equation, whether or not it has a solution.
Several theorems are established bearing on a related
problem which arises if the diophantine equation is
taken in the following sense: equation of the form P = O,
where P is a polynomial whose exponents may them-
selves be variables as well as constants, to be solved
in integers.

1833

Rensselaer Polytechnic Inst. Dept. of Mechanics, Troy, N. Y.

ON THE ELASTIC IMPACT OF SHORT CYLINDRICAL RODS ON LONG CYLINDRICAL RODS, by C. 3. Barton and E. G. Volterra. [1959] [13]p. incl. diagrs. table. (AF 49(638)19)   Unclassified

Published in Proc. Fourth Midwestern Conf. on Solid Mech., Texas U., Austin (Sept. 9-11, 1959), Austin, Texas U. Press, 1959, p. 318-330.

This paper presents the results of experiments carried out on the longitudinal elastic impact of short cylindrical steel rods (with lengths which varied from 2.54 cm to 100 cm) on very long cylindrical rods. The heights of drop of the impinging bars varied from 2.5 to 10 cm while the diam of the impacted and impinging bars were of 1 in. The electronic circuitry and the equipment used are described. Experimental results obtained are compared in graph form with the theoretical results deduced by applying Hertz's elastic theory of impact. (Contractor's abstract)

1834

Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.

OPTIMUM POWER GENERATION FROM A MOVING PLASMA, by J. L. Neuringer. Apr. 1959 [23]p. incl. diagrs. table. (SRS(PPL) rept. no. 105) (AFOSR-TN-59-515) (AF 49(638)552) AD 216280; PB 144491
                                             Unclassified

Also published in Jour. Fluid Mech., v. 7: 287-301, Feb. 1960.

Solutions for the compressible generator are obtained for only 1 particular value of the entrance Mach number. It is planned to obtain a family of solutions over a wide Mach number range. Interest here is not only toward the determination of the effect on the interaction of the various states of compressibility of the entering plasma, but to see whether the cuspidal behavior occurs for other Mach numbers as well, and at what values of θ. The physical significance, if any, of the cuspidal behavior itself should be investigated. Some analysis should be made into the asymptotic behavior of the solution for limiting values of M_o and θ; for there may exist some combination of finite values of M_o and θ which would give an overall maximum efficiency. A thorough examination should be made into the validity of the assumptions made in section 1 directed towards estimating the practicality of the results. In particular, the effect of the possible development of space charge and the formation of space charge sheaths near the walls should be thoroughly investigated. In conclusion, it is hoped that, while this paper concerned itself mainly with the theoretical treatment of a very highly idealized but in-

teresting problem in hydromagnetics, it will also serve in giving a 1st insight into the behavior of a type of generator which may prove to have future practicality. (Contractor's abstract)

1835

Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.

OPTIMUM POWER GENERATION USING A PLASMA AS THE WORKING FLUID, by J. L. Neuringer. May 1959 [50]p. incl. diagrs. tables. (SRS(PPL) rept. no. 114) (AFOSR-TN-59-571) (AF 49(638)552) AD 245868; PB 144490   Unclassified

Also published in Proc. Third Biennial Gas Dynamics Symposium on Dynamics of Conducting Gases, Evanston, Ill. (Aug. 24-26, 1959), Evanston, Northwestern U. Press, Mar. 1960, p. 153-167. (AFOSR-TR-60-87)

The steady one-dimensional motion of a plasma is considered in a channel of arbitrary and slowly varying cross section. The plasma flows across a transverse magnetic field of arbitrarily varying strength, and the conducting channel walls are connected to an external resistive load of arbitrary magnitude. The extremum problem is formulated using the techniques of the calculus of variations to obtain the appropriate system of differential equations and boundary conditions. For the special cases where the differential constraints i.e. the fluid flow equations, are integrable, analytical solutions are obtained exhibiting the dependence of the required loading on the Magnetic Reynolds number and the flow Mach numbers based on the sonic and Alfvén wave speeds. The power, electrical conversion efficiency, terminal voltage, and distribution of the fluid mechanical variables along the channel are also presented as functions of the above dimensionless parameters. (Contractor's abstract)

1836

Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.

PLASMA PINCH ENGINE. THE PROBLEM OF REPEATED PINCHES (Unclassified title), by A. E. Kunen, I. Granet, and W. J. Guman. Sept. 1959, 16p. incl. diagrs. tables. (AFOSR-TN-59-1337) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)552 and Office of Naval Research under Nonr-285100)   Confidential

1837

Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.

THE ELECTROMAGNETIC PINCH EFFECT FOR SPACE PROPULSION, by A. E. Kunen and W. McIlroy.

Aug. 1959, 22p. incl. illus. diagrs. table, refs. (PPL rept. no. 116) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)552 and Office of Naval Research under Nonr-285100) AD 266981

Unclassified

Also published in Proc. Third Biennial Gas Dynamics Symposium on Dynamics of Conducting Gases, Evanston, Ill. (Aug. 24-26, 1959), Evanston, Northwestern U. Press, Mar. 1960, p. 178-189. (AFOSR-TR-60-87)

The phenomenon of the electromagnetic pinch effect is used to accelerate ionized gases for space propulsion. Electrical energy, initially stored in capacitors, is discharged across two nozzle shaped electrodes wherein the radial pinch is converted to axial motion of the affected gases instead of confinement at the axis. The gas dynamics of a pinch using the hydrodynamical model of a "magnetic piston" driving a shock wave, is combined with the electrodynamics of the circuit to calculate the behavior of the discharge. Experiments on three different electrode designs are discussed and the results obtained are compared with the calculated values. The results of the study are applied to one particular space propulsion system consisting of a nuclear energy source, a space radiator, a turbine-generator, capacitor, and a pinch tube. The specific mission analyzed is a one-way unmanned flight to a Mars orbit, starting from an Earth orbit.

1838

Republic Aviation Corp. [Plasma Propulsion Lab.] Farmingdale, N. Y.

ELECTROMAGNETIC ACCELERATION OF PLASMA FOR SPACE PROPULSION, by A. Schock. [1959] [20]p. incl. illus. table. (Rept. no. PPL-118) (AF 49(638)552) AD 267236   Unclassified

Four methods are described for analyzing the dynamic behavior of plasma accelerators: the gas-dynamic, the snow-plow, the free particle, and the slug model. The latter method is examined in detail, and it is demonstrated that approximate solutions exist which aid in predicting the effect of various parameters on performance. The use of this analytical model in designing the system and the mode of operation can lead to favorable efficiencies in converting electrical to kinetic energy. (Contractor's abstract)

1839

Republic Aviation Corp. [Plasma Propulsion Lab.] Farmingdale, N. Y.

PART I. ELECTROMAGNETICALLY INDUCED CHEMICAL REACTIONS. PART II. POWER GENERATION USING A PLASMA AS THE WORKING FLUID (Abstract), by W. McIlroy. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)552)   Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

Part I. The electromagnetic constriction of gases between 2 electrodes (pinch effect) when a capacitor is suddenly discharged across these electrodes is discussed. The gas dynamical behavior is coupled with the electrical circuit dynamics to calculate the resultant pinch. Theoretical and experimental results are compared. The pinch effect is discussed with a chemically reacting mixture of gases admitted between the electrodes. The gas dynamic model is that of a cylindrical "magnetic piston" progressing towards the axis of the electrodes and driving ahead a detonation wave, thereby releasing chemical energy. Part II. The problem of optimum power generation from a plasma moving through magnetic fields is discussed.

1840

Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.

THE PLASMA PINCH ENGINE, by A. E. Kunen, I. Granet, and W. J. Guman. [1959] [10]p. incl. diagrs. tables. [AF 49(638)552]   Unclassified

Published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass. (Oct. 7-8, 1959), Boston, v. 1: 89-98, 1959. (AFOSR-637)

The phenomenon of the electromagnetic pinch effect is used to accelerate ionized gases for space propulsion. Electrical energy is discharged across two nozzle shaped electrodes wherein the radial pinch is converted to axial motion of the affected gases instead of confinement at the axis. Pertinent parameters that can effect the mode of operation of a pinch engine are categorized. Three analytical models are used for analyzing the radial pinch plasma engine and the results are compared with each other for two sets of system variables of interest. A study has been made for application of an electrical propulsion system to two specific space missions; i.e., satellite control, and a one-way unmanned flight to a Mars orbit. (This is an unclassified version of AFOSR-TN-59-1337, item no. 1836)

1841

RIAS, Inc., Baltimore, Md.

ON THE BEHAVIOR OF THE SOLUTIONS OF LINEAR PERIODIC DIFFERENTIAL SYSTEMS NEAR RESONANCE POINTS, by J. K. Hale. [1959] [55]p. incl. refs. (Technical rept. no. 58-13) (AFOSR-TN-59-12) (AF 49(638)382) AD 208593; PB 140042

Unclassified

Also published in Contrib. Theory of Nonlinear Oscillations, v. 5: 55-89, 1959.

A method of successive approximation which assumes that the basic frequencies of the imperturbed system are not in resonance with the frequency of the periodic disturbance is applied to a discussion of the solutions of linear periodic systems. The linear periodic systems are reviewed for solution in the important case when the frequencies of the imperturbed equation are in resonance with the freque. cy of the periodic disturbance. This case is very important for determining the stability of a periodic solution of a system of nonlinear differential equations.

1842

RIAS, Inc., Baltimore, Md.

A NEW APPROACH TO LINEAR FILTERING AND PREDICTION PROBLEMS, by R. E. Kalman. [1959] [11]p. incl. diagrs. table, refs. (Monograph no. 60-11) (AFOSR-TN-59-268) (AF 49(638)382) AD 238405
Unclassified

Also published in Jour. Basic Eng., v. 82: 35-45, Mar. 1960.

The classical filtering and prediction problem is re-examined using the Bode-Shannon representation of random processes and the "state-transition" method of analysis of dynamic systems. New results are: (1) The formulation and method of solution of the problem apply without modification to stationary and non-stationary statistics and to growing-memory and infinite-memory filters. (2) A nonlinear differential equation is derived for the covariance matrix of the optimal estimation error. From the solution of this equation the coefficients of the differential equation of the optimal linear filter are obtained without further calculations. (3) The filtering problem is shown to be the dual of the noise-free regulator problem. The new method developed here is applied to two well-known problems, confirming and extending earlier results. The discussion is largely self-contained and proceeds from 1st principles; basic concepts of the theory of random processes are reviewed in the appendix. (Contractor's abstract)

1843

RIAS, Inc., Baltimore, Md.

RECENT SOVIET CONTRIBUTIONS TO ORDINARY DIFFERENTIAL EQUATIONS AND NONLINEAR MECHANICS, by J. P. LaSalle and S. Lefschetz. Apr. 1959, 1v. incl. diagrs. refs. (Technical rept. no. 59-3) (AFOSR-TN-59-308) (AF 49(638)382) AD 213092
Unclassified

A summary is presented, in somewhat nontechnical language, of a few of the major areas of research and the significance of recent major Soviet contributions to differential equations and nonlinear mechanics. The areas covered are: stability of physical systems, equi-

librium states, nonlinear vibrations, control systems, and mechanics. In the appendix, a brief mathematical abstract is given of the major Soviet contributions which were available in the year 1958. Authors and exact references are given for each paper and book.

1844

RIAS, Inc., Baltimore, Md.

ASYMPTOTIC STABILITY IN 3-SPACE, by C. Coleman. [1959] [12]p. incl. diagrs. (AFOSR-TN-59-438) (AF 49(638)382) AD 247250 Unclassified

Also published in Contrib. Theory on Nonlinear Oscillations, v. 5: 257-268, 1960.

The system, $\frac{dx}{dt} = f^{(m)}(x) + g(x,t)$ is considered. Conditions are found to ensure the asymptotic stability of the trivial solution of $\frac{dx}{dt} = f^{(m)}(x)$ for $n = 3$. These conditions are that the origin be an attracting focus if the function $h(x_1, x_2) x_2 f_1^{(m)} - x_1 f_2^{(m)}$ has no real zeros, and that $\frac{dr}{dt} < 0 (r^2 = x_1^2 + x_2^2)$ on the zeros of h if they exist. It is pointed out that the 2 conditions given for asymptotic stability are usually easy to apply and in a certain sense are necessary for asymptotic stability. In addition, if $m = 1$, the 2 conditions are equivalent to the condition that the characteristic roots of the matrix of coefficients of the linear terms have negative real parts.

1845

RIAS, Inc., Baltimore, Md.

THE LOCAL THEORY OF PIECEWISE CONTINUOUS DIFFERENTIAL EQUATIONS. I. IDEAL SYSTEMS, by J. André and P. Seibert. [1959] [31]p. incl. diagrs. refs. (AFOSR-TN-59-439) (AF 49(638)382) AD 247251
Unclassified

Also published in Contrib. Theory of Nonlinear Oscillations, v. 5: 225-255, 1959.

A generalization is given on notes by André and Seibert (Arch. Math., v. 7: 148-156; 157-164, 1956) concerning n-dimensional piecewise linear systems. The systems under consideration are piecewise of type C^2 and the set of discontinuity is assumed to consist of certain hypersurfaces of class C^3. The entire sets of solutions passing through given closed subsets of a switching space is qualitatively described. In addition, systems with switching delay, distinguished from the other systems discussed by the property of the discontinuous function changing sign shortly after the trajectory has reached the switching space, rather than at the exact moment of transition, are described.

1846

RIAS, Inc., Baltimore, Md.

THE APPLICATION OF A FIXED POINT THEOREM
TO A VARIETY OF NON-LINEAR STABILITY PROB-
LEMS, by A. Stokes. [1959] [12]p. (AFOSR-TN-59-440)
(AF 49(638)382) AD 247252   Unclassified

Also published in Contrib. Theory of Nonlinear Oscilla-
tions, v. 5: 173-184, 1960.

A fixed point theorem for locally convex linear spaces,
due to Tychonoff, is used to reduce the study of the
boundedness and stability of certain n-dimensional vec-
tor differential equations to the study of the correspond-
ing properties of related 1st-order equations. (Contrac-
tor's abstract)

1847

RIAS, Inc., Baltimore, Md.

EXISTENCE THEOREMS FOR PERIODIC SOLUTIONS
OF NONLINEAR LIPSCHITZIAN DIFFERENTIAL SYS-
TEMS AND FIXED POINT THEOREMS, by L. Cesari.
[1959] [56]p. (AFOSR-TN-59-441) (AF 49(638)382)
AD 247253   Unclassified

Also published in Contrib. Theory of Nonlinear Oscilla-
tions, v. 5: 115-172, 1960.

Nonlinear systems of ordinary differential equations in
the complex field containing a small parameter and sat-
isfying merely conditions of continuity, or a Lipschitz
condition, are considered. Existence theorems for peri-
odic solutions, and familities of periodic solutions are
proved. (Contractor's abstract)

1848

RIAS, Inc., Baltimore, Md.

ON THE STABILITY OF PERIODIC SOLUTIONS OF
WEAKLY NONLINEAR PERIODIC AND AUTONOMOUS
DIFFERENTIAL SYSTEMS, by J. K. Hale. [1959] [23]p.
incl. refs. (AFOSR-TN-59-442) (AF 49(638)382)
AD 247254   Unclassified

Also published in Contrib. Theory of Nonlinear Oscilla-
tions, v. 5: 91-113, 1960.

Application is made of results from a previous report
concerning the behavior of the solutions of linear peri-
odic differential systems near resonance points. An
analysis is made to determine a number of sufficient
conditions for asymptotic stability. The same methods
are applied to the linear variational equations for a
periodic solution of an autonomous nonlinear differential
system to obtain a number of sufficient conditions for
asymptotic orbital stability.

1849

RIAS, Inc., Baltimore, Md.

THE TIME OPTIMAL CONTROL PROBLEM, by J. P.
La Salle. [1959] [24]p. incl. diagrs. (AFOSR-TN-
59-444) (AF 49(638)382) AD 247256   Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 573-
577, Apr. 1959.

Also published in Contrib. Theory of Nonlinear
Oscillations, v. 5: 1-24, 1960.

Let $A(t)$; $B(t)$ be continuous $n \times n$, $n \times r$ matrices,
respectively, $f(t)$ a continuous n vector for $t \geq 0$, x an
n vector and u an r vector. Let Ω be the set of steering
functions $u(t) = (u_1(t),\dots, u_r(t))$, where $u_i(t)$ is a meas-
urable function for $t \geq 0$ satisfying $|u_i(t)| \leq 1$; Ω_0 the
subset of Ω consisting of bang-bang steering functions,
those $u(t)$ for which $|u_i(t)| \equiv 1$. Let x_0 and a path
$x = z(t)$ be given, let $x = x(t;u)$ be the solution of $(1)x' =
A(t)x + B(t)u(t) + f(t)$ satisfying $x = x_0$ at $t = 0$; an ad-
missible steering function $u^* \in \Omega$ is called optimal
relative to Ω if, for same $t^* > 0$, $x(t^*;u^*) = z(t^*)$ and
$x(t;u) \neq z(t)$ for $0 < t < t^*$ and all $u \in \Omega$. Several re-
sults are announced, among which are the following.
(I) If $u^* \in \Omega_0$ is optimal relative to Ω_0, then it is
optimal relative to Ω. (II) If Ω contains an optimal
steering function, then Ω_0 contains one. (III) If, for
some $u \in \Omega$, $x(t;u) = z(t)$ for some $t > 0$, then Ω contains
an optimal steering function u^* which is necessarily of
the form $(2)u^*(t) = \text{sgn}(yX^{-1}(t)B(t))$, where $X(t)$ is a
fundamental matrix solution if $x' = A(t)x$, y is an n-
dimensional (row) vector and $\text{sgn}(v_1, \dots, v_r)$ ($\text{sgn } v_1$,
$\dots, v_r$).

1850

RIAS, Inc., Baltimore, Md.

THE BANG-BANG PRINCIPLE, by J. P. LaSalle. Nov.
1959 [17]p. incl. refs. (Technical rept. no. 59-5)
(AFOSR-TN-59-1142) (AF 49(638)382) AD 231866;
PB 145770   Unclassified

Presented at First Internat'l. Cong. of the Internat'l.
Federation of Automatic Control, Moscow (USSR), 1960.

Also published in Automatic and Remote Control, v. 1:
493-497, 1960.

The so-called "bang-bang" principle has for sometime
been an intuitive one, i.e., if a system is to be guided
to an objective in minimum time with limited steering,
then the optimal steering can only be achieved at all
times by using the maximum steering available. The
validity and extent of control that can be achieved are
the main topics discussed. The system being controlled

is assumed to be linear and considered as a function
of the time the steering enters linearly. The coeffi-
cients need not be constants, although some aspects of
the constant coefficient case are simpler. (Contrac-
tor's abstract)

1851

RIAS, Inc., Baltimore, Md.

AFTER END-POINT MOTIONS OF GENERAL DISCON-
TINUOUS CONTROL SYSTEMS AND THEIR STABILITY
PROPERTIES, by J. Andre and P. Seibert. [1959] [4]p.
incl. refs. (AFOSR-TN-59-1150) (AF 49(638)382)
Unclassified

Presented at First Internat'l. Cong. of the Internat'l.
Federation of Automatic Control, Moscow (U.S.S.R.),
1960.

Also published in Automatic and Remote Control, v. 2:
919-922, 1960.

In this paper application is made of the results of pre-
vious research on problems of stability and asymptotic
behavior. A review of these earlier results is first
given in 2 sections. The first deals with "ideal" sys-
tems (in which the physical effect of switching delay is
neglected) and the second deals with the switching de-
lay and also discusses end-point motion. The basic sta-
bility theorem, according to which, a system with switch-
ing delay is stable at the origin if the corresponding
system with infinitesimal switching delay has this prop-
erty, is discussed. An application of this theorem is
given and it is shown that every solution starting in a
certain domain around the origin tends to a limit cycle
near the state of equilibrium. Rough formulas for the
period and amplitude of this periodic solution are given.

1852

RIAS, Inc., Baltimore, Md.

PROBLEMS OF ASYMPTOTIC BEHAVIOR AND STA-
BILITY, by L. Cesari. [1959] [6]p. incl. refs. (AFOSR-
TN-59-1176) (AF 49(638)382)   Unclassified

Presented at Pacific General meeting of the Amer. Inst.
Elec. Engineers, San Diego, Calif., Aug. 8-12, 1960.

Also published in Trans. Amer. Inst. Elec. Engineers,
v. 80: (Pt. II) 161-166, 1961.

A discussion is presented on a number of areas in non-
linear differential equations which appear to be of
heightened interest. Some of the subjects considered
are points of equilibrium and their stability in the small,
second method of Lyapunov and stability in the large,
periodic solutions, families of periodic solution, and al-
most periodic solution. Primarily nonlinear differen-
tial systems of the form $\dot{x} = f(x, t)$ are considered or, in
the autonomous case, of the form $\dot{x} = f(x)$.

1853

RIAS, Inc., Baltimore, Md.

A NOTE ON THE CONTINUITY OF CHARACTERISTIC
EXPONENTS, by J. C. Lillo. [1959] [4]p. (Monograph
no. 60-7) (AFOSR-TN-59-1177) (AF 49(638)382)
AD 236448   Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 46: 247-
250, Feb. 1960.

A new number which is called the major characteristic
exponent, written $\lambda(A)$, is introduced for the system
$\dot{x} = A(t)x$ where $A(t) \epsilon M_n$. Here $\|A\| = \text{l.u.b.} \|A(t)\|$
$t \epsilon R$
where R may be taken as either the real line or the
positive real half line, $\|A(t)\| =$
n
$\Sigma \quad |a_{ij}(t)|$, and M_n is the set of all continuous n x n
i,j=1
matrices A(t) whose norms are finite. It is shown that
for any $A \epsilon M_n, \lambda(A)$ is upper semicontinuous with re-
spect to the norm. A number of perturbation results
are given which are straightforward generalizations of
known results.

1854

RIAS, Inc., Baltimore, Md.

LIAPUNOV'S FUNCTION AND BOUNDEDNESS OF
SOLUTIONS, by T. Yoshizawa. Dec. 1959 [10]p.
(Technical rept. no. 59-7) (AFOSR-TN-59-1218)
(AF 49(638)382) AD 231861; PB 146151
Unclassified

Presented at Symposium on Ordinary Differential Equa-
tions, Mexico City, Sept. 1959.

Also published in Bol. Soc. Matem. Mexicana, Series
II, v. 5: 146-151, 1960.

A system of differential equation $\frac{dx}{dx} = F(t,x)$ is consid-
ered where x denotes an n-dimensional vector and
F(t,x) is a given vector field which is defined and con-
tinuous in a domain. Let $x = x(t;x_0,t_0)$ be a solution
of $\frac{dx}{dt}$ through the initial point (t_0,x_0). The solution
for $t \geq t_0$ is considered.

1855

RIAS, Inc., Baltimore, Md.

CONTROLS: AN APPLICATION OF THE DIRECT
METHOD OF LIAPUNOV, by S. Lefschetz. Dec. 1959,
11p. (Technical rept. no. 59-8) (AFOSR-TN-59-1219)
(AF 49(638)382) AD 231862; PB 146150
Unclassified

Presented at Symposium on Ordinary Differential Equations, Mexico City, Sept. 1959.

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 139-143, 1960.

The results of Lur'e, Letov, Malkin and Jakubovič on the application of the direct method of Liapunov to the generalized problem of Lur'e in the theory of control systems are described and extended. The system (F), $\dot{x} = Ax + f(\sigma)b$, $\dot{\sigma} = c'x - rf(\sigma)$ is considered, where x, b, c are n-vectors and σ, $f(\sigma)$, r are scalars. The matrix A is constant. The system $\dot{x} = Ax$ is the initial physical system, the components of x are its parameters, while σ, $f(\sigma)$ are feedback signal and characteristic. It is assumed that $f(\sigma)$ is to be continuous,

$\sigma f(\sigma) > 0$ for $\sigma \neq 0$ and $\int_0^s f(\sigma)d\sigma \to \infty$ as $|s| \to \infty$. The problem is to choose the control parameters (the components of c and the scalar r), so as to obtain asymptotic stability for all initial values x and all allowable choices of $f(\sigma)$. The solution is worked with a positive definite function (if all the characteristic roots A have negative real parts) $V(x,\sigma) =$

$x'Bx + \int_0^\sigma f(\sigma)d\sigma$, where B is the solution of the matrix equation $A'B + BA = -C$ for given $C > 0$, so that $B > 0$, as is well-known. The control parameters are now chosen so that the time derivative of V along any solu-

tion of (F), $\dot{V}(x,\sigma) = x'A'Bx + x'BAx - rf^2(\sigma) + 2f(\sigma)\{\frac{1}{2}(b'Bx + x'Bb) + \frac{1}{2}C'x\}$, is a negative definite function of x and $f(\sigma)$. The case when A has some characteristic roots with zero real parts is also considered.

1856

RIAS, Inc., Baltimore, Md.

ON THE CHARACTERISTIC EXPONENTS OF LINEAR PERIODIC DIFFERENTIAL SYSTEMS, by J. K. Hale. Dec. 1959 [13]p. incl. refs. (Technical rept. no. 59-6) (AFOSR-TN-59-1220) (AF 49(638)382) AD 231589; PB 146149   Unclassified

Presented at Symposium on Ordinary Differential Equations, Mexico City, Sept. 1959.

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 58-66, 1960.

A new exposition is presented concerning linear systems with periodic coefficients $y' = Ay + \epsilon C(t)y$, $(y = y_1, y_2, ..., y_N)$ near systems with constant coefficients. In principle, of course, the behavior of the solutions is described by Floquet's theory, but this description will depend on the nature of the characteristic multipliers. Here symmetrics, reversibility and similar properties are shown to lead to criteria which ensure that all or some of the characteristic multipliers lie on the unit circle, in which case, boundedness is obtained for all or some solutions. The method of successive approxi-

mations is applied to a linear differential system with periodic coefficients to determine the characteristic exponents. A theorem implying asymptotic stability for weakly nonlinear systems of differential equations is also mentioned.

1857

RIAS, Inc., Baltimore, Md.

BEHAVIOR OF SOLUTIONS NEAR INTEGRAL MANIFOLDS, by J. K. Hale and A. P. Stokes. Mar. 1960 [59]p. incl. refs. (Technical rept. no. 60-10) (AFOSR-TN-59-1222) (AF 49(638)382) AD 236444; PB 147319
                                   Unclassified

Also published in Arch. Rational Mech. Anal., v. 6: 133-170, 1960.

The behavior of the solution of the differential equation $dx/dt = Ax + f(t,x)$; $x = x_i$, $i = 1,2,...,n$, $f(t,0) = 0$, is discussed in a neighborhood of $x = 0$, where some of the roots of the constant matrix A have zero real parts, and $f(t,x)$ is small compared with x when x is small. The relationship of this system to the ones where the eigenvalues of A have nonzero real parts is given. The system of equations arises in a natural way as variational equations for invariant surfaces which consist of families of periodic solutions.

1858

RIAS, Inc., Baltimore, Md.

INTEGRAL MANIFOLDS OF PERTURBED DIFFEREN-TIAL SYSTEMS, by J. K. Hale. [1959] [36]p. incl. refs. (Monograph no. 61-14) (AFOSR-TN-59-1233) (AF 49-(638)382)   Unclassified

Also published in Ann. Math., v. 73: 496-531, May 1961.

A discussion is presented on the properties of integral manifolds of perturbed differential systems. A brief review is given of a single 2nd order differential equation $z'' + \omega^2 z = \epsilon Z(t, z, z')$, $(' = d/dt)$ where $\omega > 0$, $\epsilon > 0$, $Z(t, z, z')$ is a periodic function of t of period $2\pi/\sigma$, and is sufficiently smooth. The problem addressed is under what conditions is the qualitative behavior of the solution of $x' = \epsilon X(t,x)$ where $X(t,x)$ is an almost periodic function of t with frequencies ω, σ, the same as the qualitative behavior of $x' = \epsilon X_0(x)$, $X_0(x) = \lim_{T \to \infty} T^{-1} \int_0^T X(t,x)dt$. More specifically, supposing that the latter condition has an asymptotically stable equilibrium point x (which in the z,z' variables would be a periodic function of period $2\pi/\omega$), is it true that the former system exact solution $x = x^*(t,\epsilon)$ which is almost periodic with basic frequencies ω, σ and agrees when $\epsilon = 0$. This question is answered in the

affirmative. Several proofs concerning this subject are included in this report, presented as a contrast to other results found elsewhere.

1859

RIAS, Inc., Baltimore, Md.

PERIODIC ORBITS ON TWO MANIFOLDS, by B. :.. Reinhart. Jan. 1960 [7]p. incl. diagr. (Technical rept. no. 60-2) (AFOSR-TN-59-1282) (AF 49(638)382) AD 233043; PB 146722   Unclassified

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 184-187, 1960.

In this note the author gives conditions under which a vector field defined on a solid torus M admits a periodic orbit lying on its surface B. The method is to exploit the concept of winding number of a regular curve of class C^1 with respect to a fixed vector field on an oriented 2-dimensional manifold. Earlier the author related the winding number of a curve and a vector field to the non-existence of periodic orbits. The result alluded to in the first sentence above is established by showing that the obstruction to sectioning a circle bundle over an appropriately chosen disk is a generator of $H^2(M, B; \pi_1(S'))$. (Math. Rev. abstract)

1860

RIAS, Inc., Baltimore, Md.

A DISCUSSION OF DIFFERENTIAL EQUATIONS ON PRODUCT SPACES, by J. K. Hale and A. Stokes. Jan. 1960 [15]p. (Technical rept. no. 60-3) (AFOSR-TN-59-1283) (AF 49(638)382) AD 233044; PB 146721   Unclassified

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 67-74, 1960.

Consider the equation (1) $\overset{o}{x} = Ax + f(t,x)$, x an n-vector, where $f(t,x) = o(\| x \|)$ as $\| x \| \to 0$, uniformly in t, and A is a constant matrix, all of those eigen-values have negative real parts. Then the origin is asymptotically stable. and solutions beginning near the origin tend to O exponentially. For many reasons, it would be beneficial to know how the behavior of (1) is altered if the system is disturbed. In this case, there is the result that in the equation (2) $\overset{}{x} = Ax + f(t,x) + g(t,x)$, where A and f are as in (1), and $\|g(t,x)\| \le \eta$, for $t \ge 0$, $\| x \|$ bounded, the origin is stable if η is sufficiently small. Here observe that the stability of the origin has been preserved, (even though the origin may not be a solution of (2)), but the presence of g destroys the asymptotic stability. If however, it is required that $\| g \| \le \eta$, and $g \to 0$ as $t \to \infty$, for $\| x \|$ bounded, the origin in (2) is asymptotically stable, if η is small enough, although no longer do the solutions approach zero exponentially. In fact, if x(t) is a solution, $x(t) \to 0$ as $t \to \infty$ at very

nearly the same rate as g does; for instance, if $\int_0^\infty \| g(t) \| dt < \infty$, $\int_0^\infty \| x(t) \| dt < \infty$, etc. (see H.S.). Note that if $g \to 0$ for $\| x \|$ small, as $t \to \infty$, it may be assumed $\| g \|$ small for all $t \ge O$, or discuss the equation for $t > T$, where T is such that $\| g(t,x) \| \le \eta$ for $t \ge T$. (Contractor's abstract)

1861

RIAS, Inc., Baltimore, Md.

ON THE METHOD OF KRYLOV-BOGOLIUBOV-MITROPOLSKI FOR THE EXISTENCE OF INTEGRAL MANIFOLDS OF PERTURBED DIFFERENTIAL SYSTEMS, by J. K. Hale. Jan. 1960 [13]p. incl. refs. (Technical rept. 60-1) (AFOSR-TN-59-1293) (AF 49-(638)382) AD 233806; PB 146365   Unclassified

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 51-57, 1960.

Some important results of N. Bogoliubov and Y. Mitropolski [Asymptotic methods in the theory of non-linear oscillations, (Russian) Moscow (1955) Rev. 1958] on the existence of integral manifolds of differential systems are discussed. The results are stated in terms of a particular problem, but the proofs of these results apply to a much larger variety of questions. Only those generalizations are mentioned which are essential to make an association with some recent results of various authors in this country, and postpone a more complete discussion of the generalizations to a later paper. (Contractor's abstract)

1862

RIAS, Inc., Baltimore, Md.

THE STRUCTURE OF LOCAL HOMEOMORPHISMS, III, by S. Sternberg. [1959] [27]p. incl. refs. (AF 49-(638)382)   Unclassified

Published in Amer. Jour. Math., v. 81: 578-604, July 1959.

Let V^n [U^n] be the group of all local C^∞ volume-preserving [respectively, volume-preserving up to a constant factor] mappings in n-space which leave the origin fixed; H^n the group of all local Hamiltonian mappings in 2n-space; C^n the set of all mappings given by $x_i = x_i f_i(\omega)$, $\omega = x_1 \ldots x_n$, with $\Pi f_i = 1$ (which is proven to be a maximal commutative subgroup of V^n). Theorems: 1-4. If $T \epsilon V^n$, n > 2, has a diagonizable Jacobian with eigenvalues λ_i such that if $\lambda_i = \lambda_1^{m_1} \ldots \lambda_n^{m_n}$, then $m_i - 1 = m_j$, $j \ne i$, there exists $R \epsilon V^n$ such that if $RTR^{-1} \epsilon C^n$; if n = 2 the same holds true under the

additional assumption $|\lambda_i| \neq 1$; each such T lies in a
one parameter group in V^n. 5-7. If $T \in U^n$ and $\lambda_i \neq$
$\lambda_1^{m_1} ... \lambda_n^{m_n} 1$ for all $m_j \geq 0$, $\Sigma_{mj} > 1$, there exists
$R \in V^n$ such that RTR^{-1} is the linear part of T; every
such T lies in a one-parameter group in U^n. If $T \in H^n$,
$|\lambda_i| \neq 1$ and $\lambda_1^{m_1} ... \lambda_n^{m_n} \neq 1$ for all integers m_j posi-
tive or negative which are not all zero, there exists an
$R \in H^n$ such that RTR^{-1} is of the form $x_i = x_i f_i$
$(\omega_1, ... \omega_n)$, $y_i = y_i g_i(\omega_1 ..., \omega_n)$, $\omega_i = x_i y_i$, $f_i g_i = 1$, $\partial \log$
$f_i / \partial \omega_j = \partial \log f_j / \partial \omega_i$. The proofs are via correspond-
ing theorems for formal mappings. (Math Rev.
abstract)

1863

RIAS, Inc., Baltimore, Md.

EXTERIOR DIFFERENTIAL SYSTEMS AND ELLIPTIC
EQUATIONS, by B. L. Reinhart and S. Sternberg.
[1959] [2]p. (AF 49(638)382)   Unclassified

Published in Proc. Nat'l. Acad. Sci., v. 45: 1522-1523,
Oct. 1959.

It is stated without proof that systems of elliptic par-
tial differential equations (in the sense of Douglis-
Nirenberg) give rise to exterior differential systems
which are globally in involution. It is also stated as a
remark of Hausner and Sternberg (unpublished) that the
2nd order parabolic, hyperbolic, and ultrahyperbolic
equations give rise to exterior differential systems
which are not raised to an assigned power. It is thought
that the above suggests some sort of equivalence be-
tween the notions of ellipticity and involution, and also
the possibility of a non-analytic theory of exterior dif-
ferential systems in involution. (Math. Rev. abstract)

1864

RIAS, Inc., Baltimore, Md.

A THEORY OF SCHAEFER'S EXPANSION PATTERNS,
by R. H. Aranow and L. Witten. [1959] [12]p. incl.
illus. diagrs. (Monograph no. 61-13) (AFOSR-TN-59-
1155) (AF 49(638)735) AD 261733   Unclassified

Also published in Jour. Colloid Sci., v. 16: 127-138,
Apr. 1961.

An attempt is made to interpret theoretically the ex-
pansion patterns observed by Schaefer when an oil drop
is deposited on a water surface covered with a protein
layer. Schaefer observed that the line separating the
oil from the protein could be smooth, rough circular,
or star-shaped. The proposed interpretation involves

a type of hydrodynamic instability known as the
Rayleigh-Taylor instability. Jagged or star-shaped
separations indicate the presence of these hydrodynam-
ic instabilities. They require that small perturba-
tions of the interfacial line from smooth circular will
grow rapidly with time. Since these perturbations are
always present the patterns for the unstable cases will
always jagged or star-shaped. The physical criteria
for the presence of these instabilities are derived, and
the difference between the rough circular and star-
shaped patterns is discussed. (Contractor's abstract)

1865

Rice Inst. [Dept. of Mathematics] Houston, Tex.

A NUMERICAL METHOD FOR THE SOLUTION OF A
PARABOLIC SYSTEM, by J. Douglas, Jr. Feb. 9, 1960,
15p. incl. refs. (AFOSR-TN-59-1121) (AF 49(638)632)
AD 232551; PB 146383   Unclassified

Also published in Numerische Math., v. 2: 91-96, 1960.

The object of this paper is to introduce a finite difference
method for the approximate solution of a parabolic sys-
tem of differential equations that arises in the descrip-
tion of 2-phase flow of incompressible fluids in a multi-
dimensional porous medium. The differential system is
$\nabla \cdot (\alpha u) + \nabla \cdot (\beta \nabla v) = 0$, $\nabla \cdot (\beta u) + \nabla \cdot (\alpha \nabla v) =$
$\gamma \frac{\partial v}{\partial t}$, where the coefficients α, β, and γ are functions of
x, y, and v. The coefficients satisfy the relations (1)
$M \geq \alpha (x,y,v) \geq m > 0$, (2) $|\beta (x,y,v)/\alpha(x,y,v)| \leq B < 1$,
(3) $\gamma (x,y,v) \geq m > 0$. In addition. they are expected to
be twice continuously differentiable. The convergence
of the solution of the difference system to that of the
differential system is proved. An alternating direction
iteration method for solving the system of linear equa-
tions that occur at each time step is discussed also.
(Contractor's abstract)

1866

Rochester U. Dept. of Chemical Engineering, N. Y.

ADHESION OF PROTECTIVE COATINGS TO METALS
BY TENSILE TESTS, by G.-J. Su, T. R. Faucett, and
B. Gumowski. Sept. 1959, 63p. incl. illus. diagrs. tables,
refs. (AFOSR-TR-59-172) (AF 18(600)1187)
AD 230751; PB 145362   Unclassified

The results discussed in the report were obtained by
means of tensile tests with butt joints, using steel, brass,
and aluminum as the metal substrates, and various com-
mercial resins and coating formulations. The following
factors which affect adhesion are discussed: (1) Effect of
loading rate on measured bond strength. (2) Surface
treatment effects on adhesion to aluminum. (3) Bond
strength as a function of bond thickness. (4) Bond
strength as a function of curing time for thermosetting
coatings. (Contractor's abstract)

1867

Rochester U. [Dept. of Chemistry] N. Y.

THE PHOTOOXIDATION OF ISOPROPYL IODIDE, by
G. R. McMillan. Jan. 14, 1959, 8p. incl. tables.
(AFOSR-TN-59-32) (AF 18(600)1528) AD 209204;
PB 139825   Unclassified

Also published in Jour. Phys. Chem., v. 63: 1526-1528,
Sept. 1959.

Experiments were performed to gain information about
the reactions of the isopropyl radical with O. The
photooxidation was conducted in a conventional vacuum
line free of stopcocks. Oxygen was prepared by heating
reagent-grade $KMnO_4$, and dried by passage through a
series of traps cooled in liquid N. The light source
was a Hg lamp. The lines at 3130A were isolated by a
filter composed of a solution of $NiSO_4 \cdot 6H_2O$ and
$CoSO_4 \cdot 7H_2O$, both in a 5-cm optical path, together with
a 3-mm thickness of Corning Glass 9863 and 1 mm of
Pyrex. In a few experiments, a thickness of 5 mm of
Pyrex was used to remove all light of wavelength less
than 2900A. Light intensity was varied by the use of
screens. Quantum yield was based on the production of
CO from the photolysis of diethyl ketone at 110°. At the
end of a photolysis, residual O was pumped away and
measured with all products and excess isopropyl iodide
condensed in a trap cooled with liquid N. A fraction
volatile at -130° was removed and analyzed with a mass
spectrometer. The fraction of products not condensed
at -130° contained only propylene, propane, and CO_2.

The liquid products were isopropyl alcohol and Me_2CO.

Strong heating of the quartz reaction cell and connecting
tubing after a series of experiments resulted in the evo-
lution of only traces of gas not condensed at liquid N
temperature, which indicated that HgO is not a major
product of the oxidation.

1868

Rochester U. Dept. of Chemistry, N. Y.

THE PHOTOLYSIS OF AMMONIA IN THE PRESENCE
OF NITRIC OXIDE, by A. Serewicz and W. A. Noyes,
Jr. Feb. 9, 1959, 11p. incl. tables. (AFOSR-TN-59-
125) (AF 18(600)1528) AD 210430; PB 139826
                                       Unclassified

Also published in Jour. Phys. Chem., v. 63: 843-845,
June 1959.

The products of the photolysis of ammonia in the pres-
ence of nitric oxide are N_2, N_2O, H_2O, and H_2. The
last is a minor product unless the concentration of
nitric oxide is very low. A possible mechanism is
proposed. (Contractor's abstract)

1869

Rochester U. Dept. of Chemistry, N. Y.

THE PHOTOCHEMICAL TYPE II PROCESS IN 2-
HEXANONE-5, 5-d_2 AND 2-HEXANONE, by R.
Srinivasan. Apr. 20, 1959, 19p. incl. table, refs.
(AFOSR-TN-59-423) (AF 18(600)1528) AD 214773
                                       Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81:
5061-5065, Oct. 5, 1959.

The photolysis of 2-hexanone-5, 5-d_2 at 3130A and
room temperature was found to give mainly C_3H_5D and
acetone which was a mixture of CH_3COCH_2D (45%) and
CH_3COCH_3 (54%). Since the course of the photolysis and
the nature of the minor products were similar to that
of 2-hexanone, it was surmised that acetone-d_1, which
may have been formed in the type II primary process,
was subsequently exchanging the odd deuterium atom
for a hydrogen atom. Such an exchange was not found
to take place. The photolysis of 2-hexanone in a cell
that had been exposed to D_2O vapor and then evacuated,
gave rise to C_3H_6 and acetone which was made up of
CH_3COCH_2D (25%) and CH_3COCH_3 (75%). Pure ace-
tone did not exchange with the D_2O on the walls under
the same conditions. These results can be explained on
the basis of the formation of propylene and the enolic
form of acetone in the primary process, and the sub-
sequent rearrangement of the enolic form to the ketonic
form on the walls, the latter step often involving the
exchange of one hydrogen (or deuterium) atom. (Con-
tractor's abstract)

1870

Rochester U. Dept. of Chemistry, N. Y.

PHOTOISOMERIZATION PROCESSES IN CYCLIC
KETONES. IV. CYCLOHEPTANONE, by R. Srinivasan.
May 22, 1959, 10p. incl. tables, refs. (AFOSR-TN-59-
533) (AF 18(600)1528) AD 221894   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 5541-
5542, Nov. 5, 1959.

One of the products of the vapor phase photolysis of
cycloheptanone at 3130A has been identified as 6-
heptenal. The other products were carbon monoxide,
propylene, traces of ethylene, 1-hexene and cyclohexane.
Quantum yields for the formation of carbon monoxide
and 6-heptenal have been obtained. The mechanism of
the photochemical decomposition of cycloheptanone
appears to be similar to that of cyclopentanone and
cyclohexanone. (Contractor's abstract)

1871

Rochester U. Dept. of Chemistry, N. Y.

PHOTOCHEMICAL STUDIES. [LV]. THE NITROUS
OXIDE-ETHANE SYSTEM: LIQUID PRODUCTS AND
COMPETITIVE RATES, by E. Murad and W. A.
Noyes, Jr. June 19, 1959, 18p. incl. diagr. tables,
refs. (AFOSR-TN-59-641) (AF 18(600)1528)
AD 219173   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 6405-
6408, Dec. 20, 1959.

The reactions of oxygen atoms produced by the direct
photochemical decomposition of nitrous oxide with
ethane have been studied. The relative rates of reac-
tion of these atoms with ethane and with ethylene have
been determined, the latter being about 330 times the
former. Many of the products not volatile at -77° have
been determined, although a complete material balance
has not been achieved. Many steps in the complete
mechanism are suggested strongly by the natures of
the products and their dependence on conditions. The
oxygen atoms react so much more rapidly with some of
the products than they do with ethane that the over-all
mechanism is very complex. (Contractor's abstract)

1872

Rochester U. Dept. of Chemistry, N. Y.

PHOTOISOMERIZATION OF 5-HEXEN-2-ONE, by R.
Srinivasan. Aug. 24, 1959 [13]p. incl. diagr. table,
refs. (AFOSR-TN-59-876) (AF 18(600)1528)
                                    Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 775-
778, Feb. 20, 1960.

The photochemistry of 5-hexen-2-one has been studied
in the vapor phase in the temperature range from 27°
to 139° at 3130A and also with radiation from an un-
filtered mercury arc. The compound was found to
be very stable towards photolysis. The most important
product at 3130A up to 139° was an isomer, the struc-
ture of which is most probably

$CH_3 - C - O - CH_2 - CH - CH_2 - CH_2$. Evidence for

this structure is based on the ultraviolet, infrared,
nuclear magnetic resonance, and mass spectra of the
product. The only other product at 3130A that was
identified was carbon monoxide. At shorter wave-
lengths, in addition to these products, methane, C_2 and

C_3 hydrocarbons, acetone and biacetyl were identified.

Although the ultraviolet absorption spectrum of 5-
hexen-2-one resembles that of 2-hexanone, its photo-
chemical stability is similar to that of unsaturated
carbonyl compounds with the double bond conjugated
with the carbonyl group. (Contractor's abstract)

1873

Rochester U. Dept. of Chemistry, N. Y.

THE PHOTOLYSIS OF AMMONIA ($N^{15}H_3$) IN THE

PRESENCE OF NITRIC OXIDE, by R. Srinivasan.
Nov. 13, 1959 [7]p. incl. diagr. (AFOSR-TN-59-1196)
(AF 18(600)1528)   Unclassified

Also published in Jour. Phys. Chem., v. 64: 679-680,
May 1960.

It was observed by Serewicz and Noyes (Jour. Phys.
Chem., v. 63: 843-845, June 1959) that the photolysis
of ammonia in the presence of nitric oxide led to the
formation of nitrogen, nitrous oxide, water, and small
amounts of hydrogen. The present study was under-
taken to obtain confirmatory evidence for the reaction

mechanisms discussed in these findings. Nitrogen[15]
was used to label the nitrogen atom in the ammonia
molecule. It was observed that the exclusive forma-
tion of nitrogen molecules of mass 29 and nitrous ox-
ide of mass 44 is predicted by the mechanism.

1874

Rochester U. Dept. of Physics and Astronomy, N. Y.

EFFECTS OF INTRA-CLUSTER GAS AND DUST
UPON THE VIRIAL THEOREM, by D. N. Limber.
[1959] [33]p. incl. tables. (AFOSR-TN-59-805) (AF 49-
(638)52) AD 254094   Unclassified

Also published in Astrophys. Jour., v. 130: 414-428,
Sept. 1959.

The application of the virial theorem to clusters of
galaxies (or stars) is reexamined for the case in
which a significant fraction of the total mass of the
cluster exists in the form of intra-cluster gas. A modi-
fied form for the expression of the virial theorem in this
case is obtained in terms of the mean-square velocity
of the galaxies, the total mass of the galaxies, the total
mass of the gas, the radius of the cluster, a coefficient
depending upon the spatial distribution of the galaxies,
and a 2nd coefficient depending upon both the spatial
distribution of the galaxies and the spatial distribution
of the gas——the 2 distributions being different in gener-
al. The 2 coefficients are evaluated and tabulated for
those cases in which the 2 distributions can be approxi-
mated by the polytropic distributions with integral in-
dices. It is shown how the coefficients corresponding
to more general distributions can be approximated by
means of the tabulated coefficients. (Contractor's
abstract)

1875

Rochester U. [Dept. of Physics and Astronomy] N. Y.

K^{+} SCATTERING IN THE ENERGY RANGE 100-250

MEV, by D. F. Davis, N. Kwak, and M. F. Kaplon.
[1959] [4]p. incl. diagrs. tables, refs. (AFOSR-4117)
(Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)303] and Atomic Energy Commission)   Unclassified

Published in Phys. Rev.. v. 117: 846-849, Feb. 1, 1960.

Approximately 65 m of K^+-meson track was scanned in the energy interval 100-250 mev. Analysis of the data shows that the K^+-neutron charge exchange scattering rises appreciably above the value 1/5 corresponding to a pure I = 1 interaction and at energies > 150 mev appears to be larger than the K^+-neutron direct scattering. Analysis of the angular distribution of the inelastic events for K^+ incident energies greater than 150 mev indicates a nonisotropic center-of-mass angular distribution, peaked towards $\theta_{c.m.}$ = 180°. (Contractor's abstract)

1876

Rochester U. [Dept. of Physics and Astronomy] N. Y.

K^--MESON ELASTIC SCATTERING BY EMULSION NUCLEI, by D. F. Davis, N. Kwak, and M. F. Kaplon. [1959] [4]p. incl. diagrs. refs. (AFOSR-4118) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)303] and Atomic Energy Commission)   Unclassified

Published in Phys. Rev., v. 117: 850-853, Feb. 1, 1960.

Data on elastic nuclear scattering of K^- mesons in emulsion have been obtained. The differential cross section has been calculated by the WKB approximation in the method of partial waves. It is concluded that the real and imaginary potentials necessary to give the correct K^- nucleon cross section also give a good fit to the elastic nuclear scattering data. (Contractor's abstract)

1877

Rochester U. Dept. of Physics and Astronomy, N. Y.

POSSIBLE EVIDENCE FOR A NEGATIVE HEAVY MESON, by T. Yamanouchi and M. F. Kaplon. [1959] [2]p. incl. diagr. (AFOSR-4119) [AF 49(638)303]   Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 283-284, Sept. 15, 1959.

Evidence is presented which suggests the existence of a negative heavy meson. It is shown that the new negative meson has a total of 8 prongs, 1 of which is the primary particle initiating the event. It lies in the beam direction, and the grain density measurements at 0.5 mm and 8.5 mm from the star yield the values 2.89 ± 0.12 and 2.58 ± 0.11 times the minimum, respectively, indicating that the particle is indeed moving in the direction of the star. One prong (no. 7) is shown

as a "picture book" Σ^+ hyperon decaying at rest by the protonic mode; it has an energy at emission of 23.2 mev. Another prong (no. 6), in conjunction with no. 7 gives the event its peculiar nature. It appears to come to rest after traversing 628μ and at this point there is associated with it a singly charged particle (6') of 101μ range and a recoil of a few grains. The decay of a He hyperfragment by $\pi^°$ mode seems to be compatible with the observations. Assuming that this represents the event, then the lower limit to the total visible prong energy emitted from A is 565 mev. This represents a production of strangeness -2 in a strong interaction.

1878

Rochester U. Dept. of Physics [and Astronomy] N. Y.

STRANGENESS 2 MESON, by T. Yamanouchi. [1959] [3]p. incl. table. (AFOSR-4120) [AF 49(638)303]   Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 480-482, Nov. 15, 1959.

Additional support for a previously reported new strange particle (item no. 1877 , Vol. III) is presented. It is pointed out that several other investigators have reported events which agree within the limits of experimental error with some of the present findings. According to conventional scheme, a meson of strangeness 2 should occur as an isotopic singlet having Q = +1 and S = +2; the antiparticle would have Q = -1 and S = -2. They are called D^+ and D^- respectively. This paper reports on the evidence that suggests the existence of D^-.

879

Rochester U. [Dept. of Physics and Astronomy] N. Y.

K^+-MESON INTERACTIONS IN NUCLEAR EMULSION (Abstract), by D. F. Davis, M. F. Kaplon, and N. Kwak. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)303] and Atomic Energy Commission)   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31. 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 25, Jan. 28, 1959.

The study of K^+-meson interactions in nuclear emulsion has been continued. The "separated" K^+-meson beam produced at the Berkeley bevatron entered the stack at an energy of 250 mev and was brought to rest in the emulsion. A track length of 77.5 meters has been scanned giving 97 inelastic events. The energy

dependence of the cross section and of the ratio, charge exchange/inelastic scatter, will be discussed. The elastic scattering in the energy region 100-250 mev will also be presented.

1880

Rochester U. [Dept. of Physics and Astronomy] N. Y.

CORRELATION THEORY OF STATIONARY ELECTROMAGNETIC FIELDS. Part I. THE BASIC FIELD EQUATIONS, by P. Roman and E. Wolf. Oct. 1959, 22p. (Technical note no. 1) (AFOSR-TN-59-1188) (AF 49(638)602) AD 232919; PB 146336
Unclassified

Also published in Nuovo Cimento, Series X, v. 17: 462-476, Aug. 16, 1960.

In recent papers a class of 2nd order correlation tensors was introduced and certain differential equations which govern their propagation were postulated. These correlation tensors, which may be regarded as natural generalizations of functions used in the analysis of partially coherent optical wavefields, characterize the correlations which exist between the electromagnetic field vectors at any 2 points in the field, at any 2 instants of time. A derivation of the basic differential equations is presented; and it is shown that the 2 sets into which the equations naturally split are not independent, but in fact follow from each other as a consequence of certain symmetry properties which the correlation tensors exhibit. (Contractor's abstract)

1881

Rochester U. Inst. of Optics, N. Y.

ULTRAVIOLET ABSORPTION IN THALLOUS HALIDES, by S. Tutihasi. July 1959 [13]p. incl. diagrs. refs. (Technical rept. no. 2 under AF 49(638)432 and technical note no. B-4 under AF 49(639)433) AD 225508; PB 143635
Unclassified

Also published in Jour. Phys. Chem. Solids, v. 12: 344-348, Feb. 1960.

The ultraviolet absorption in TlCl and TlBr was measured on thin films and fused samples as a function of temperature. The effect of excessive chlorine or thallium on the optical absorption of TlCl was studied. The experiments of Vysochanskii are discussed in the light of the observations obtained here. The 1st absorption band in TlCl, which peaks at 3.44 ev at -185°C, is absent in films condensed on a cold substrate of KCl and appears after annealing. It seems that the crystal structure of evaporated films of TlCl changes from the NaCl-type to the CsCl-type. (Contractor's abstract)

1882

Rochester U. Inst. of Optics, N. Y.

OPTICAL CONSTANTS OF GERMANIUM IN THE REGION 0-10 ev, by M. P. Rimmer and D. L. Dexter. Oct. 1959 [12]p. incl. diagrs. (Technical rept. no. 3) (AFOSR-TN-59-1254) (AF 49(638)432) AD 231204; PB 145646
Unclassified

Also published in Jour. Appl. Phys., v. 31: 775-777, May 1960.

A program was written for the IBM 650 digital computer to evaluate the Kramers-Kronig dispersion relation between real and imaginary parts of the index of refraction, n and k. By this means measurement of the reflection coefficient over a sizable energy range allows the determination of n and k throughout most of this region. Reflection data of Philipp and Taft on Ge were analyzed in this way, and the results are compared with those of Philipp and Taft obtained by another method. The results are similar, minor differences occurring in the fine structure. (Contractor's abstract)

1883

Rochester U. Inst. of Optics, N. Y.

ON THE VARLEY MECHANISM FOR DEFECT FORMATION IN ALKALI HALIDES, by D. L. Dexter. Nov. 1959, 5p. (Technical rept. no. 4) (AFOSR-TN-59-1255) (AF 49(638)432) AD 231205; PB 145645
Unclassified

Also published in Phys. Rev., v. 118: 934-935, May 15, 1960.

Also published in Proc. Internat'l. Conf. on Color Centers and Crystal Luminescence, Turin (Italy) (Sept. 8-12, 1960) Turin, Litografia F. Gili, 1961, p. 1-5. (AFOSR-982)

The Varley mechanism is examined, according to which Frenkel defects are produced in the halogen sublattice of alkali halides subsequent to multiple ionization of the halide ions. Arguments are presented to show that the lifetime of a positive halogen ion against recapture of electrons in orders of magnitude smaller than the ejection time of the halogen, and thus that the Varley mechanism is inoperative. The arguments may not be applicable for inner shells alone, but experimental evidence is adduced to eliminate this case.

1884

Rochester U. Inst. of Optics, N. Y.

OPTICAL INVESTIGATION OF SEMICONDUCTORS AT THE UNIVERSITY OF ROCHESTER, by D. L. Dexter. [1959] [9]p. incl. diagrs. refs. (AFOSR-4464) (AF 49-(638)432)
Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Presented at 1958 Internat'l. Conf. on Semiconductors, Rochester U., N. Y., Aug. 18-22, 1958.

Also published in Jour. Phys. and Chem. Solids, v. 8: 473-481, Jan. 1959.

A survey is given of recent investigations at this institution of optical properties of non-metals. The fundamental absorption of the alkali, silver, and thallous halides and of cadmium sulfide; intrinsic photoconductivity in the alkali halides; electron multiplication in lead sulfide and selenide; and the theory of excitons in the tight binding approximation are among the topics discussed. (Contractor's abstract)

1885

Rochester U. Inst. of Optics, N. Y.

EXCITON STATES IN RARE-GAS CRYSTALS, by R. S. Knox. [1959] [27]p. incl. diagrs. refs. [AF 49(638)432] Unclassified

Published in Jour. Phys. and Chem. Solids, v. 9: 238-264, Mar. 1959.

A formulation of Frenkel's theory of excitons is given in which a general method of constructing orthonormal 1-electron trial exciton functions from atomic functions is outlined, and excitation energies, band structure, effective masses, and integrated absorption cross-sections are computed in an approximation which includes atomic spin-orbit interaction and overlapping of atomic wave functions through terms of the order S^2. A treatment of singlet and triplet states built from the atomic p^5s configuration in a cubic lattice is given as an example which is intended to apply to the lowest excited states of the rare gases themselves or to corresponding states of halide lattices on a simple excitation model. With the omission of momentum-dependent terms, the formalism is applicable to computations of 1st-order excitation energies in systems involving substitutional impurities. (Contractor's abstract)

1886

Rochester U. Inst. of Optics, N. Y.

EXCITON STATES IN CRYSTALLINE ARGON, by R. S. Knox. [1959] [16]p. incl. diagrs. tables, refs. [AF 49-(638)432] Unclassified

Published in Jour. Phys. and Chem. Solids, v. 9: 265-280, Mar. 1959.

The formalism of a previous paper is applied numerically to exciton states in crystalline argon arising from the atomic $3p^54s$ configuration. Under the assumptions that higher configurations do not perturb the energies and transition probabilities and that the Löwdin symmetrical orthogonalization process converges at terms

of order S^2, the Frenkel model predicts 2 exciton absorption lines at 9 ev (± 1 ev) separated by 0.2 ev and having a combined integrated absorption coefficient of the order of 10^6 cm^{-1} ev. The estimated computational error in excitation energy arises not from the neglect of any important interactions but from difficulties in evaluating 2- and 3-center integrals and from the natural inaccuracy of the atomic Hartree-Fock functions. Exciton effective masses are relatively insensitive to the direction of exciton momentum, are of the order +5 electron masses and are found to depend primarily on exchange and overlap interactions rather than the Heller-Marcus long-range interaction. It is suggested that closely related overlap and exchange terms may be of considerable importance in the attractive part of crystal binding energies, particularly in the rare gases. (Contractor's abstract)

1887

Rochester U. Inst. of Optics, N. Y.

PHOTOCONDUCTIVITY IN KI AND RbI, by K. Teegarden. Apr. 10, 1959 [20]p. incl. diagrs. refs. (Technical note no. B3) (AFOSR-TN-59-303) (AF 49-(633)433) AD 213087; PB 140537 Unclassified

A threshold for photoconductivty was observed in single crystals of KI at room temperature and RbI at room temperature and 203°K. This threshold occurs at a wavelength somewhat shorter than the position of the first fundamental band in both materials and is presumed to result from band to band transitions. No photocurrent is observed in the region of the first fundamental band in either KI or RbI. (Contractor's abstract)

1888

Rome U. School of Aeronautical Engineering (Italy).

THE EQUIELASTIC MODEL TECHNIQUE IN BLOWN-DOWN WIND-TUNNEL TESTS, by L. Broglio. Dec. 1958 [39]p. incl. diagrs. (Technical note no. 6; SIARgraph no. 46) (AFOSR-TN-59-409) (AF 61(514)888) AD 214506 Unclassified

The importance of building up an equielastic model for solving aeroelastic similarity problems, previously pointed out (see item no. ROM.02:004, Vol. II) is further shown by a general procedure for determining the equielastic model. The 2 main problems of this procedure are: (1) to find the pressure distribution on a solid model, the spanwise and chordwise rotations being known at every station; and (2) to determine the tip rotation for a given wing structure. Both problems are here solved in the most general way. Numerical examples complete the work. (Contractor's abstract)

> 462 <

1889

Rome U. School of Aeronautical Engineering (Italy).

EXPERIMENTAL INVESTIGATION ON DELTA WING
AND COMPLETE CONFIGURATION MODELS FOR
AEROELASTIC SIMILARITY PROBLEMS AT SUPER-
SONIC BLOW DOWN WIND-TUNNEL, by L. Broglio,
C. Buongiorno and others. Mar. 1959 [58]p. incl. illus.
diagrs. tables. (Technical note no. 7; SIARgraph no.
50) (AFOSR-TN-59-954) (AF 61(514)888) AD 228439;
PB 144304   Unclassified

The experimental techniques for the aeroelastic inves-
tigation at the supersonic blow down wind tunnel are
presented. Wind tunnel data at M = 3.01 on triangular
wing model are given. These results show the small
importance of the chordwise deflection of the section
on the aerodynamic characteristics. An experimental
investigation at M = 3.12 on a complete airplane con-
figuration is presented, showing the importance of the
parameter $\frac{P_o}{E}$ on the lateral stability derivatives.
In the Appendix of the report the preliminary design of
a magnetic support for dynamic stability tests is pre-
sented. (Contractor's abstract)

1890

Rome U. School of Aeronautical Engineering (Italy).

RESEARCH ON AEROELASTICITY, by L. Broglio.
Final rept. May 1959 [12]p. (SIARgraph no. 51)
(AFOSR-TR-59-134) (AF 61(514)888) AD 226438;
PB 144297   Unclassified

Research is reported on the following: (a) modeling
technique and theory for aeroelastic similarity in blow-
down wind tunnel tests; (b) developing technique and an
experimental device to study the same problems of
point (a) but including dynamic effects; (c) finding exact
solutions of the problem of the heat conduction in het-
erogeneous solids with boundary conditions function of
space and time.

1891

Rome U. School of Aeronautical Engineering (Italy).

TRANSIENT TEMPERATURES AND THERMAL VI-
BRATIONS IN SPACE STRUCTURES, by L. Broglio.
June 1959 [61]p. incl. diagrs. (Technical note no. 2;
SIARgraph no. 53) (AFOSR-TN-59-1014) (AF 61(052)-
198) AD 230271; PB 146708   Unclassified

Also published in Proc. Durand Centennial Conf. on
Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-
8, 1959), New York, Pergamon Press, 1960, p. 52-75.
(AFOSR-TR-59-108)

The problems of heat conduction analysis and thermal

vibrations were unified and analyzed. The general solu-
tion of each of the 2 problems is reached by obtaining
Green's function. Application of this method is used for
the problems of ablation in heat conducting bodies. Also
discussed is the problem of a reentering ablating body
of infinitely small conductivity being subjected to kinetic
heating.

1892

Rome U. School of Aeronautical Engineering (Italy).

ANISOTROPIC COMPOSITE THERMAL STRUCTURES
FOR HYPERSONIC FLIGHT, by L. Broglio. Feb. 1959
[55]p. incl. diagrs. (Technical note no. 1; SIARgraph
no. 52) (AFOSR-TN-59-1015) (AF 61(052)198)
AD 230231; PB 146707   Unclassified

The solution is given for the instantaneous source of
heat located at a generic point of an anisotropic heter-
ogeneous composite body of whatever shape. The solu-
tion satisfies both the differential equation of the heat
conduction and the boundary conditions of the specific
body. Thus, by using appropriate space integrals of
such solution and by leaving all kinds of nonlinearities
(such as variation of thermal properties, radiation and
so on) to the final timewise integration, a very general
solution is found. The solution is introduced for the
thermal shock generated by an instantaneous unit time-
wise temperature step at a generic point of a body of
whatever shape. The solution satisfies the differential
equations of the dynamic thermal motion and the bound-
ary conditions of the specific body. Here again the most
general solution is immediately written as an appropri-
ate space and time integral of the unit solution. By
combining the results, the thermal motion generated
by an instantaneous heat source located at a generic
point is obtained. (Contractor's abstract)

1893

[Royal Coll. of Science and Tech. Dept. of Mathematics,
Glasgow (Scotland)].

THE SOLUTION OF BOUNDARY VALUE PROBLEMS
FOR A GENERAL HODOGRAPH EQUATION, by A.
G. Mackie. Oct. 1958 [16]p. incl. diagrs. refs. (Tech-
nical note no. 5) (AFOSR-TN-59-195) (AF 61(514)-
1170) AD 211472   Unclassified

Also published in Proc. Cambridge Philos. Soc., v. 54:
538-553, Oct. 1958.

See item no. RCS.01:006, Vol. II for abstract.

1894

Royal Inst. of Tech., Stockholm (Sweden).

LIQUID FLOW IN TUBES. I. THE TRANSITION
PROCESS UNDER HIGHLY DISTURBED ENTRANCE

FLOW CONDITIONS, by E. R. Lindgren. [1959] [23]p. incl. illus. diagrs. refs. (AFOSR-TN-59-955) (AF 61-(514)1202) AD 226598　Unclassified

Also published in Arkiv Fysik, v. 15: 97-119, Mar. 1959.

Previously reported observations on the transition process in stream bi-refringent tube flow have been repeated in part. New photographic records are presented in order to improve the illustrative material of previous reports with respect to the characteristics of the transition process. Some of the topics discussed, are as follows: (1) Some effects appearing within laminar flow region; (2) Turbulent spots and turbulent flashes (slugs); (3) Some observations on the decay of eddies; (4) The intermittency factor and the shape of the turbulent flashes; and (5) Turbulent tube flow.

1895

Royal Inst. of Tech., Stockholm (Sweden).

LIQUID FLOW IN TUBES. II. THE TRANSITION PROCESS UNDER LESS DISTURBED INLET FLOW CONDITIONS, by E. R. Lindgren. [1959] [17]p. incl. illus diagrs. (AFOSR-TN-59-956) (AF 61(514)1202) AD 226599　Unclassified

Also published in Arkiv Fysik, v. 15: 503-519, May 1959.

Previous findings (item no. 1894) are confirmed, according to which transition is caused by primary inlet disturbances of finite strength which cause the initiation of turbulent spots before they fade away and according to which the spots during their downstream travel develop into turbulent slugs. It also is confirmed that the fully developed turbulent slug should be regarded as being composed of a turbulent spot (or spots) traveling along the boundaries and of a central core of eddies with decay maintained by a process of continuous diffusion of eddies from the spot into the core. The "splitting" of turbulent slugs as well as the elongation of turbulent streaks, both of which have been reported previously, are found to be due to the core eddies being brought forward of their generating spots. Some of these always decaying eddies may, before they fade away, initiate the formation of a new spot ahead of the original one. The same process may then repeat itself with the new spots with a probability determined by the flow conditions. The turbulent streaks and possibly also the self-preserving turbulent flow in general appear to be inhomogeneously maintained by discrete turbulent spots. (Contractor's abstract)

1896

Royal Inst. of Tech., Stockholm (Sweden).

LIQUID FLOW IN TUBES. III. CHARACTERISTIC

DATA OF THE TRANSITION PROCESS, by E. R. Lindgren. [1959] [12]p. incl. diagrs. (AFOSR-TN-59-957) (AF 61(052)1202) AD 226597　Unclassified

Also published in Arkiv Fysik, v. 16: 101-112, July 1959.

Qualitative studies on the transition process in tube flow of liquids reported in previous papers of this series were extended to cover also quantitative relationships of this phenomenon for flow of White Hector bentonite sols of various concentrations. Experimental evidence is presented which indicates that the transition process depends on some physical (e.g. structural) properties of the liquids which are not accounted for by the coefficient of viscosity and the density. The findings actually demonstrate that the Reynolds law of similarity does not entirely apply to the flows investigated. These findings are supported also by studies of a new transition quantity, the maximum relative spot velocity (=maximum relative velocity of the rear of the turbulent slugs as defined previously (ROY.02:001, Vol. II), the determination of which is independent of the viscosity of the liquids. (Contractor's abstract)

1897

Royal Inst. of Tech., Stockholm (Sweden).

TRANSITION IN BIREFRINGENT FLUID FLOWS, by E. R. Lindgren. Final rept. Jan. 1, 1957-Mar. 3, 1959. June 23, 1959, 5p. (AFOSR-TR-59-135) (AF 61(514)-1202) AD 242413; PB 150331　Unclassified

The aim of the present study has been to try to remove apparent discrepancies between findings of various authors and if possible to add facts about the transition process which may have escaped previous investigators. Only a general survey of the experimental technique and the findings are presented in this report.

1898

Royal Inst. of Tech. Dept. of Inorganic Chemistry, Stockholm (Sweden).

ON THE CRYSTAL STRUCTURE OF TELLURIUM (IV) CATHECOLATE, by P. J. Antikainen and G. Lundgren. July 27, 1959 [10]p. incl. diagrs. tables. (Technical note no. 1) (AFOSR-TN-59-661) (AF 61(052)162) AD 232076; PB 145621　Unclassified

Also published in Suomen Kemistilehti, v. 32B: 175-179, 1959.

The crystals of $Te(C_6H_4O_2)_2$ are monoclinic with $a = 22.6_8 \pm 0.1A$, $b = 6.93 \pm 0.05A$, $c = 16.5_2 \pm 0.1A$, $\beta = 123.3° \pm 1°$, $V = 2.17 \cdot 10^3 A^3$. They contain 8 formula units per unit cell giving a calculated density of 210 g/ml. Weissenberg photographs along [010] and [001] show that the reflections hkl are absent when $h + k =$

odd and the reflections h0l when h = odd and l = odd. This is characteristic for the space groups no 15 C2/c and no 9 Cc. The tellurium arrangement in the crystals has been determined. It can be described by space group C2/c, where the tellurium atoms are situated in 8(f) with x = 0.236, y = 0.165, and z ≈ 0.175. Work on the determination of the positions of the oxygen and carbon atoms is in progress. (Contractor's abstract)

1899

Royal Inst. of Tech. Dept. of Inorganic Chemistry, Stockholm (Sweden).

THE HYDROLYSIS OF THE SILVER ION, Ag^+, IN ACID SELF-MEDIUM, by G. Biedermann and S. Hietanen. [1959] [6]p. incl. table. (Technical note no. 2) (AFOSR-TN-59-662) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)-162 and Swedish Natural Science Research Council)
AD 255002   Unclassified

Also published in Acta Chem. Scand., v. 14: 711-716, 1960.

The hydrolysis of the Ag^+ ion has been investigated at 25°C by measuring the hydrogen ion concentration in the self-medium 1 M Ag^+(NO_3^-) with a glass electrode.

The data, which indicate an extremely slight hydrolysis at log [H+] ≥ −6.3, can be explained by the equilibrium

$Ag^+ + H_2O \rightleftharpoons AgOH + H^+$ with log $*K_1 \leq -11.1$; the effect may also be due to polynuclear complexes. No evidence was found for the presence of appreciable amounts of polynuclear hydrolysis products proposed previously. (Contractor's abstract)

1900

Royal Inst. of Tech. Dept. of Inorganic Chemistry, Stockholm (Sweden).

POTENTIOMETRIC STUDY OF THE ARGENTATE (I) COMPLEX IN ALKALINE SOLUTION, by P. J. Antikainen, S. Hietanen, and L. G. Sillén. July 27, 1959 [16]p. incl. diagrs. table. (Technical note no. 3) (AFOSR-TN-59-663) (AF 61(052)162) AD 232056; PB 145613   Unclassified

Also published in Acta Chem. Scand., v. 14: 95-101, 1960.

The composition of the argentate (I) complex formed in alkaline solutions of silver oxide has been studied by emf titrations with constant ionic medium (0.95 and 12.6 M NaOH, 1.15 and 11.5 M KOH) using Ag-AgI electrodes. The data indicate that only mononuclear complexes are formed, from this result, together with the solubility data of other workers, it is concluded that the formula of the complex is $Ag(OH)_2^-$. No evidence has been found for the presence of the polynu-

clear argentate complexes proposed by some previous workers. The solubility product of $Ag_2O(s)$ in 3 M $Na(ClO_4)$ at 25°C was determined as log K_{s0} = log $[Ag^+][OH^-]$ = −7.42 ± 0.02. (Contractor's abstract)

1901

Royal Inst. of Tech. Dept. of Inorganic Chemistry, Stockholm (Sweden).

APPLICATION OF A LIQUID DISTRIBUTION METHOD TO THE STUDY OF THE HYDROLYSIS OF Ag^+, by P. J. Antikainen and D. Dyrssen. July 30, 1959 [20]p. incl. diagrs. tables. (Technical note no. 4) (AFOSR-TN-59-644) (AF 61(052)162) AD 232053; PB 145612
                    Unclassified

Also published in Acta Chem. Scand., v. 14: 86-94, 1960.

The distribution of silver at 25°C between solutions of quinoline (Q) in benzene and 3 M $Na(ClO_4,OH)$ has been studied as a function of $[Q]_{org}$, $[OH^-]$ and the silver concentration. In these experiments the reaction

Ag^+ (aq) + 2 Q (org) + ClO_4^- (aq) = AgQ_2ClO_4 (org)

(eq. const. log K = 3.23 ± 0.02) was used for the study of the hydrolysis of Ag^+ in 3 M $NaClO_4$ at low concentrations of silver. The data provide no evidence for the presence of significant amounts of polynuclear complexes. Furthermore, the data indicate that AgOH is not formed to any large extent in 3 M $Na(ClO_4, OH)$. The value of log $K_1K_2 = log[Ag(OH)_2^-] [Ag^+]^{-1} [OH^-]^{-2}$ was calculated to be 3.50 ± 0.10 in 3 M $Na(ClO_4, OH)$. No evidence was found for $Ag(OH)_3^{2-}$ in solutions less alkaline than 0.5 M. These conclusions are supported by measurements of the solubility of Ag_2O in 3 M $Na(ClO_4, OH)$. The value of log K_{s2} = log $[Ag(OH)_2^-][OH^-]^{-1}$ was determined to be −3.82 ± 0.06. Together with the solubility product, $K_{s0} = 10^{-7.42 \pm 0.02}$, determined by Hietanen (Acta Chem. Scand., v. 13: 1828-1838, 1959) we obtained log K_1K_2 = 3.60 ± 0.08. The pH of the solubility minimum of Ag_2O is determined by this constant. In connection with the distribution experiments the distribution constant, K_d, of quinoline between various organic solvents and 3 M $NaClO_4$ has been determined. (Contractor's abstract)

1902

Rutgers U. Coll. of Engineering. New Brunswick, N. J.

ANALYSIS OF COMPOSITE X-RAY DIFFRACTION

PRCFILES, by J. J. Slade, Jr. and L. L. Nanni. June 1960 [8]p. incl. diagrs. refs. (AFOSR-TN-59-1198) (Sponsored jointly by Air Force Office of Scientific Research as technical note no. 1 under AF 49(638)17 and Atomic Energy Commission as technical note no. 3 under AT(30-1)1730) AD 238640 Unclassified

Also published in Jour. Appl. Phys., v. 31: 699-706, Apr. 1960.

The irregular line profiles associated with crystals that have a random structure which is coarse relative to the irradiated area are regarded as the result of the composition of a characteristic distribution and a set of broadening and translating processes. The inversion of this composition is expressed operationally. A differential operator associated with the transform of the intrinsic distribution is introduced. This operator reduces the line profile to the set of broadening and translating elements. The operations are such as may be performed by an analogue computer. Preliminary experiments show that it may be possible to obtain the desired resolution. The effects of "noise" and distortion are investigated. (Contractor's abstract)

1903

Rutgers U. Microwave Electronics Lab., New Brunswick, N. J.

POWER CONVERSION WITH NONLINEAR REACT-ANCES, by E. Della Torre and M. D. Sirkis. June 1959, 12p. incl. diagr. refs. (Research rept. no. 59-1) (AFOSR-TN-59-596) (AF 49(638)554) AD 217181; PB 143958 Unclassified

Also published in I.R.E. Trans. on Circuit Theory, v. CT-8: 95-99, June 1961.

The Manley-Rowe relationships for a nonlinear reactance are derived proceeding from the voltage-charge characteristic for a capacitance. The method used follows the work of Van der Ziel. The problem is generalized to an arbitrary number of generators. A criterion on the degree of nonlinearity required for power conversion to power at a particular frequency is also derived. A condition on the oscillator frequencies is found, but this condition proves to be less strict in any practical case than the Manley-Rowe requirement of incommensurability. Output filter considerations are also discussed. (Contractor's abstract)

1904

Rutgers U. School of Chemistry, New Brunswick, N. J.

SENSITIZATION OF MERCUROUS OXALATE BY DYES, by P. A. van der Meulen and R. H. Brill. [1959] [7]p. incl. diagrs. tables. (AFOSR-TN-59-451) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1150 and Squier Signal Lab., Fort Monmouth, N. J. under DA 36-039-sc-15860) AD 264119 Unclassified

Also published in Photog. Sci. and Eng., v. 2: 121-127, Oct. 1958.

See item no. RUT.05:001, Vol. II for abstract.

1905

Rutgers U. School of Chemistry, New Brunswick, N. J.

PHOTOTHERMOGRAPHIC SENSITIZATION OF MER-CUROUS OXALATE BY MERCUROUS AND SILVER IODIDES, by P. B. Gilman, Jr., P. A. Vaughan, and P. A. van der Meulen. [1959] [21]p. incl. diagrs. table, refs. (AFOSR-TR-59-67) (AF 18(600)1150) AD 217410 Unclassified

Also published in Photog. Sci. and Eng., v. 3: 21-220, Sept.-Oct. 1959.

Gelatin emulsions containing mercurous oxalate and mercurous iodide have photothermographic sensitivity to visible light. Sensitometric studies show that the sensitization of mercurous oxalate by mercurous iodide is increased considerably by the addition of silver iodide, although the latter compound by itself is not a sensitizer. Sensitometric and x-ray diffraction studies indicate that the sensitization is caused by the photolysis of mercurous iodide to form mercury and mercuric iodide. In the absence of silver iodide, yellow mercuric iodide is a product of photolysis. If silver iodide is present, red mercuric iodide and/or Ag_2HgI_4 are

formed and the efficiency of the photolysis of mercurous iodide is increased. (Contractor's abstract)

1906

St. Louis U. [Dept. of Physics] Mo.

THE BETHE-SALPETER EQUATION AND THE HY-
DROGENLIKE ATOM, by Z. V. Chraplyvy and E. M.
MacKinnon. Final technical rept. Oct. 15, 1959, 24p.
(AFOSR-TR-59-155) (AF 18(600)789) AD 229677
Unclassified

The Breit Hamiltonian for a 2-particle system consists
of 2 Dirac Hamiltonians plus interaction terms. The
Bethe-Salpeter (B.S.) Hamiltonian does not have such
a simple relation to the Dirac Hamiltonian except in the
case of uncoupled particles. A requirement which the
B.S. equation should fulfill is the ability to reproduce
the established results of the Dirac equation to the ex-
tent they agree with the experiment. To test this point,
the B.S. equation for the hydrogenlike atom is converted
to an equivalent 1-particle equation, comparable to the
Dirac equation. Its eigenfunctions and eigenvalues are
determined in 2 steps. The equation is simplified
further and the exact solutions of the simplified ver-
sion are found in closed form. They serve as an ap-
proximation to the solutions of the full 1-particle equa-
tion using the Fock transformation and the Funk-Hecke
theorem.

1907

St. Louis U. [Dept. of Physics] Mo.

SOLUTION OF A REDUCED BETHE-SALPETER
EQUATION (Abstract), by E. M. Mackinnon and Z. V.
Chraplyvy. [1959] [1]p. [AF 18(600)789]
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
156, Mar. 30, 1959.

One test of the validity of the Bethe-Salpeter (B.S.)
equation and especially of the ladder approximation is
its capability of reproducing the Dirac results for the
H atom. This is examined theoretically by using
Salpeter's 3-dimensional form of the B.S. equation and
reducing it to an equivalent 1 body form similar to the
Dirac equation. This is solved in momentum space by
the Fock-Lévy method. The reduced B.S. equation re-
produces the Dirac eigenvalues to the order of ac-

curacy of the fine-structure splitting (order α^4). The
principal (order 1 and α) terms in the eigenfunctions
are reproduced but not the higher coefficients (of or-
der α^2 and α^3).

1908

St. Louis U. Dept. of Physics, M.

PART I. CRITICAL ANALYSIS AND APPLICATIONS

OF A QUASI-RESONANT THEORY OF PRESSURE
BROADENING OF LINEAR MOLECULES. PART II.
COLLISION BROADENING IN THE MICROWAVE SPEC-
TRA OF SYMMETRIC TOP MOLECULES, by L. J.
Kieffer, J. G. Broerman, and A. V. Bushkovitch. Final
technical rept. May 1, 1959, 1v. incl. diagrs. tables, refs.
(AFOSR-TR-59-29) (AF 18(600)1590) AD 212702;
PB 142160   Unclassified

Part I also published in Jour. Molec. Spectros., v. 2:
558-565, Dec. 1958.

Part I. See item no. STL.02:004, Vol. II, for abstract.
Part II. The collision cross sections for dipole-dipole,
dipole-quadrupole, and quadrupole-quadrupole interac-
tions were calculated in this paper. Unfortunately, line
breadth data for non-inversion symmetric top spectra
are insufficient for comparison with experiment.

1909

St. Louis U. [Dept. of Physics] Mo.

SOME APPLICATIONS OF RELATIVISTIC WAVE
EQUATIONS TO SOLID STATE PROBLEMS. I, by W.
A. Barker, R. Pendergast, and M. Lal Narchal. [1959]
14p. incl. refs. (AFOSR-TN-59-1259) (Sponsored
jointly by Air Force Office of Scientific Research under
AF 49(638)612 and National Science Foundation)
Unclassified

In solid state physics the spin and the magnetic moment
of the electron play important roles. However a relati-
vistic formulation of solid state problems is not common.
The Dirac equation for an electron in an electromagnetic
environment which may include the local effects of the
solid as well as externally applied fields is rewritten in
an approximately relativistic formulation, using the
Foldy-Wouthuysen method. Both spin dependent and
spin independent terms are discussed in connection
with hydrogen like problems and electron spin reso-
nance. (Contractor's abstract)

1910

San Andres U. Laboratorio de Fisica Cosmica de
Chacaltaya, La Paz (Bolivia).

SIDEREAL ANISOTROPY OF HIGH ENERGY COSMIC
RAYS, by I. Escobar V., N. Nerurkar, and R. Well.
[1959] [6]p. incl. diagrs. tables. (Sponsored jointly by
Air Force Office of Scientific Research under [AF 49-
(638)290], Atomic Energy Commission, and Office of
Naval Research)   Unclassified

Published in Planetary and Space Sci., v. 1: 155-160,
Aug. 1959.

Abstract published in Proc. Internat'l. Conf. on
Cosmic Rays, Moscow (USSR) (July 6-11, 1959), Moscow,
v. 4: 273-274, 1960.

The experiment, detecting extensive air showers responding to primary energies greater than 10^{14} ev and being carried out at Chacaltaya, Bolivia (elevation of 5220 m; geographic latitude of 16^{c} S), is described. The counter trays were separated by at least 20 m. The results (over a period of 230 days) indicated that there was evidence of a sidereal anisotropy of about 1.6% with the time maximum at 1400 LST (local sidereal time). The barometric coefficient was discussed in connection with the absorption curve for extensive showers. It showed that the pressure correction had no effect on the obtained anisotropy. (Contractor's abstract, modified)

1911

San Andres U. Laboratorio de Fisica Cosmica de Chacaltaya, La Paz (Bolivia).

[INTERNATIONAL CONFERENCE OF COSMIC RAYS] Conferencia Internacional de Radiacion Cosmica, by I. Escobar V. [1959] [8]p. [AF 49(638)290]
Unclassified

Also published in Rev. Mex. Fis., v. 8: 273-280, Oct. 1959.

The conference on cosmic rays, sponsored by the International Union of Pure and Applied Physics over 2 yr, was held from July 6th to 11th, 1959 at the University of Moscow. It was attended by many people. The new president of the conference was D. S. Skobeltyn. The highlights of the conference are given.

1912

San Andres U. Laboratorio de Fisica Cosmica de Chacaltaya, La Paz (Bolivia).

[THE DENSITY SPECTRUM OF AIR SHOWERS AT 4100 m] Espectro de densidad de chubascos a 4,100 m, by J. Hersil. [1959] [8]p. incl. diagrs. (AF 49(638)290)
Unclassified

Published in Resumen de Labores, 1959, La Paz (Bolivia), Laboratorio de Fisica Cosmica, Dec. 1959, p. 34-38.

The density spectrum of air showers at this altitude was determined by means of a plastic scintillation detector, G-M counters, and a cathode ray oscilloscope. Based on the histogram taken without an absorber, a straight line was obtained by connecting the mean arithmatic densities for each interval. Using the same method, spectra obtained under different conditions with respect to the absorber were analyzed. Some measurements were also made to see if the density spectrum showed any energy dependence at this altitude. Results

seem to indicate that the spectrum coincides perfectly with that obtained without absorbing material, except for density values less than 70/sq m. (Contractor's abstract, modified)

1913

San Andres U. Laboratorio de Fisica Cosmica de Chacaltaya, La Paz (Bolivia).

[PRELIMINARY RESULTS ON THE DEGREE OF DEVELOPMENT OF THE EXTENSIVE AIR SHOWERS OF HIGH ENERGY AT 4100 m] Resultados preliminares sobre el grado de desarrollo de los chubascos extensos de alta energia a 4,100 m, by J. Hersil and R. H. Schulcezwski. [1959] [7]p. incl. diagrs. (AF 49(638)-290)
Unclassified

Published in Resumen de Labores, 1959, La Paz (Bolivia), Laboratorio de Fisica Cosmica, Dec. 1959, p. 39-43.

The status of the work on extensive air showers being carried out at El Alto is described. The influence of temperature on detector sensitivity is analyzed in some detail. The preliminary results are given on the lateral distribution of showers at this altitude. A zenith angle distribution for showers in a relatively broad size range is worked out without the aid of a computer. Conclusions, however, should not be drawn until a more complete analysis is made on larger samples that are now in process at MIT computing center. The data handling system used at La Paz in order to reduce reaction errors to a minimum is also described. (Contractor's abstract)

Sarah Mellon Scaife Radiation Lab., Pittsburgh, Pa. see Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

Sibley School of Mechanical Engineering, Ithaca, N. Y. see Cornell U. Sibley School of Mechanical Engineering, Ithaca, N. Y.

Sloane Physics Lab., New Haven, Conn. see Yale U. Sloane Physics Lab., New Haven, Conn.

1914

Smith Coll. Dept. of Chemistry, Northampton, Mass.

A THEORETICAL STUDY OF THE RELATIONSHIP BETWEEN THE PROPERTIES OF A SOLID AND CHARACTERISTICS OF ITS CONSTITUENT PARTICLES, by G. S. Durham, B. A. Soderberg, and E. B. Rothman. Final rept. Apr. 1959, 13p. incl. diagrs. tables, refs. (AFOSR-TR-59-55) (AF 18(600,775) AD 216254
Unclassified

A brief summary of the work reported in a previous

paper (SMI.01: 002, Vol. II) is presented. The calculations used to arrive at the lattice sum or any higher interaction sum are shown. The conclusions reached from a study of the surface-structure calculations for outer $1 + 0 + 0$ planes of NaCl, KCl, and KBr are discussed. It is shown that consideration of van der Waals forces can make as much as $0.05\ r_o$ difference in the displacement of the ions; also cation polarization makes very little difference in the case of NaCl, but is appreciable for KCl and KBr. The work concerned with the free energies of mixing of NaCl-NaBr solid solutions at 35° is reported on also. The results presented in table form show the free energy curve is such as to predict partial immiscibility in the system. A discussion is also given on the determination of the heat of mixing of a KCl-KBr solid solution prepared at 25°. These are done as an experimental check on the calculations of the energy of local order in an equimolar KCl-KBr solid solution. The last section discusses the equation for the cohesive energy of a metallic crystal as a function of distance of particle separation.

1915

South Carolina U. Dept. of Electrical Engineering, Columbia.

APPLICATIONS OF DIELECTRIC PRISMS AT MILLIMETER WAVELENGTHS, by R. G. Fellers. July 16, 1959 [21]p. incl. illus. diagrs. refs. (AFOSR-TN-59-637) (AF 18(603)43) AD 219785　　　Unclassified

This paper describes the use of a pair of dielectric prisms as an adjustable bidirectional coupler and as a cut-off attenuator capable of theoretical calibration. Such devices may be used as a part of a free-space transmission system intended to replace waveguide for transmission of energy over within-system distances. It is expected that transmission of this type will find its max usefulness in the mm wavelength range. (Contractor's abstract)

1916

Southern California U. Dept. of Chemistry, Los Angeles.

THE REACTION OF (+)-ENDO-NORBORNYLAMINE WITH NITROUS ACID, by J. A. Berson and D. A. Ben-Efraim. [1959] 20p. incl. diagrs. refs. (AFOSR-TN-59-23) (AF 18(600)1544) AD 208753
　　　　　　　　　　　　　　　　Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 4094-4099, Aug. 5, 1959.

(-)-endo-Norbornanecarboxylic acid, 34-35% optically pure, reacts with hydrazoic acid to give (+)-endo-norbornylamine of the same optical purity. In acetic acid, the (+)-amine reacts with sodium nitrite to give exo-norbornylacetate with 23-24% retention of optical purity. The enantiomeric configurations of the amine

and product acetate are related on the basis of the stereochemical result and known data on isotope-position rearrangement in this reaction. The optical result is virtually identical with the % retention of skeletal integrity observed in the nitrous acid deamination of endo-2-amino-5-norbornene-3-^{14}C. The correspondence suggests that the excess unrearranged portion of the product acetate from both amines is derived by direct displacement of solvent on the diazonium ion. (Contractor's abstract)

1917

Southern California U. Dept. of Chemistry, Los Angeles.

DERIVATIVES OF SULFENIC ACIDS. XXXVII. STUDIES OF SULFENYL ESTERS (THIOPEROXIDES). PART 5. THERMAL DECOMPOSITIONS, by R. S. Irwin and N. Kharasch. [1959] 11p. incl. diagrs. refs. (AFOSR-TN-59-847) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)330] and Office of Ordnance Research)　　　　Unclassified

Presented at meeting of the Org. Chem. Div. of the Amer. Chem. Soc., Atlantic City, N. J., Sept. 13-18, 1959.

Abstract published in 136th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1959, p. 39-p. (Title varies)

Also published in Jour. Amer. Chem. Soc., v. 82: 2502-2505, May 20, 1960.

The pyrolysis of selected t-butyl esters of sulfenic acids was studied.

$$R\text{-}S\text{-}O\text{-}\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}\text{-}CH_3 \quad \begin{cases} \text{I; R} = CL_3C\text{-} \\ \text{II; R} = C_6H_5\text{-} \\ \text{III; R} = 2,\ 4\text{-}(NO_2)_2\text{-}C_6H_3\text{-} \end{cases}$$

Compounds II and III yield isobutylene as the major volatile product, whereas I yields up to 90% t-butyl chloride. No acetone was found in any case, showing that t-butoxy radicals are not involved, as might be expected by comparisons with peroxide pyrolyses. Other evidence suggests that the pyrolyses of I, II and III, under the conditions studied, do not involve homolysis of the -S-O-bond. A mechanism, which involves a cyclic transition state, analogous to that proposed for the pyrolysis of alkyl xanthates, is proposed. (Contractor's abstract)

1918

Southern California U. Dept. of Chemistry, Los Angeles.

DERIVATIVES OF SULFENIC ACIDS. XXXIII.

2,4-DINITROPHENYL SELENIUM TRICHLORIDE, by
D. D. Lawson and N. Kharasch. [1959] [2]p. incl.
diagrs. refs. (AF 49(638)330)   Unclassified

Published in Jour. Org. Chem., v. 24: 857-859, June
1959.

The original purpose of the research was to prepare
2,4-dinitrobenzeneselenenyl chloride (II). In the course
of the work, however, a superior method for cleaving
bis(2,4-dinitrophenyl) disulfide was devised, involving
the use of sulfuryl chloride and pyridine. This pro-
cedure was successful in the chlorinolysis of the cor-
responding diselenide, but the product was not the se-
lenenyl chloride (II), but the trichloride (I). Further
study established that the trichloride is in equilibrium
with the monochloride $ArSeCl_3 \rightleftharpoons ArSeCl + Cl_2$ (Ar =
$\qquad$ I $\qquad$ II

2,4-dinitrophenyl), but that I can be prepared by using
excess sulfuryl chloride in the chlorinolysis of the se-
lenocyanate or bis(2,4-dinitrophenyl) diselenide. It is
pointed out that the trichloride is an excellently crystal-
line solid and can be stored for long periods of time
without change. The results suggest that the readily
prepared trichloride may be used as the in situ precur-
sor for reactions requiring the selenenyl chloride.

1919

Southern California U. Engineering Center, Los Angeles.

A NOTE ON THE THERMAL CONDUCTIVITY OF
SOLID NITROGEN AND THE DIRECT CONDENSATION
OF NITROGEN GAS INTO A SOLID, by K. Karamcheti.
Jan. 31, 1959, 13p. incl. diagrs. (USCEC rept. no. 56-
208) (AFOSR-TN-59-183) (AF 18(603)95) AD 211323;
PB 140225   Unclassified

In a low density tunnel designed to operate on the "2-
phase" principle, nitrogen gas is used as the working
medium. Downstream of the test section, the gas is
condensed directly into a solid by exposing the gas to a
refrigerated surface maintained at a constant tempera-
ture (in the range of 15 to 30°K). To estimate the con-
densation rate/unit area of surface, the problem is
treated from the point of view of 1-dimensional unsteady
heat conduction through the growing layer of the solid
condensate. An analytical solution of the problem is
obtained. It is seen that the condensation rate can be
evaluated once the density, the specific heat, the latent
heat of sublimation, and the thermal conductivity, k, of
solid nitrogen are known. While the other quantities are
known, k is not known. The analysis is, therefore, used
in conjunction with some test data, where the growth
with time of the condensate thickness is measured, to
obtain an estimate for k. This turns out to be 2.455 x
10^{-4} cal/sec cm °K. Using this value of k, relations
are given for the condensate thickness and the conden-
sation rate at any time. (Contractor's abstract)

1920

Southern California U. Engineering Center, Los Angeles.

SOME PROBLEMS IN HYDROMAGNETICS, by K. P.
Chopra. Jan. 31, 1959, 210p. incl. diagrs. tables, refs.
(USCEC rept. no. 56-205) (AFOSR-TN-59-265)
(AF 18(603)95) AD 212468; PB 142687   Unclassified

The following topics are discussed: (1) Induction drag
of a sphere moving in a conducting fluid in the presence
of a magnetic field; (2) Hydromagnetic flow in a circu-
lar pipe; (3) Magnetic fields in a conducting fluid sphere
and infinite cylinder with electric currents flowing in
them; (4) Change in energy of a magnetic sphere under
a P_1-deformation (equilibrium configurations of the
sphere); (5) Radial adiabatic pulsations of an infinite
cylinder in the presence of a magnetic field; (6) Tunnel
effect in hydromagnetics; (7) Compressible hydromag-
netics; (8) Thermodynamics of compressible hydromag-
netic flow; (9) Hydromagnetic shock waves; (10) Diffu-
sion and plane hydromagnetic shock waves; (11) Drag
of a sphere in an ionized gas; and (12) Transmission
properties of Alfvén waves.

1921

Southern California U. Engineering Center, Los Angeles.

PRODUCTION OF CARBON IN THE UPPER ATMOS-
PHERE, by K. P. Chopra. July 31, 1959, 8p. incl. refs.
(USCEC rept. no. 56-208) (AFOSR-TN-59-902) (AF 18-
(603)95) AD 228197; PB 144474   Unclassified

This technical note describes a process by which pene-
trating cosmic rays may produce atomic carbon in the
upper atmosphere. High energy cosmic ray particles
bombard the atoms and molecules of the upper atmos-
phere and release neutrons along the other products
of disintegration. Some of these neutrons escape out-
wards and undergo a natural free decay. Some others
may collide with nitrogen atoms and produce atomic car-
bon with the release of a proton. These carbon atoms
are radioactive and decay back into atomic nitrogen
with the release of a high energy electron. But the fair-
ly long lifetime (5569 years) ensures a copious supply of
carbon atoms in the upper atmosphere. The other pro-
ducts of this process, viz. protons and electrons, may
get trapped in the earth's magnetic field, and hence
contribute to the formation of the inner radiation belt.
(Contractor's abstract)

1922

Southern California U. Engineering Center, Los Angeles.

SOME FURTHER RESULTS ON HEATING A SUPERSONIC
GAS STREAM WITH A RADIO FREQUENCY DISCHARGE,
by F. O. Smetana. Nov. 1, 1959, 16p. incl. illus. diagrs.
(USCEC rept. no. 56-207) (AFOSR-TN-59-1127) (AF 18-
(603)95) AD 229491; PB 144781   Unclassified

Resu'ts of further experiments with RF discharge heating of a supersonic gas stream are reported. Temperature increases of at least 600°F were recorded although the presence of strong electrical fields made it extremely difficult to interpret temperature indications. The action of the ionized gas and the strong field limits the type of materials which may be used for nozzle materials. Qualitative indications of the decay of active species, N-N recombination, wall heating, effect of pressure, nozzle configuration, and electrode configuration were also obta'ned. (Contractor's abstract)

1923

Southern California U. Engineering Center, Los Angeles.

DIFFUSION OF A FULLY IONIZED GAS CONFINED IN A STRONG MAGNETIC FIELD, by T. Koga. Dec. 30, 1959, 33p. incl. diagrs. table, refs. (USCEC rept. no. 56-209) (AFOSR-TN-59-1132) (AF 18(603)95)
AD 231047; PB 145638   Unclassified

Presented at meeting of the Amer. Phys. Soc., Ann Arbor, Mich., Nov. 23-25, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 5: 127, Mar. 4, 1960.

The transport phenomena is studied of a fully ionized gas in the presence of a strong magnetic field. It is shown that there is a certain domain in the density-temperature space where the Boltzmann equation is valid. The mean free path is assumed to be longer than the mean Larmor radius. An average of the Boltzmann equation is made along a circular trajectory of gyrating particles. By this method of coarse-graining, the Boltzmann equation is reduced to the equation of diffusion. It is not assumed that the distribution function is close to the Maxwell function. A special case of constant er : gy per particle is treated in detail. No specific assumption of the distribution function is made. The effect of the collisions between similar particles is negligible, and the ions and electrons diffuse almost at the same velocity. It is easily possible to apply the method to more general cases. (Contractor's abstract)

1924

Southern California U. [Engineering Center] Los Angeles.

ON THE SECOND APPROXIMATION TO THE STRESS AND THE HEAT FLUX IN A GAS (Abstract), by H.-T. Yang. [1958] [1]p [AF 18(603)95]   Unclassified

Presented at meeting of the Amer. Phys. Soc., San Diego, Calif., Nov. 24-26, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 199, Mar. 30, 1959.

The classical expressions for the 2nd approximation

to the stress and the heat flux in a gas are those of Burnett. More recent work in the kinetic theory of gases consists of Grad's 13th-moment equations and Ikenberry-Truesdell's iterates. The Burnett equations may be deduced from the latter 2 systems, which are, therefore, more general. All these 3 approaches are approximating the Boltzmann equation by partial differential equations for the flow variables. Another way is to approximate the Boltzmann equation directly by replacing the collision integral by a simple collision term. This results in the simplified partial differential equation of Bhatnagar, Gross, and Krook for the molecular distribution function. The 2nd approximation to the stress based on this simplified collision equation is obtained by Burgers and that to the heat flux is obtained here. It is shown that these 2nd approximations based on the simplified collision equation are compared favorably with those based on the full Boltzmann equation.

1925

Southern California U. Engineering Center, Los Angeles.

EXPERIMENTS ON A RADIO FREQUENCY DIS-CHARGE PLASMA IN SUPERSONIC FLOW, by R. L. Chuan and F. O. Smetana. [1959] [8]p. incl. illus. diagr. table. [AF 18(603)95]   Unclassified

Published in Proc. 1959 Heat Transfer and Fluid Mech. Inst., California U., Los Angeles (June 11-13, 1959), Stanford, Stanford U. Press, 1959, p. 236-243.

The little-studied problems associated with the heating technique used when developing a radio frequency discharge for use as a heat source in low density, supersonic flow are discussed. These problems include that of providing a suitable electrode configuration which permits matching of the generator to the load and which provides for minimum stray radiation and high density power input. Also studied was the problem of determining an optimum length of time or distance during which the recombination processes would be sufficiently near completion and for which the physical length would not be unreasonable or the heat transfer to the walls self-defeating. As a means for permitting the decay processes to reach equilibrium, control of diffusion of free electrons with its subsequent heat transfer to the wall was also discussed. The results and some preliminary interpretations of their significance are given. (Contractor's abstract, modified)

1926

Southern California U. [Engineering Center] Los Angeles.

DRAG OF AN ARTIFICIAL EARTH SATELLITE (Abstract), by R. L. Chuan and K. P. Chopra. [1959] [1]p. [AF 18(603)95]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Recently the problem of drag on an artificial satellite has been taxing the curiosity of several authors. This paper discusses several physical processes which may contribute to the drag of an artificial satellite (or for that matter, any body) moving in an ionized atmosphere with a pervading magnetic field. These processes involve electromagnetic induction (induction drag), Coulomb scattering of charged particles (Coulomb drag), ionization caused by the satellite (ionization drag), the emission of plasma waves (wave drag), surface interactions with impinging particles (surface drag), etc., besides the direct collisions (neutral aerodynamic drag). An insight can be obtained by performing simple experiments in a low-density wind tunnel under specified conditions.

1927

Southern California U. [Engineering Center] Los Angeles.

PROPAGATION OF A PLANE NORMAL SHOCK WAVE IN A GAS MIXTURE OF TWO KINDS OF CHARGED PARTICLES IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD (Abstract), by I. Singh and K. P. Chopra. [1959] [1]p. [AF 18(603)95]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

The propagation of a shock wave in a gas mixture sets up diffusion and causes a change in the composition of the fluid. The effect of diffusion on the propagation properties of a shock wave in the presence of a transverse magnetic field forms the subject matter of this paper. Transverse (induced by magnetic field) and thermal diffusions have been ignored for simplicity. Expressions for the composition parameter, and pressure, density, and velocity ratios are obtained. Chief conclusion is that the presence of a transverse magnetic field narrows down the range of values for the density ratio. The analysis is suggestive of the contribution of diffusion to the structure of the shock front. However, this conclusion is not established to finality.

1928

Southern California U. [Engineering Center] Los Angeles.

THERMODYNAMIC PROPERTIES OF FLUID FLOW ACROSS MAGNETIC FIELD. I. (Abstract), by K. P. Chopra. [1959] [1]p. [AF 18(603)95]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

This paper deals with the study of various thermodynamic quantities like internal energy, enthalpy, entropy, etc., involved in the investigation of the flow of a conducting fluid in the presence of a uniform transverse magnetic field. The analogs of Rayleigh and Fanno lines readily follow from the basic equations. It is shown that in the presence of a transverse magnetic field, the internal energy and enthalpy of an electrically conducting fluid, obeying perfect gas equation, depend (unlike in ordinary fluid-flow thermodynamics) on its density and the strength of the magnetic field. The entropy and the specific heat at constant volume do not seem to be affected by the presence of the magnetic field. The behavior of specific heat at constant pressure depends on which of the gas and the total pressure is kept constant. A transverse magnetic field reduces the specific heat at constant gas pressure and the corresponding adiabatic constant by a factor proportional to the ratio of the magnetic pressure to the gas pressure. However, if the total (gas plus magnetic) pressure is kept constant, the magnetic field has no effect. Lastly, the effect of the magnetic field on velocity of sound and the Mach number is discussed. In the limiting cases of weak and strong magnetic fields, the velocity of sound reduces to the ordinary sonic speed and the Alfvén speed respectively.

1929

Southern California U. [Engineering Center] Los Angeles.

THERMODYNAMIC PROPERTIES OF FLUID FLOW ACROSS A MAGNETIC FIELD. II. (Abstract), by K. P. Chopra and I. Singh. [1959] [1]p. [AF 18(603)95]
                                        Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

This paper is devoted to the study of the effects of a transverse magnetic field on some of the flow characteristics of a perfectly conducting fluid. It is seen that the effect of an area change (as in a nozzle) on the subsonic or supersonic flow is not affected by the presence of the magnetic field. However, it is demonstrated that the presence of a transverse magnetic field is conducive to the formation of a shock wave. The analog of Prandtl's equation is derived and the expression for the critical speed is obtained. It follows that the flow is definitely subsonic if the stream velocity is less than or equal to the critical speed. On the contrary, if the stream velocity exceeds the critical speed, the hydromagnetic flow may be supersonic, sonic or subsonic. Use of the jump conditions leads to the analog of Prandtl's relation for shock waves. The expressions for jumps in internal energy and enthalpy across the shock front readily follow. New Hugoniot function is defined and the surface

represented by the Hugoniot equation in the (τ, p^*, H) space is a hyperbolic paraboloid. As in ordinary shock waves, the entropy change across the shock-front is of the 3rd order in specific volume.

1930

Southern California U. [Engineering Center] Los Angeles.

INTEGRATED FORM OF THE BOLTZMANN EQUATION AND ITS APPLICATION TO GAS DYNAMICS, by T. Koga. [1959] [3]p. (AF 18(603)95)   Unclassified

Published in Phys. Fluids, v. 2: 580-582, Sept.-Oct. 1959.

In this note the Boltzmann equation is analyzed and an integration derived which may be used directly for obtaining macroscopic variables as functions of space and time variables, satisfying given boundary conditions.

Here the Boltzmann equation is treated as $\frac{\partial f}{\partial t} + c \cdot \frac{\partial f}{\partial r} + F \cdot \frac{\partial f}{\partial c} - (\frac{\partial f}{\partial t})_{coll} = 0$. This method of approach permits fairly simple relations to be obtained to which the distribution function is subject in cases where a gas field is known to have a certain uniformity. It can also be applied to magnetohydrodynamics of gases.

1931

Southern California U. Engineering Center, Los Angeles.

THE COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH ARBITRARY PRESSURE GRADIENT AND WALL TEMPERATURE DISTRIBUTION, by J. C. Williams, III. [1959] [2]p. (AF 18(603)95)   Unclassified

Published in Jour. Aero/Space Sci., v. 26: 677-678, Oct. 1959.

A method is presented for removing the restriction of similar solutions and thereby obtaining solutions to the compressible laminar boundary layer with arbitrary pressure gradient and wall temperature distributions. It is necessary to assume the following conditions: (a) constant specific heat, (b) Prandtl Number of unity, and (c) a viscosity-temperature relationship $\mu = \mu_0 \lambda T/T_0$, and by employing the Stewartson type of transformation the compressible laminar boundary layer equations can be transformed into the set (1) $(\partial U/\partial X) + (\partial V/\partial Y) = 0$, (2) $U(\partial U/\partial X) + V(\partial U/\partial Y) = U_E(dU_E/dX)(1 + S) + \nu_0(\partial^2 U/\partial Y^2)$ and (3) $U(\partial S/\partial X) + V(\partial S/\partial Y) = \nu_0(\partial^2 S/\partial Y^2)$. Thus (4) $dX = \lambda(a_e/a_0)(pe/po)dx$, $dY = (p/po)(a_e/a_0)dy$, $U = (\partial \psi/\partial X) = (a_0/a_e)u$, $V = \partial \psi/\partial Y$ and any solution of the transformed set of equations (1-3) is a solution of a physical-boundary-layer problem and is related to the physical problem through equation 4. The equation 1-3 are solved by a series solution type of analysis.

1932

Stanford Research Inst., Menlo Park, Calif.

FLUX DISTRIBUTION NEAR THE FOCAL POINT, by R. E. de la Rue, Jr., E. Loh and others. [1957] [5]p. incl. diagrs. (AFOSR-3505) (AF 18(600)1499)
Unclassified

Also published in Jour. Solar Energy Sci. and Eng., v. 1: 94-98, Apr.-July 1957.

It is shown that off-focus operation can be used to control flux and thus the temperature of a target, instead of the various possible mechanical methods. Although the size of the area of uniform flux decreases as the plane of interest moves away from the focal plane, it again increases in size and uniformity at a distance of over 2 sun images from the focal plane. Also, the average flux received by the central uniform region of an off-focus plane cannot be determined by the inverse area law. It is also shown that to obtain the maximum flux delivered by a parabolic solar furnace, the target must be positioned properly. To obtain temperatures within 5% of the maximum attainable temperatures, a target must be placed within a distance of one-half of a sun image unit from the focal plane.

1933

Stanford Research Inst., Menlo Park, Calif.

THE SOLAR FURNACE. NEW TOOL FOR HIGH-TEMPERATURE WORK, by G. Benveniste and N. K. Hiester. [1956] [6]p. incl. illus. diagrs. tables, refs. (AFOSR-3666) [AF 18(600)1499]   Unclassified

Presented at meeting of the Amer. Soc. Mech. Engineers, Denver Colo., Sept. 10-12, 1956.

Also published in Mech. Eng., v. 78: 915-920, Oct. 1956.

The application of the solar furnace to high temperature research and industrial programs is discussed. The discussion includes the basic principles and characteristics of furnaces in operation, descriptions of the units now being utilized or being planned throughout the country, and the historical background of solar furnaces. These units are useful tools for high-temperature work up to $3000-3500^{\circ}C$. They can be used in experiments where lack of contamination from flames, combustion products, electrodes and refractory fragments is important.

1934

Stanford Research Inst., Menlo Park, Calif.

NEW ELECTRON ACCEPTORS FOR THE HILL

REACTION II. CHROMIC ION, by R. J. Marcus. Dec. 1, 1959, 7p. incl. diagrs. (Technical note no. 3; rept. no. 14) (AFOSR-TN-59-1321) (AF 18(603)7) AD 231929; PB 145671   Unclassified

A new electron acceptor for the Hill reaction, chromic ion, has been found on the basis of previous work on the absorption spectra of Hill reaction oxidants. Because of its low solubility at physiological pH, this oxidant must be used in conjunction with a secondary oxidant (MnO_2), an excess of which will maintain a

constant, but small, concentration of chromic ion by immediate reoxidation of the reduction product. No reoxidation appears to take place in the absence of MnO_2, either by reduction of water or by ultraviolet

photooxidation of the reduction product. (Contractor's abstract)

1935

Stanford Research Inst., Menlo Park, Calif.

SURVEY OF ELECTRON TRANSFER SPECTRA OF INORGANIC IONS, by R. J. Marcus. Dec. 1, 1959, 13p. incl. tables, refs. (Technical note no. 2; rept. no. 13) AFOSR-TN-59-1322) (AF 18(603)7) AD 231930; PB 145670   Unclassified

The literature was searched for electron transfer spectra of inorganic ions. These are reported, together with the chemical evidence of light-induced electron transfer and with thermodynamic data needed for interpretation of the spectra. (Contractor's abstract)

1936

Stanford Research Inst., Menlo Park, Calif.

THE HILL REACTION AS A MODEL FOR CHEMICAL CONVERSION OF SOLAR ENERGY, by R. J. Marcus. Dec. 1, 1959, 9p. (Rept. no. 15) (AFOSR-TR-59-208) (AF 18(603)7) AD 231931; PB 161462   Unclassified

The possibility of storing solar energy for use during dark periods by decomposition of water into its elements was explored along 2 lines. One of these consisted of taking advantage of the electron transfer spectra of inorganic ions. These were surveyed and listed, together with chemical and thermodynamic correlative data. The conclusion was reached that electron transfer spectra corresponding to the evolution of hydrogen will always lie at the far ultraviolet end of the solar spectrum. The cause for this is an uncommonly high activation energy (of the order of 35 kcal/mol) in addition to the energy requirement for the intermediate H atom (48 kcal/mol). The other method consisted of a study of various Hill reaction oxidants. In the course of this study it was found that the efficiency of Hill reaction oxidants depended more on their energy levels than it did on their oxidation-reduction potentials, as

had been previously supposed. This was related, in turn, to the electron-transfer properties of chlorophyll itself. Two new electron acceptors, $Co(C_2O_4)_3^{-3}$ and Cr^{+3}, were found to be active in the Hill reaction. (Contractor's abstract)

1937

Stanford Research Inst., Menlo Park, Calif.

MASS SPECTROMETER ANALYSIS OF THE VAPOR IN EQUILIBRIUM WITH THE ALKALI-METAL CHLORIDES, by T. A. Milne, H. M. Klein, and D. Cubicciotti. [1959] [2]p. incl. tables, refs. (AFOSR-TN-59-230) (AF 49(638)89) AD 264456   Unclassified

Also published in Jour. Chem. Phys., v. 28: 718-719, Apr. 1958.

A study is made, by mass spectrometric means, of the vapors in equilibrium and free evaporation from the alkali-metal halides. In a preliminary investigation of the vapors in equilibrium with the alkali-metal chlorides the observed ions and their relative intensities were found to exhibit some interesting trends relative to the problem of the importance of polymers in vapors of these salts. Tables of these data for chlorides of lithium, sodium, potassium, rubidium, and cesium are included. (ASTIA abstract)

1938

Stanford Research Inst., Menlo Park, Calif.

DETERMINATION OF RELATIVE PARTIAL PRESSURES FROM MASS SPECTROMETER ION INTENSITY MEASUREMENTS, by T. A. Milne. [1959] [2]p. (AFOSR-TN-59-231) (AF 49(638)89) AD 264457
                                                       Unclassified

Also published in Jour. Chem. Phys., v. 28: 717-718, Apr. 1958.

A method has been devised to permit a direct measurement of the proportionality of response of the mass spectrometer to the partial pressure for different polymeric species in equilibrium with the alkali-metal halides. Intensities are measured at 3 or more temperatures and are applicable to systems of more than 1 component. One restriction to the application of this method is for species whose partial pressures will be different in the 2 regions of the furnace due to some shift in gaseous equilibrium. (ASTIA abstract)

1939

Stanford Research Inst., Menlo Park, Calif.

LATTICE ENERGIES OF THE ALKALI HALIDES AND

THE ELECTRON AFFINITIES OF THE HALOGENS, by
D. Cubicclotti. July 1959 [22]p. incl. tables, refs.
(AFOSR-TN-59-726) (AF 49(638)89) AD 225024;
PB 143162   Unclassified

Also published in Jour. Chem. Phys., v. 31: 1646-1651,
Dec. 1959.

The overlap repulsion parameters that occur in the
Born-Mayer treatment of lattice energies have been
re-evaluated for the alkali halides from recent com-
pressibility data. With these parameters the lattice
energies of the alkali halides were calculated. The
lattice energies were combined with thermochemical
data to calculate the electron affinities of the halogens.
The values obtained were: F 80.2; Cl 85.0; Br 79.5;
I 72.5 kcal/mol. (Contractor's abstract)

1940

Stanford Research Inst., Menlo Park, Calif.

ION-MOLECULE REACTIONS IN MASS SPECTRO-
METRIC STUDIES OF ALKALI HALIDE SALTS, by
T. A. Milne. Dec. 1959, 8p. incl. table. (Technical
note no. 5) (AFOSR-TN-59-1331) (AF 49(638)89)
AD 231607; PB 145641   Unclassified

Also published in Jour. Chem. Phys., v. 32: 1275-1277,
Apr. 1960.

An experiment was made to demonstrate directly and
sensitively the contribution of ion-molecule reactions
to the observed intensities of M_2Cl^+ under the experi-
mental conditions used. A double orifice cell contain-
ing pure KCl in 1 chamber and pure NaCl in the other
was used. A Bendix time-of-flight spectrometer with
a 2-channel pulse counter and electron multiplier was
utilized to detect individual ions formed. Some $NaKCl^+$
was found; no clear evidence was noted of an ion-mol-
ecule reaction contribution to $NaKCl^+$. An estimation
was made that if ion-molecule reactions were the sole
source of M_2X^+, the ratio $Na_2Cl^+/NaKCl^+$ should be
about 0.5. The conclusion was drawn that under these
experimental conditions ion-molecule reactions ac-
count for less than 0.1% of the observed M_2X^+.

1941

Stanford Research Inst., Menlo Park, Calif.

CALCULATION OF THE ENERGIES OF SOME
ALKALI HALIDE TRIMERS, by T. A. Milne and D.
Cubicclotti. [1959] [2]p. incl. diagr. table. (AFOSR-
3468) (AF 49(638)89)   Unclassified

Also published in Jour. Chem. Phys., v. 30: 1625-1626,
June 1959.

The energies of formation of gaseous halide molecules
from the monomers were calculated by means of a

model suggested by Pauling. The dimers we e calcu-
lated to be 40 to 60 kcal more stable energetically than
their separated monomers. The free energies of dimer-
ization were calculated and used to predict the trends
observed in the ratio of monomer to dimer for several
salts. The energies of dimers were different cations
were slightly more negative than the average of the 2-
pure dimers.

1942

Stanford Research Inst., Menlo Park, Calif.

ENERGIES AND VIBRATIONAL FREQUENCIES OF
GASEOUS ALKALI HALIDE M_2X^+ IONS, by T. A. Milne
and D. Cubicciotti. [1959] [4]p. incl. diagrs. tables,
refs. (AFOSR-3478) (AF 49(638)89)   Unclassified

Also published in Jour. Chem. Phys., v. 30: 1418-1421,
June 1959.

A potential function describing the interaction between
the ions M_2X^+ molecules has been developed using a
model suggested by Pauling. From this potential the
energies and vibrational frequencies have been calcu-
lated for these molecules. The harmonic contributions
to the bending frequencies are shown to be far from
negligible based on this purely ionic model. The en-
tropy and free energy changes for the reaction
$M(g)^+ + MX(g) \rightarrow M_2X^+(g)$ are considered.

1943

Stanford Research Inst., Menlo Park, Calif.

LUMINESCENCE OF SOLIDS PRODUCED BY SURFACE
RECOMBINATION OF ATOMS, by K. M. Sancler, W. J.
Fredericks, and H. Wise. Mar. 1959 [2]p. incl. diagr.
(AFOSR-TN-59-367) (AF 49(638)353) AD 213863
                                             Unclassified

Presented at Symposium on Unstable Chem. Species,
Los Angeles, Calif., June 23-24, 1958.

Also published in Jour. Chem. Phys., v. 30: 1355-1356,
May 1959.

The research deals with an experimental investigation
of converting to luminous energy of a solid the energy
released from the heterogeneous recombination of atoms
and other labile species. Theoretically such a process
of energy transfer requires an overlap of the electronic
energy levels of the recombining atom system with those
of the solid. Further, in order that the transferred en-
ergy may be converted to light, the energy levels of the
solid must be non-interacting, such as in a semi- or non-
conductor. The intensity and spectral distribution of the
luminescence of a solid activated by such means will be
measured, the temperature effect of the solids deter-
mined, and the absorption spectra of the solids examined
and compared with the energy levels of the atom systems.

Furthermore, the surface energy levels in luminescent solids can be explored by measuring their absorption of low energy electrons or ions in the range of 0.2 to 20 ev. The solid phosphors will be selected from organic and inorganic substances, encompassing a range of excitation energies. This research will contribute to our basic knowledge of surface-catalyzed atom recombinations and of energy transfer between solids and gases. Also in propulsion systems it may lead to a reduction of the high surface temperatures encountered in hypersonic flight. (Contractor's abstract)

1944

Stanford Research Inst., Menlo Park, Calif.

LUMINESCENCE OF SOLIDS PRODUCED BY SURFACE RECOMBINATION OF ATOMS, by K. M. Sancier, W. J. Fredericks and others. June 15, 1959, 39p. incl. illus. diagrs. tables, refs. (Technical rept. no. 1) (AFOSR-TN-59-716) (AF 49(638)353) AD 220729; PB 143297   Unclassified

During the heterogeneous recombination of atoms on surfaces of solid lumophors the energy released in the process may be converted to luminous energy of the lumophor. Lumophors based on the CaO and MgO host lattices and containing various activators were prepared. The luminescence characteristics of these materials when exposed to hydrogen, oxygen, and nitrogen atoms were examined. Included in this investigation are the effects of atom species, atom concentration, lumophor temperature, and lumophor composition. Some luminescence spectra were obtained. Photoluminescence and candoluminescence (in a hydrogen diffusion flame) of some of the lumophors were also examined. A model is presented which describes the processes of chemical reaction and energy transfer associated with luminescence produced by heterogeneous atom recombination. (Contractor's abstract)

1945

Stanford Research Inst. Poulter Labs., Menlo Park, Calif.

STUDIES IN THE THEORY OF SHOCK PROPAGATION IN SOLIDS. PART I. THE PERMANENT REGIME SOLUTION. PART II. FORMAL THEORY OF ANELASTICITY. PART III. STEADY-STATE COMPRESSION PROFILES PROPAGATING IN HEAT-CONDUCTING ANELASTIC SOLIDS, by W. Band. Sept. 3, 1959 [59]p. incl. diagrs. tables. refs. (AFOSR-TN-59-1280) (AF 49(638)625) AD 230167; PB 147515   Unclassified

Also published in Jour. Geophys. Research, v. 65: 695-719, Feb. 1960.

A theoretical treatment of compressive wave propagation in an anelastic solid is presented in 3 parts. (Part I.) A theory is developed for shock profiles in terms of a single parameter, defined as "shear-yield-

ing viscosity". Reasonable numerical estimates of the viscosity parameters for Al, Pb, Sn, and Zr are obtained by extrapolating the maximum slopes of the profiles as functions of the shock compressions to ideally complete compressions, and by relating the ultimate maximum slopes so derived to the material lattice spacing. (Part II.) Zener's linear theory of anelasticity has been generalized to materials with cubic crystal structure. The theory of the propagation and attenuation of plane waves, both longitudinal and transverse, along a principal axis of the crystal, is presented. The combined effects of relaxation mechanisms and thermal diffusion are included. The significance of the results for the theory of shock propagation are briefly discussed. (Part III.) The general equations for propagation of steady-state compression profiles in shear-yielding, heat-conducting anelastic solids are given. Methods of solution by successive approximation are developed for Hookean solids with both "adiabatic" and "isothermal" (very steep) profiles, and for shock profiles in non-Hookean solids. Correction terms compared with results of (I.) for the shock profiles are given for the thermal conductivity and anelastic effects. Heating after-effects of shocks are discussed. Calculation of the temperature of the solid after passage of a shock profile is shown.

1946

Stanford Research Inst. Poulter Labs., Menlo Park, Calif.

ATTENUATION OF THE SHOCK WAVE PRODUCED BY A FLYING PLATE, by G. R. Fowles. Aug. 20, 1959, 24p. incl. diagrs. table, refs. (AFOSR-TN-59-1281) (AF 49(638)625) AD 236852; PB 147684
                Unclassified

Also published in Jour. Appl. Phys., v. 31: 655-661, Apr. 1960.

The attenuation of the plane shock wave produced in a solid by a flying plate of the same material is treated neglecting dissipative processes and effects of material rigidity. Explicit formulas for the position of the shock front and the shape of the pulse as functions of time are obtained by application of Friedrich's method. A numerical example for an aluminum target and projectile is presented to illustrate some of the features of the calculation, and an experiment is proposed to test the theory. The experiment should also allow a reasonably precise measurement of sound velocity immediately behind the shock front to be obtained. This possibility applies equally well to the case of target and projectile of different materials.

1947

Stanford Research Inst. Poulter Labs., Menlo Park, Calif.

FORMATION OF AN AMORPHOUS FORM OF QUARTZ

UNDER SHOCK CONDITIONS, by P. S. De Carli and J. C. Jamieson. [1959] [2]p. [AFOSR-3660] [AF 49(638)-625] AD 613792   Unclassified

Also published in Jour. Chem. Phys., v. 31: 1675-1676, Dec. 1959.

Observations of change in quartz single crystals in a series of tests in which samples were recovered after shock loading are reported. Possible explanations for the formation of amorphous material from single crystals are presented.

1948

Stanford U. Applied Mathematics and Statistics Lab., Calif.

ON THE ADJOINT SEMIGROUP AND SOME PROBLEMS IN THE THEORY OF APPROXIMATION, by K. de Leeuw. Apr. 13, 1959 [34]p. (Technical note no. 3) (AFOSR-TN-59-214) (AF 49(638)294) AD 211776; PB 145742   Unclassified

Also published in Math. Zeitschr., v. 73: 219-234, Mar. 1960.

Results concerning the identification of saturation classes arising in the theory of approximation are extended to non-reflexive Banach spaces by the consideration of adjoint semigroups. (Contractor's abstract)

1949

Stanford U. Applied Mathematics and Statistics Lab., Calif.

ON THE DEGREE OF APPROXIMATION OF BERNSTEIN POLYNOMIALS, by K. de Leeuw. May 22, 1959 [24]p. (Technical note no. 4) (AFOSR-TN-59-402) (AF 49(638)294) AD 214522   Unclassified

Also published in Jour. Anal. Math. (Jerusalem), v. 7: 89-104, 1959.

A question concerning the degree of approximation of a function by its Bernstein polynomials is studied. All functions are determined for which the degree is $0(\frac{1}{n})$ and show that if the degree is $o(\frac{1}{n})$ on an interval, the function must be linear on that interval. (Contractor's abstract)

1950

Stanford U. Applied Mathematics and Statistics Lab., Calif.

TRANSLATION INVARIANT FUNCTION ALGEBRAS

ON ABELIAN GROUPS, by K. de Leeuw and H. Mirkil. Aug. 26, 1959, 45p. incl. refs. (Technical note no. 5) (AFOSR-TN-59-659) (AF 49(638)294) AD 225363; PB 143524   Unclassified

Also published in Bull. Soc. Math. (France), v. 88: 345-370, 1960.

Results are established concerning translation invariant uniformly closed subalgebras of the algebra $C_0(X)$ of continuous functions, zero at infinity, on a locally compact abelian group X. (Contractor's abstract)

1951

Stanford U. Applied Mathematics and Statistics Lab., Calif.

CONTINUOUS TRANSLATION OF HOLDER AND LIPSCHITZ FUNCTIONS, by H. Mirkil. Oct. 30, 1959, 18p. (Technical note no. 7) (AFOSR-TN-59-983) (AF 49(638)294) AD 229089; PB 144763
                     Unclassified

Also published in Canad. Jour. Math., v. 12: 674-685, 1960.

This paper attempts to solve the Plessner problems associated with various spaces of Hölder functions. It aims at an abstract Banach space formulation just general enough to include the Hardy-Littlewood results on integration of L_p spaces. A brief analysis of Plessner's characterization of absolutely continuous functions is given based on the fact that there exist $f \in F$ such that the translate $T_x f$, defined by $(T_x f)(y) = f(x + y)$, does not vary continuously with x. The problem is to identify the $f \in F$ for which the mapping $x \rightarrow T_x f$ is continuous. Some general facts about continuous translation are also reviewed.

1952

Stanford U. Applied Mathematics and Statistics Lab., Calif.

THE ISOMETRIES OF H_1, by K. deLeeuw. Nov. 30, 1959, 26p. (Technical note no. 8) (AFOSR-TN-59-1111) (AF 49(638)294) AD 231321; PB 145516
                     Unclassified

Linear isometries of H_1 onto itself are shown to be induced by conformal maps of the unit disk. Proof is presented of the following theorem: let t be a 1-1 conformal map of the unit disk onto itself and λ a complex constant with $|\lambda| = 1$. Then the mapping T defined by $Tf(z) = \lambda t'(z)f(t(z))$, $f \in H_1$, $|z| < 1$, is a linear transformation of H_1 onto itself that is an isometry; i.e., $\|Tf\| = \|f\|$, f in H_1.

1953

Stanford U. Applied Mathematics and Statistics Lab., Calif.

APPLICATIONS OF ALMOST PERIODIC COMPACTI-FICATIONS, by K. de Leeuw and I. Glicksberg. Dec. 28, 1959 [63]p. incl. refs. (Technical note no. 9) (AFOSR-TN-59-1174) (AF 49(638)294) AD 231322; PB 145552   Unclassified

Almost periodic compactifications of operator semi-groups are constructed. Applications to the theory of weakly almost periodic functions and to ergodic theory are given. (Contractor's abstract)

1954

Stanford U. Applied Mathematics and Statistics Lab., Calif.

MULTIPLIERS OF COMMUTATIVE BANACH ALGE-BRAS, by J.-K. Wang. Dec. 29, 1959, 36p. (Technical note no. 10) (AFOSR-TN-59-1288) (AF 49(638)294) AD 231323; PB 145507   Unclassified

Commutative Banach algebras A in which $xA = o$ im-plies $x = o$ are considered. A multiplier of A is a map-ping T: $A \rightarrow A$ satisfying $xTy = Tyx$. The multipliers of A are bounded linear operators and they form a com-mutative algebra M(A), called the multiplier algebra of A. M(A) is complete under the strong operator to-pology. A can be algebraically embedded in M(A) as an ideal. When A is semi-simple, M(A) is also semi-simple; and the maximal ideal space of A can be em-bedded in that of M(A). If A is supremum norm alge-bra, so is also M(A). In this case there are 3 natural topologies for M(A): (1) the norm topology σ, (2) the strong operator topology β, and (3) the compact-open topology x; each being stronger than the following one. σ and β are equivalent if and only if A has a compact Silov boundary. Under suitable assumptions, B and x are equivalent if and only if every countable union of compact subsets of the Silov boundary of A has a com-pact closure. The multiplier algebras of several spe-cial algebras are exhibited. (Contractor's abstract)

1955

Stanford U. Applied Mathematics and Statistics Lab., Calif.

THE REPRESENTATIONS OF LINEAR FUNCTIONALS BY MEASURES ON SETS OF EXTREME POINTS, by E. Bishop and K. de Leeuw. Oct. 26, 1959, 42p. incl. refs. (Technical note no. 6) (AFOSR-TR-59-133) (AF 49(638)-294) AD 228266; PB 144348   Unclassified

Also published in Ann. Inst. Fourier, Grenoble, v. 9: 305-331, 1959.

The existence of representations of linear functionals

on subspaces and subalgebras of a Banach space by measures on boundaries smaller than the Silov bound-ary are discussed. (Contractor's abstract)

1956

Stanford U. Dept. of Aeronautical Engineering, Calif.

MECHANICS APPLIED TO CREEP TESTING; WILLIAM M. MURRAY LECTURE, by N. J. Hoff. Dec. 1958, 80p. incl. diagrs. tables, refs. (SUDAER no. 83) (AFOSR-TN-59-39) (AF 49(638)223) AD 238418
                                                            Unclassified

Presented at meeting of the Soc. for Experimental Stress Analysis, Albany, N. Y., Nov. 13, 1958.

The non-linearity of the creep laws governing the ine-lastic deformations of structural materials at high temperatures makes it difficult for the engineer to in-terpret correctly the results of creep tests and to pre-dict the effect of small changes in the parameters upon the strain rates. It is the purpose of this paper to pre-sent information on the basis of which these tasks can be performed a little more easily. The causes of the large scatter in the results of creep tests, the effect of creep on the stress distribution, the interaction between linear elasticity and non-linear creep, and the difficul-ties encountered in the determination of the primary phase of creep are discussed with the aid of the princi-ples of applied mechanics. The paper closes with a brief survey of instability phenomena. (Contractor's abstract)

1957

Stanford U. Dept. of Aeronautical Engineering, Calif.

A THEORY OF SMALL DEFORMATIONS OF SOLID BODIES, by J. F. Besseling. Feb. 9, 1959, 104p. incl. diagrs. refs. (SUDAER no. 84) (AFOSR-TN-59-605) (AF 49(638)223) AD 238419; PB 148754   Unclassified

A theory is presented which is capable of giving a mathematical description of the following phenomena observed in the deformation and heating of solid bodies: thermal stresses, thermoelastic damping of vibrations, dynamic and static moduli, Bauschinger effect and other anisotropic hardening phenomena in plastic deforma-tion, primary creep preceding the secondary stage of steady creep under constant stress, creep recovery and stress relaxation. The variational principles of thermo-elasticity, creep and of the theories of plasticity are all derived from 1 thermodynamic variational principle which is formulated with the aid of the entropy displace-ment field introduced by Biot. Thermoelastic damping of bending vibrations of beams and creep damping of pure shear vibrations are considered in some detail. (Contractor's abstract)

1958

Stanford U. Dept. of Aeronautical Engineering, Calif.

THERMODYNAMIC FOUNDATIONS OF THE THEORY OF DEFORMATION, by J. F. Besseling. Aug. 1959, 26p. (SUDAER no. 86) (AFOSR-TN-59-871) (AF 49.. (638)223) AD 238420; PB 148503   Unclassified

Also published in Proc. Durand Centennial Conf. on Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-8, 1959), New York, Pergamon Press, 1960, p. 247-266. (AFOSR-TR-59-108)

It is shown that the theory of deformation can be founded on thermodynamic principles, the Galilean principle of relativity, and the concept of a natural reference state which at any instant is locally reproducible by a reversible process. The theory is a priori restricted to small inelastic strains. Explicit relations in terms of material properties are presented for small deviations from the natural reference state. Attention is drawn to the inherent nonlinearity of the thermoelastic equations in dynamic problems. (Contractor's abstract)

1959

Stanford U. Dept. of Aeronautical Engineering, Calif.

BUCKLING OF A THIN CIRCULAR CYLINDRICAL SHELL HEATED ALONG AN AXIAL STRIP, by D. W. Hill. Oct. 1959, 91p. incl. illus. diagrs. tables, refs. (SUDAER no. 88) (AFOSR-TN-59-1250) (AF 49(638)-223) AD 238421; PB 148504   Unclassified

A thin circular cylindrical shell was heated along a narrow strip in the axial direction. The restraint of the cooler portion causes compressive axial stresses in the heated strip, and if these stresses are sufficient in magnitude the cylinder can buckle into waves along the heated strip. The problem is solved using the Ritz method, assuming for the displacements Fourier series modified by a shape factor chosen to magnify the solution in the vicinity of the heated strip. The convergence rate of the solution is greatly increased by the shape factor. The cylinder is assumed to be simply supported on its ends so that the radial and circumferential displacements there are zero, but the axial displacements and end rotations are not restricted. The stresses caused by heating are assumed to vary around the circumference but to be constant in the axial direction. Expressions are given relating the physical parameters of the cylinder, the temperature distribution, and the magnitude of the temperature causing buckling. Experimental results for buckling tests on 11 cylinders are presented and are in reasonable agreement with the theoretical calculations. The modified Fourier series assumed for the displacements are shown to converge to the true solution as the number of terms included becomes indefinitely large. For practical purposes the convergence is so rapid that a single term gives results correct to within a few percent.

Courant's maximum-minimum principle is used to establish that the buckling stress for a cylinder under uniform axial compression is a lower bound for all other cases of axial loading, provided that the buckling stress is taken as the maximum compressive stress on the cross section. (Contractor's abstract)

1960

Stanford U. Dept. of Aeronautical Engineering, Calif.

PROCEEDINGS OF THE DURAND CENTENNIAL CONFERENCE ON AERONAUTICS AND ASTRONAUTICS, Stanford U., Calif. (Aug. 5-8, 1959), ed. by N. J. Hoff and W. G. Vincenti. New York Pergamon Press, 1960, 460p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-108) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)671, American Society of Mechanical Engineers, Institute of Aeronautical Sciences, Office of Naval Research, Office of Ordnance Research, and National Science Foundation) AD 253799
Unclassified

Nineteen papers were presented at a jointly sponsored conference covering such topics as rarefied gas dynamics, heat transfer, gas dynamics, material properties at hypersonic speeds, plasma dynamics, and accurate orbit and trajectory calculation as well as other areas of aeronautics and astronautics. Included among the papers are the following AFOSR supported reports: TN-59-790, item no. 2120, Vol. III; TN-59-871, item no. 1958, Vol. III; TN-59-1014, item no. 1891, Vol III; TR-59-125, item no. 787, Vol. III; plus 2 additional reports, Magnetogasdynamic Problems from the Point of View of Particle Dynamics, by J. M. Burgers and Observation Requirements for Precision Orbit Determination, by S. Herrick, for which abstracts will be published in a future volume.

1961

Stanford U. Dept. of Chemistry, Calif.

KINETICS OF NITRIC ACID DECOMPOSITION IN HIGH TEMPERATURE SHOCK TUBE, by R. Hardwick, T. Harrison, and H. S. Johnston. Final technical rept. July 1959 [18]p. incl. diagrs. tables. (AFOSR-TR-59-121) (AF 49(638)306)   Unclassified

The decomposition of nitric acid vapor in a shock tube was studied between 770 - 1240°K. The reaction was followed in terms of the appearance of nitrogen dioxide and in terms of the appearance and disappearance of the intermediate nitrate free radical, NO_3. The decomposition is the unimolecular reaction, $HNO_3 + M \rightarrow HO + NO_2 + M$, near its 2nd order limit. The rate is given by $\log k = 17.3 - (37.9 \times 10^3/RT)$, with k in cc mol^{-1} sec^{-1} and E in cal mol^{-1}; this result is in good agreement with low temperature data. The presence of the NO_3 radical and its rate of disappearance agree

with previous work on nitric acid kinetics and nitrogen pentoxide kinetics. Eight reactions are simultaneously important in this system. The work confirms the observation of Schott and Davidson that above 1000°K the decomposition of NO_3 is unimolecular. (Contractor's abstract)

1962

Stanford U. Dept. of Physics, Calif.

HIGH-ENERGY ELECTRON SCATTERING AND THE CHARGE DISTRIBUTION OF CARBON-12 AND OXYGEN-16, by H. F. Ehrenberg, R. Hofstadter and others. [1959] [9]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)545], Atomic Energy Commission, and Office of Naval Research)   Unclassified

Published in Phys. Rev., v. 113: 666-674, Jan. 15, 1959.

The scattering of high-energy electrons from C^{12}, reported previously, has been extended to 420 mev. The elastic and inelastic scattering from the first excited level at 4.43 mev has been studied between 33° and 70°. The new data are in good agreement with the earlier measurements on C^{12} performed at 187 mev. Additional measurements of the elastic O^{16}-scattering cross sections of 240-, 360-, and 420- mev electrons as functions of the scattering angle furnish information on the size and shape of the O^{16} nucleus. Pronounced diffraction minima in the angular distributions were observed for C^{12} and O^{16}. The experimental results are compared with the predictions of a theoretical phase-shift analysis derived for the harmonic-well independent-particle model of the nucleus. Preliminary best fits confirm the shell-model predictions for the charge density distribution of the p-shell nuclei. The preliminary analysis of the data shows that the length parameter of the well is 1.66×10^{-13} cm for C^{12}, and 1.76×10^{-13} cm for O^{16}, thus indicating a slight variation of the curvature of the harmonic well as the p shell is filled in. (Contractor's abstract)

1963

Stanford U. [Dept. of Physics] Calif.

HIGHER ELECTROMAGNETIC CORRECTIONS TO ELECTRON-PROTON SCATTERING, by S. D. Drell and S. Fubini. [1959] [4]p. incl. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)545] and Office of Naval Research)   Unclassified

Published in Phys. Rev., v 113: 741-744, Jan. 15, 1959.

Higher order electromagnetic corrections to the elec-

tron-proton scattering amplitudes are studied. The scattering amplitude is subjected to a dispersion analysis which permits the e^4 contribution to be written as the sum of two terms. The first corresponds to radiative corrections to the form factors, the second to virtual photon Compton scattering by the proton. A simple model is constructed for the resonant contribution to Compton scattering which is shown to correct the form factor analysis negligibly up to ~1 bev for all scattering angles. (Contractor's abstract)

1964

Stanford U. Dept. of Physics, Calif.

ON THE ANOMALOUS LOSS OF RESOLUTION OF PARAMAGNETIC RESONANCE HYPERFINE STRUCTURE IN LIQUIDS, by G. E. Pake and T. R. Tuttle, Jr. Sept. 1959 [6]p. incl. diagrs. [Technical note no. 2] (AFOSR-TN-59-1018) (AF 18(603)131) AD 230273; PB 145305   Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 423-425, Nov. 1, 1959.

The temperature dependence in the resolution of hyperfine splittings for paramagnetic molecules in liquid solution observed by Hausser is that with increasing temperature from a point of high solvent viscosity ultimately brings out a well-resolved structure which blurs and disappears at still higher temperatures. An explanation is proposed for this anomalous loss of structure by invoking theories of motional narrowing.

1965

Stanford U. Dept. of Physics, Calif.

THE INFLUENCE OF EXCHANGE INTERACTION OF PARAMAGNETIC RELAXATION TIMES, by J. P. Goldsborough, M. Mandel, and G. E. Pake. Nov. 1959 [11]p. incl. table, diagrs. (Technical note no. 3) (AFOSR-TN-59-1245) (AF 18(603)131) AD 230273; PB 145313   Unclassified

Also published in Phys. Rev. Ltrs., v. 4: 13-15, Jan. 1, 1960.

The spin-lattice relaxation and inverse line width at 10 kmc and 24 kmc are measured with a conventional magic tee microwave bridge for 1,3-bis(biphenylene)-2-phenylallyl (BDPA) and 1,1-diphenyl-2-picrylhydrazyl (DPPH) crystalized from $CHCl_3$ and C_6H_6 as well as in polystyrene solid solutions, and Wurster's blue perchlorate. Deviations are observed from results reported in previous studies with respect to dependencies in the polystyrene. The results are interpreted by a 3-reservior model of Bloembergen and Wang.

1966

Stanford U. Dept. of Physics, Calif.

TRIDENTS, μ-PAIRS, AND QUANTUM ELECTRODY-
NAMICS AT SMALL DISTANCES, by J. D. B. Jorksen
and S. D. Drell. Jan. 1959 [26]p. incl. diagrs. table,
refs. (Technical note no. 2) (AFOSR-TN-59-44)
(AF 49(638)388) AD 209415   Unclassified

Also published in Phys. Rev., v. 114: 1368-1375,
June 1, 1959.

Four experiments are proposed and discussed as tests
of quantum electrodynamics, as applied to photons,
electrons, and μ-mesons at distances $<10^{-13}$ cm.
These are: (1) Electron-positron pair production by
electrons in hydrogen (tridents); (2) Wide-angle photo-
production of μ-meson pairs in hydrogen with detection
of one final meson; (3) Wide-angle photoproduction of
μ-meson pairs in hydrogen with detection of both final
mesons in coincidence; and (4) μ-meson pair-produc-
tion by electrons in hydrogen. Taken together with
wide-angle photoproduction of electron-positron pairs,
which are discussed earlier, these experiments will ex-
tend knowledge of electron, photon, and μ-meson size to
distance $\sim 0.3 \times 10^{-13}$ cm. They are all feasible for the
Stanford linear accelerator operating in the 500-mev-1-
bev energy range. (Contractor's abstract)

1967

Stanford U. Dept. of Physics, Calif.

NUCLEON STRUCTURE AND ELECTROMAGNETIC
INTERACTION - THEORY, by L. I. Schiff. Sept. 1959,
27p. incl. diagrs. table, refs. (Technical note no. 3)
(AFOSR-TN-59-900) (AF 49(638)388) AD 226977;
PB 146471   Unclassified

Also published in Proc. Ninth Internat'l. Annual Conf.
on High-Energy Phys., Kiev (USSR) (July 15-25, 1959),
Moscow, 1960, p. 410-435.

This is a review paper reporting progress during the
past year on the theoretical side of nucleon structure
and electromagnetic interaction. The presentation is
divided into 4 parts: (1) A consideration of corrections
to the single-virtual photon approximation that can
arise in electron scattering processes; (2) Information
on nucleon form factors obtainable from experiments
involving polarized particles, and from pion production;
(3) Theory of the nucleon form factors; and (4) Possible
breakdown of quantum electrodynamics at small dis-
tances. There are 46 domestic and foreign references
cited covering a time period from 1957 to 1959.

1968

Stanford U. Dept. of Physics, Calif.

SPECTRAL REPRESENTATIONS OF GREEN'S
FUNCTIONS IN PERTURBATION THEORY, by J. D.
Bjorken. Sept. 1959, 41p. incl. diagrs. refs. (Techni-
cal note no. 4) (AFOSR-TN-59-948) (AF 49(638)388)
AD 229094; PB 144764   Unclassified

An approach to the subject of quantum field theory is
presented based upon the Feynman diagram expansion
which has an intuitive appeal in the "unphysical" re-
gions. The approach also exhibits the role of caus-
ality in determining analytic properties of scattering
amplitudes, as well as showing the role of real inter-
mediate states in determining their singularities. The
physical idea involved in the development at the ex-
pense of mathematical precision is outlined. The inte-
gration of a Feynman graph is carried out over 4-
momenta of internal loops in a general way. The Nambu
representation, which exhibits analytic properties of
the general Feynman diagram is derived. The analytic
properties are shown to be determined by the existence
of real causal intermediate states. The vertex oper-
ator is discussed as function of momentum transfer and
its analytic properties are determined to all finite or-
ders of the coupling constants. Scattering of particles
of equal mass is also discussed. (Contractor's
abstract)

1969

Stanford U. Dept. of Physics, Calif.

FLUX AT SEA LEVEL OF HEAVY CHARGED PARTI-
CLES PAIR-PRODUCED IN COSMIC-RAY SHOWERS,
by A. Goldberg. Sept. 1959 [8]p. incl. diagr. refs.
(Technical note no. 6) (AFOSR-TN-59-964) (AF 49-
(638)388) AD 229423; PB 144964   Unclassified

Also published in Phys. Rev., v. 117: 1128-1129,
Feb. 15, 1960.

The flux at sea level of charged particles with mass
300-600 electron masses is calculated assuming the
particles to be pair-produced by cosmic-ray photons.
The cross section for pair production, including the ef-
fects of nuclear size, is folded into the distribution of
photons predicted by shower theory. Absorption of the
produced particles is also considered approximately.
The results are well below the experimental upper limit
set up by Keuffel and co-workers (Phys. Rev. Ltrs., v.
1: 203, 1958). (Contractor's abstract)

1970

Stanford U. Dept. of Physics, Calif.

INTERFERENCE EFFECTS IN HIGH-ENERGY

BREMSSTRAHLUNG FROM CRYSTALS, by L. I. Schiff. Sept. 1959, 25p. incl. refs. (Technical note no. 5) (AFOSR-TN-59-965) (AF 49(638)388) AD 229408
Unclassified

Also published in Phys. Rev., v. 117: 1394-1401, Mar. 1, 1960.

An attempt is made to understand the negative results of Panofsky and Saxena (Phys. Rev. Ltrs., v. 2: 219, 1959), and the positive results of Frisch and Olson (Phys. Rev. Ltrs., v. 3: 141, 1959), in terms of the theory of the interference effects in high-energy bremsstrahlung from crystals, worked out by Überall (Phys. Rev., v. 103: 1055, 1956). Several theoretical approximations are examined in detail: the validity of the Born approximation, the calculation of temperature effects, the validity of the closure approximation for the crystal lattice, and the use of the Debye form for the lattice vibration spectrum. It is concluded that all of these are justified, except that a partial failure of the Born approximation may be responsible for the nonappearance of the central minimum in the Frisch-Olson experiment. The interference should be enhanced by making the primary electron energy as large as possible and the ratio of photon to electron energy as small as possible. In the case of a diamond-type crystal the 110 direction for the electron beam is preferred to the 100 or the 111 direction. Little advantage is to be gained from cooling the crystal. (Contractor's abstract)

1971

Stanford U. Dept. of Physics, Calif.

ON EXPERIMENTAL TESTS OF THE GENERAL THEORY OF RELATIVITY, by L. I. Schiff. Sept. 1959, 11p. incl. diagrs. (Technical note no. 7) (AFOSR-TN-59-1020) (AF 49(638)388) AD 229421   Unclassified

Also published in Amer. Jour. Phys., v. 28: 340-343, Apr. 1960.

The general theory of relativity is usually regarded as being supported by the 3 "crucial tests", i.e., (1) the red shift of spectral lines emitted by atoms in a region of strong gravitational potential, (2) the deflection of light rays that pass close to the sun, and (3) the precession of the perihelion of the orbit of the planet Mercury. The extent of its full structure supported by these 3 tests is evaluated. Both (1) and (2) are shown to be obtainable by using the equivalence principle and the special theory of relativity, which are amply supported by other experimental evidence. Only (3) provides a real test of general relativity. Terrestrial or satellite experiments that would go beyond merely supplying corroborative evidence for the equivalence principle and special relativity would be extremely difficult to perform, and would for example require a frequency standard with an accuracy somewhat better than 10^{-18}.

1972

Stanford U. Dept. of Physics, Calif.

PION-PION SCATTERING IN THE Φ^4 THEORY, by M. Baker and F. Zachariasen. Dec. 1959, 22p. incl. diagrs. (Technical note no. 9) (AFOSR-TN-59-1324) (AF 49-(638)388) AD 231747; PB 145642   Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 368, Aug. 27, 1959.

Also published in Phys. Rev., v. 118: 1659-1664, June 15, 1960.

Pion-pion scattering was calculated using the determinantal method, assuming that a relativistic ($\lambda/4$) $(\varphi_i \varphi_i)^2$ coupling is responsible for the interaction. The scattering amplitude for the individual partial waves is expressed as a ratio of 2 power series and terms through λ^3 were kept in each series. Numerical results for the S- and P-waves were obtained. The term λ is adjusted by attempting to fit the electromagnetic structure of nucleons. The best value of λ obtained by this fit is unfortunately so large that the validity of the determinantal approximation is doubtful. (Contractor's abstract)

1973

Stanford U. Dept. of Physics, Calif.

SOME REMARKS ON COMPTON SCATTERING, by J. D. Walecka. Dec. 1959, 13p. incl. diagr. (Technical note no. 8) (AFOSR-TN-59-1332) (AF 49(638)388) AD 231746; PB 145640   Unclassified

The kinematics of Compton scattering are discussed and the general covariant form of the T-matrix written. This amplitude is written in the laboratory and center-of-momentum systems as an operator standing between Pauli (not Dirac) spinors. The entire spin and photon polarization dependence of the amplitude can be expressed in terms of 6 invariants involving $\vec{\sigma}$ matrices and the polarization vectors. The particular coefficients of these invariants coming from Powell scattering (a point anomalous moment) are given to 2nd order in the charge. (Contractor's abstract)

1974

Stanford U. [Dept. of Physics] Calif.

MEASUREMENT OF THE PROTON POPULATION READJUSTMENT TIME IN THE OVERHAUSER EFFECT OF FREE RADICALS (Abstract), by R. S. Rhodes and J. H. Burgess. [1959] [1]p. [AF 49(638)388] Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Honolulu, Hawaii, Aug. 27-29, 1959.

The nuclear population distribution undergoes a transient readjustment following a change in the electronic saturation factor in materials exhibiting the Overhauser effect. Measurements have been made of the readjustment time τ for protons in 3 organic free radicals in a magnetic field of 3100 oe. The power applied to the electronic transition was chopped at a variable audiofrequency. Proton absorption was observed with a marginal oscillator and phase-sensitive detector. The output signal was proportional to the difference between enhanced and normal nuclear absorption. The decrease of the output with increasing chopping frequency served to determine τ. The results for the free radicals DPPH, BDPA, and picryl-amino carbazyl are respectively 1.2 ± 0.2, 1.3 ± 0.3, and 1.6 ± 0.3 msec. Since the electronic spin-lattice relaxation time is 10^{-4} times that of the protons, the observed τ should be equal to the proton T_1. For DPPH, τ agrees closely with a pulse measurement: $T_1 = 1.4 \, (\pm 0.1) \times 10^{-3}$ sec.

Although the technique described here can be used to measure the enhancement of the nuclear resonance, additional information is required to determine the branching ratios for the various nuclear relaxation paths.

1975

Stanford U. [Dept. of Physics] Calif.

FIXED-ANGLE DISPERSION RELATIONS FOR SCATTERING OF PARTICLES OF EQUAL MASS (Abstract), by J. D. Bjorken. [1959] [1]p. [AF 49(638)388]
Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

By use of the Nambu representation, fixed-angle dispersion relations are derived in all orders of perturbation theory for the scattering of particles of equal mass. Singularities are confined to cuts along the real energy axis. If the lowest singularity for positive energy corresponds to a threshold of a physical process (in the physical region), partial-wave dispersion relations may be derived. This case is applicable to π-π and N-N scattering. In these cases, singularities along the negative real energy axis due to production processes lie beyond those due to I- and 2-meson exchange terms. In cases of "anomalous thresholds," the fixed-angle dispersion relations can be derived, at best, for a range of angles more limited than $(-\pi, \pi)$.

1976

Stanford U. Div. of Engineering Mechanics, Calif.

SYNTHESIS OF THIRD ORDER CONTACTOR CONTROL SYSTEMS, by I. Flügge-Lotz. Oct. 15, 1959, 30p. incl. diagrs. refs. (Technical rept. no. 123) (AFOSR-TN-59-918) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)513, Boeing Airplane Co. under AF 33(600)35030, and National Aeronautics and Space Administration under NAw 6533) AD 228824; PB 145504   Unclassified

Presented at First Internat'l. Cong. of the Internat'l. Federation of Automatic Control, Moscow (USSR), 1960.

The transfer function of the uncontrolled linear dynamic system has I real and 2 complex poles and may have zeros. The system parameters change with operating conditions. A feedback contactor control with linear switching function is suggested; it can be realized easily and is efficient under different operating conditions. The design is based on the idea of approaching the most "optimum" control in those cases for which the latter is known. The influence of imperfections (time delay, threshold) on the performance of the control system is discussed. (Contractor's abstract)

1977

Stanford U. High-Energy Physics Lab., Calif.

SCINTILLATION PHENOMENA IN NaI AND CsF, by W. J. Van Sciver. Apr. 1955 [128]p. [Rept. no. HEPL-36] (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116]) AD 63827
Unclassified

The spectra of the luminescence from Tl-activated and unactivated NaI and CsF crystals were measured in the temperature range $-190°C$ to $125°C$ using α-particles, γ-rays, and UV light as sources of excitation. Results are presented graphically. An analysis is presented of factors contributing to scintillation emission following activation of crystals of NaI and CsF, and a qualitative explanation is presented of scintillation phenomena in NaI.

1978

Stanford U. [High-Energy Physics Lab.] Calif.

REVISED WEIZSÄCKER SEMI-EMPIRICAL FORMULA FOR DIFFUSE NUCLEAR SURFACES, by W. D. Gunter, Jr. and R. A. Hubbs. [1959] [4]p. incl. diagrs. table.

[Rept. no. HEPL-153] (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission and Office of Naval Research under [N6onr-25116])   Unclassified

Published in Phys. Rev., v. 113: 252-255, Jan. 1, 1959.

An attempt is made to modify the Weizsäcker semi-empirical mass formula to include effects of the diffuse nuclear surface indicated by recent electron scattering experiments. Volume and surface effects are combined by integrating over an assumed trapezoidal density function similar to that found experimentally. Good fits to the experimental nuclear masses are achieved with r_0 (a radius parameter) and ϵ (half the surface depth) equal to 1.081×10^{-13} cm and 1.202×10^{-13} cm, respectively. These are in reasonably good agreement with the experimental values $(1.07 \pm 0.02) \times 10^{-13}$ cm and $(1.50 \pm 0.20) \times 10^{-13}$ cm found by Hahn, Ravenhall, and Hofstadter. (Contractor's abstract)

1979

Stanford U. High-Energy Physics Lab., Calif.

SEARCH FOR ENHANCEMENT OF BREMSSTRAHLUNG PRODUCED BY 575-MEV ELECTRONS IN A SINGLE CRYSTAL OF SILICON, by W. K. H. Panofsky and A. N. Saxena. Jan. 21, 1959 [5]p. incl. diagr. (Rept. no. HEPL-161) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])   Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 219-220, Mar. 1, 1959.

An attempt to measure the enhancement of bremsstrahlung when the momentum transfer corresponds to a reciprocal lattice vector in a single crystal of silicon, irradiated by 575 mev electrons is made. X-rays were detected by production of positive pions, of energy defined by magnetic analysis, from a polyethylene target. No significant dependence of x-ray intensity on crystal orientation was found, which is contrary to the calculations of Überall. No explanation of the discrepancy has yet been found.

1980

Stanford U. [High-Energy Physics Lab.] Calif.

ABSOLUTE ELASTIC ELECTRON-SCATTERING CROSS SECTIONS OF Ca, V, Co, In, Sb, AND Bi AT 183 Mev (Abstract), by M. R. Yearian, J. Oeser, and R. H. Helm. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 61, Jan. 28, 1959.

The detector ladder described by Kendall has been used in measuring the elastic electron-scattering cross sections of Ca, V, Co, In, Sb, and Bi at several angles at 183 mev. Absolute cross sections are obtained by comparison with the scattering from hydrogen. The earlier work of Hahn, et al on the same elements yielded angular distributions which were analyzed by Ravenhall, using a Fermi 2-parameter model, in terms of c (radius to half-maximum), t (90% - 100% surface thickness), and the cross section $\sigma(\theta)$. Ford has analyzed these data using a very similar charge distribution and finds that in general there is an alternate solution characterized by values of c and t quite close to Ravenhall's best values, and by cross sections which vary from 0.6 to 0.65 of Ravenhall's values. Preliminary examination of the present work indicates that measured absolute cross sections are more nearly in agreement with those predicted by the original analysis than with those predicted by Ford's alternate solutions.

1981

Stanford U. [High-Energy Physics Lab.] Calif.

NEUTRON FORM FACTORS FROM HIGH-ENERGY ELECTRON-DEUTERON SCATTERING (Abstract), by S. Sobottka and R. Hofstadter. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Am. Phys. Soc., Series II, v. 4: 257, Apr. 30, 1959.

The inelastic electron-deuteron scattering cross section has been measured from 300 to 650 mev in order to improve the determination of F_{2n} and to place rough limits on F_{1n}. The data were analyzed in terms of the impulse approximation. Rough calculations by Jankus and Durand indicate that corrections due to final-state interactions may be important, so the analysis in terms of neutron form factors must remain incomplete until more satisfactory calculations appear. If these corrections are neglected and if F_{1n} is assumed to be zero, F_{2n}^2 appears to be about 25% larger than the proton form-factor at the smallest values of q^2 measured (2.65 to 5), the difference decreasing to zero at the largest values of q^2 measured (10 to 15.1). The final state interaction, correction would accentuate this

difference. For $5.1 < q^2 < 12.8 \, f^{-2}$, data were taken both at 135° and at a small angle (60° to 90°) for the same q. The results indicate that $-2.5 < (F_{1n}/F_{2n}) < 0.5$ for these q values.

1982

Stanford U. High-Energy Physics Lab., Calif.

SCATTERING OF 200-MEV POSITRONS BY ELEC-TRONS, by J. A. Poirier, D. M. Bernstein, and J. Pine. July 1959 [33]p. incl. diagrs. tables, refs. (Rept. no. HEPL-174) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under N6onr-25116)
Unclassified

Also published in Phys. Rev., v. 117: 557-565, Jan. 15, 1960.

Scattering of positrons by electrons has been investigated by bombarding a beryllium target with 200-mev positrons and observing the recoil electrons in a diffusion cloud chamber located behind the target. The cloud chamber was in a magnetic field which permitted the yield of recoil electrons to be measured as a function of their energy W. The experiment covered the range $88 \leq W \leq 200$ mev. The positron beam also traversed the cloud chamber and the total number of incident positrons was determined by track-counting. The total electron yield for $88 \leq W \leq 200$ mev is $(11 \pm 9)\%$ below that predicted by the first-order Bhabha theory. This difference cannot be interpreted until radiative corrections to the theory have been evaluated. A calculation of these corrections which is valid for the conditions of this experiment is not available. The shape of the electron energy spectrum is in good agreement with the Bhabha theory, and inconsistent with the theory if annihilation terms are omitted. (Contractor's abstract)

1983

Stanford U. High-Energy Physics Lab., Calif.

INELASTIC ELECTRON SCATTERING FROM CARBON, by W. C. Barber and F. E. Gudden. [1959] [7]p. incl. diagr. (Rept. no. HEPL-177) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116]) Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 219-221, Sept. 1, 1959.

The energy spectrum of electrons inelastically scattered from nuclei was measured in order to study the giant-resonance region of nuclear excitation. The scattered electrons corresponding to excitation of the giant resonance were observed at large angles for Si and C targets. The energy distribution of electrons scattered from C at energy level of 42.6 mev through 160° was

described in some detail. A scattering peak corresponding to a nuclear excitation of 15 mev was observed. The results indicate that the investigation of nuclear properties by inelastic electron scattering can be extended to other types of nuclear excitation and can be carried out with lower-energy electron beams.

1984

Stanford U. High-Energy Physics Lab., Calif.

INELASTIC SCATTERING OF 500-MEV ELECTRONS FROM Li^6 AND Li^7, by U. Meyer-Berkhout. [1959] [4]p. incl. diagrs. table. (Rept. no. HEPL-190) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116]) Unclassified

Published in Phys. Rev., v. 115: 1300-1303, Sept. 1, 1959.

500-mev electrons have been scattered from enriched Li^6 and ordinary Li (92.5% Li^7) between scattering angles of 60° and 135° in the laboratory system. The cross section integrated over the inelastic continuum at these large momentum transfers has been compared with the free-proton cross section at the corresponding angles. The results when compared with those obtained for other light nuclei may be used to yield some insight as to the extent to which the scattering from the individual nucleons can be considered as incoherent. (Contractor's abstract)

1985

Stanford U. [High-Energy Physics Lab.] Calif.

THE FUTURE OF HIGH ENERGY ACCELERATORS IN PHYSICS, by W. K. H. Panofsky. [1959] [4]p. [Rept. no. HEPL-180] (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116]) Unclassified

Published in Proc. Internat'l. Conf. on High-Energy Accelerators and Instrumentation - CERN 1959, Geneva (Switzerland) (Sept. 14-19, 1959), Geneva CERN, Scientific Information Service, 1959, p. 3-6.

Problems concerning the use of ultra-high energy accelerators expected to be used in the future are discussed. Various experiments are considered which will require higher energies and higher intensities than are now available.

1986

Stanford U. [High-Energy Physics Lab.] Calif.

BEAMS FROM HIGH ENERGY LINEAR

ACCELERATORS, by W. K. H. Panofsky. [1959] [2]p. [Rept. no. HEPL-197] [Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under N6onr-25116]   Unclassified

Published in Proc. Internat'l. Conf. on High-Energy Accelerators and Instrumentation - CERN 1959, Geneva (Switzerland) (Sept. 14-19, 1959), Geneva CERN, Scientific Information Service, 1959, p. 427-428.

Some general remarks are given concerning the properties of beams from high energy lines and the use of these beams. The particular features are: (1) The total beam will be available as an external beam of excellent geometrical properties. (2) The duty cycle is much lower than in any of the other machines discussed. (3) The pulse length can be reduced to about 20 ns total duration with only a relatively small loss of particles per pulse. (4) Secondary beams at small angles including 0° can be brought out for all polarities and all beam energies without fundamental difficulties. (5) The thin target bremsstrahlung angle is of the order of 0.01 mrad. (6) Some background problems may exist since the primary beam is not automatically separated from the secondary beam causing special disposal problems. The use of these beams is discussed with emphasis on the difference between thin target and thick target operation.

1987

Stanford U. [High-Energy Physics Lab.] Calif.

EXPERIENCE WITH A MICROWAVE SEPARATOR, by W. K. H. Panofsky. [1959] [4]p. incl. diagrs. table. [Rept. no. HEPL-196] [Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116]   Unclassified

Published in Proc. Internat'l. Conf. on High-Energy Accelerators and Instrumentation - CERN 1959, Geneva (Switzerland) (Sept. 14-19, 1959), Geneva CERN, Scientific Information Service, 1959, p. 428-431.

The results obtained from the microwave separator, designed, constructed and tested earlier by P. R. Phillips in connection with the Mark III 700 mev linear accelerator are discussed.

1988

Stanford U. High-Energy Physics Lab., Calif.

CHARGE DISTRIBUTIONS OF NUCLEI OF THE 1p SHELL, by U. Meyer-Berkhout, K. W. Ford, and A. E. S. Green. [1959] [55]p. incl. diagrs. tables, refs. (Rept. no. HEPL-187) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])
                                    Unclassified

Published in Ann. Phys., v. 8: 119-171, Sept. 1959.

New data have been obtained at energies of 160 to 420 mev for the scattering of electrons by Be^9, B^{10}, B^{11}, N^{14}, and O^{16}. A detailed analysis of these elastic scattering data and of other available data for p-shell nuclei is carried through, using various methods and a wide variety of assumed functional forms of the nuclear charge distribution. It is possible to fix rather accurately the spherically symmetric part of the charge distributions of Li^6, C^{12}, N^{14}, and O^{16}, and with less accuracy, those of Be^9 and B^{11}. Central densities are uncertain in all cases. Quadrupole scattering appears to be important in N^{14}, in B^{11}, and possibly in Be^9, and a crude estimate of the quadrupole moment of N^{14} is inferred from the data. The quadrupole scattering depends sensitively on the source of the quadrupole moment, as well as on its value. Regularities within the p-shell are discussed, and connection made with the properties of heavier nuclei. Be^9 and all heavier nuclei have a common value of peak particle density corresponding to a mean particle spacing of $(1.13 \pm 0.001) \times 10^{-13}$ cm. Only Li^6 fails to reach this density of saturated nuclear matter. (Contractor's abstract)

1989

Stanford U. High-Energy Physics Lab., Calif.

MAGNETIC QUADRUPOLE WITH RECTANGULAR APERTURE, by L. N. Hand and W. K. H. Panofsky. [1959] [4]p. incl. diagrs. tables. (Rept. no. HEPL-169) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])   Unclassified

Published in Rev. Scient. Instr., v. 30: 927-930, Oct. 1959.

A magnetic quadrupole of rectangular aperture, employing current sheets bounded by iron rather than shaped pole faces to establish the field, is described. The performance of a rectangular quadrupole of aperture 4 x 23 in. is reported. (Contractor's abstract)

1990

Stanford U. High-Energy Physics Lab., Calif.

APPLICATION OF SUM RULES TO ELECTRON-DEUTERON SCATTERING, by J. I. Friedman. [1959] [6]p. incl. diagrs. tables, refs. (Rept. no. HEPL-172) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])   Unclassified

Published in Phys. Rev., v. 116: 1257-1262, Dec. 1, 1959.

A measurement of elastic and inelastic electron-deuteron scattering has been made at a momentum transfer of 205 mev/c and an electron energy of 175 mev for comparison with the Drell-Schwartz sum rules. The measured value of the non-energy-weighted sum rule is in good agreement with theory. The experimental result for the energy weighted sum rule is 30% larger than the value given for a pure Wigner potential and is consistent with a Rosenfeld two-body interaction if the analysis is restricted to central forces. The analysis is extended to include tensor forces for comparison with the prediction of the Gartenhaus potential. It is found that the gauge terms introduce major ambiguities when tensor forces are included.

1991

Stanford U. High-Energy Physics Lab., Calif.

NEUTRON YIELDS FROM TARGETS BOMBARDED BY ELECTRONS, by W. C. Barber and W. D. George. [1959] [9]p. incl. diagrs. tables, refs. (Rept. no. HEPL-150) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])
Unclassified

Published in Phys. Rev., v. 116: 1551-1559, Dec. 15, 1959.

The total neutron yields from thick targets bombarded by electrons were measured as a function of electron energy for the range 10 to 36 mev. Targets ranging in thickness from 1 to 6 radiation lengths of C, Al, Cu, Ta, Pb, and U were used. The yields for 1- and 6-radiation-length targets of Pb at 34 mev are 2.1×10^{-3} and 9.0×10^{-3} neutrons/electron. Extrapolation to infinite target thickness gives a value of 9.5×10^{-3} neutron/electron. The yield, comparing targets of 1 radiation length, from C is about 10 times smaller than that from U and 2 times greater than the yield from Pb. An explanation of the relative Z-dependence of the yield in terms of known photonuclear cross sections is successful to within a factor of 1.5. The absolute accuracy of the results is estimated to be ± 15%. Calibration of the neutron-detecting equipment was made with a RaBe source and checked by measuring the yields, due to electro- and photodisintegration of the deuteron, from a heavy-water target. In addition, yields from thin targets of Be and Cu were observed as a function of electron energy. The data for Be yield a value of (0.018 ± 0.003) mev-barn for the (γ,n) cross section integrated to 17 mev. The data for Cu were analyzed and combined with other measurements to give an approximate cross section for the $Cu(\gamma,pn)$ reaction.

1992

Stanford U. High-Energy Physics Lab., Calif.

POSITIVE PION PRODUCTION BY POLARIZED

BREMSSTRAHLUNG, by R. E. Taylor and R. F. Mozley. [1959] [11]p. incl. diagrs. tables, refs. [Rept. no. HEPL-162] (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])
Unclassified

Published in Phys. Rev., v. 117: 835-845, Feb. 1, 1960.

By selecting bremsstrahlung produced in a 0.003-in. aluminum radiator at a small angle from the original electron direction, a beam of polarized bremsstrahlung has been obtained from the Stanford linear accelerator. The variation of the polarization and intensity with angle has been studied and compared with theoretical predictions. The polarized beam has been used to study π^+-meson production at 90° c.m. angle and photon energies of 242, 296, 337, and 376 mev. The ratio of meson production along and at right angles to the electric field vector has been measured and compared with the values predicted by the relativistic dispersion relation. (Contractor's abstract)

1993

Stanford U. Microwave Lab., Calif.

NOTE ON UNIQUE DECIPHERABILITY, by E. T. Jaynes. Jan. 1959 [13]p. incl. diagrs. (ML rept. no. 567) (AFOSR-TN-59-52) (AF 49(638)342) AD 209423
Unclassified

Also published in I.R.E. Trans. on Inform. Theory, v. IT-5: 98-102, Sept. 1959.

Consideration is given to an alphabet of a letters, used under the restrictions: (1) messages uniquely decipherable into words, and (2) words limited to a maximum length of L letters. Defining "semi-optimal" transmission by the condition that the mean transmission time per word is minimized for a given entropy per word, we find the attainable rate of information transmission under semi-optimal conditions. Transmission at full channel capacity is a special case of semi-optimal transmission. The constraint of unique decipherability causes no decrease in capacity of the alphabet, considered as a channel, unless accompanied by other constraints. Accordingly, in the absence of other constraints an inequality of McMillan pertaining to uniquely decipherable messages is actually an equality. Some generalizations and analogies to statistical mechanics are discussed. (Contractor's abstract)

1994

Stanford U. Microwave Lab., Calif.

A PROPOSED MILLIMETER-WAVE GENERATOR, by G. S. Kino. Sept. 1959, 18p. incl. refs. (ML rept. no. 606) (AFOSR-TN-59-890) (AF 49(638)415) AD 227664
Unclassified

Also published in Proc. Symposium on Millimeter Waves, New York, N. Y. (Mar. 31-Apr. 2, 1959), Brooklyn, Polytechnic Inst. of Brooklyn Press [1960] p. 233-248.

A mm-wave generator, using a waveguide filled with a plasma of uniform cross-sectional density, but with an axial density variation of the form $\rho_0(1 + \alpha \sin \gamma z)$, is discussed. It is shown, by solving the wave equation for the system, that slow-wave space harmonics of the normal waveguide mode are set up which can interact with an electron beam. These space harmonics, although usually of small amplitude, can have the property that their electric fields are maximum at the center of the guide and minimum at its walls. The design of a possible 1-mm backward-wave oscillator operating at 2.5 kv with approximately 12 ma starting current is dealt with. This design is postulated on the assumption that the so-called Langmuir "electrostatic sound waves" or similar modes may be used to set up the necessary density variation in the plasma. (Contractor's abstract)

1995

Stanford U. Microwave Lab., Calif.

THE EXCITATION OF PLASMA OSCILLATIONS, by P. A. Sturrock. Sept. 1959, 12p. incl. diagrs. refs. (ML rept. no. 620) (AFOSR-TN-59-891) (AF 49(638)-415) AD 227516   Unclassified

Also published in Phys. Rev., v. 117: 1426-1429, Mar. 15, 1960.

The theory of Bohm and Gross [Phys. Rev., v. 75: 1851 and 1864, 1949] and the experiments of Looney and Brown [Phys. Rev., v. 93: 965, 1954] upon the excitation of plasma oscillations by the 2-stream mechanism, which appear superficially to be in disagreement, are shown to be compatible with each other and with related experiments. (Contractor's abstract)

1996

Stanford U. Microwave Lab., Calif.

ACTION-TRANSFER AND FREQUENCY SHIFT RELATIONS IN THE NONLINEAR THEORY OF WAVES AND OSCILLATIONS, by P. A. Sturrock. Sept. 1959, 18p. incl. diagrs. refs. (ML rept. no. 625) (AFOSR-TN-59-892) (AF 49(638)415) AD 227663
          Unclassified

Also published in Ann. Phys., v. 9: 422-434, Mar. 1960.

Certain relations which have arisen in the theories of electrical networks, electron tubes, plasma oscillations and particle accelerators are here shown to be special cases of general relations attributable to any system which may be described by a Hamiltonian. If such a system is analyzed into an interesting set of modes

(waves or oscillators), we find that the rates of transfer of action to or from members of a group of interacting modes are in integral ratios, the integers being determined by the interaction, and are related in magnitude to the energy associated with the interaction. We find furthermore a conjugate set of relations which lead to the following statement: the fractional shifts in frequency of members of a group of interacting modes, when multiplied by the energies in those modes, are in integral ratios, the integers being determined by the interaction, and are related in magnitude to the energy associated with the interaction. The "action-transfer relations" allow one to draw a close parallel between the nonlinear theory of propagating media and the quantum or classical theories of particle collisions. These relations are closely related to the Poincaré and adiabatic invariants. The "frequency-shift relations" provide useful information relating the frequencies of uncoupled modes and the frequencies of excitation of these modes to the partition of energy of this excitation among these modes. This application is demonstrated by a simple example. (Contractor's abstract)

1997

Stanford U. Microwave Lab., Calif.

GROWING SPINWAVES IN FERRITES IN UNSTABLE EQUILIBRIUM, by T. Schaug-Pettersen. [1959] [2]p. (AFOSR-TN-59-1184) [AF 49(638)415]
          Unclassified

Presented at Conf. on Magnetism and Magnetic Materials, Detroit, Michigan, Nov. 16-19, 1959.

Also published in Jour. Appl. Phys., Suppl., v. 31: 382S-383S, May 1960.

It is demonstrated that when the direction of the magnetic field in a saturated ferrite is inverted, spin waves occur which have an aperiodic exponential growth. The fastest growing of these waves have the time factor $\exp(\Omega_M t/2)$ and their wave vector is oriented at right angles to the magnetic field. The significance of these waves for ferrite switching and microwave pulse generation is discussed briefly. (Contractor's abstract)

1998

Stanford U. Microwave Lab., Calif.

SATURATION EFFECTS IN FERRIMAGNETIC RESONANCE, by P. E. Seiden and H. J. Shaw. Oct. 1959 [2]p. incl. diagrs. (ML rept. no. 653) (AFOSR-TN-59-1185) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)415] and Lockheed Missiles and Space Division)   Unclassified

Presented at Conf. on Magnetism and Magnetic Materials, Detroit, Michigan, Nov. 16-19, 1959.

Also published in Jour. Appl. Phys., Suppl., v. 31: 225S-226S, May 1960.

Saturation curves of susceptibility as a function of rf magnetic field have been measured for a number of samples of polycrystalline yttrium iron garnet of varying linewidth. The curves exhibit a region of susceptibility linear in $1/h_{rf}$ at high rf powers. The region of the initial decline in susceptibility is linear in h_{rf}^2, which is predicted both by a small signal relation derived from Callen's ferromagnetic dynamical equation and by a calculation of Schlömann which includes inhomogeneity interactions. A new method of determining the critical field for spinwave build-up is discussed. This method takes account of the fact that the initial decline in susceptibility is not simply due to the Suhl mechanism for saturation in ferrites.

1999

Stanford U. Microwave Lab., Calif.

FERRIMAGNETIC RESONANCE IN POLYCRYSTAL-LINE YTTRIUM IRON GARNET, by P. E. Seiden. Oct. 1959, 76p. incl. illus. diagrs. tables, refs. (ML rept. no. 657) (AFOSR-TN-59-1186) (AF 49(638)415) AD 230374; PB 145017   Unclassified

Investigation was made to obtain a more complete description of the resonance parameters of the yttrium iron garnet system at both small signal and high power levels. A number of sets of polycrystalline samples were made whose composition varied in a systematic way. The composition was varied by choosing the desired ratio of Y_2O_3 to Fe_2O_3 used in the manufacture of the samples. The finished samples ranged from 25% Fe excess through stoichiometric proportions to 15% Y excess. In preparing the samples, 4 different firing atmospheres were used (air, O, N, and Ar) to obtain different states of sample oxidation. A number of sets were fired in each atmosphere to evaluate reproducibility. Ferrimagnetic resonance experiments were performed at 9317 mc, and the linewidth, g-value and saturation curves of microwave susceptibility as a function of RF magnetic field strength were obtained. In addition, saturation magnetization and x-ray diffraction measurements were made and photomicrographs of the samples were taken. The x-ray diffraction data and photomicrographs show that no substitution occurred in the garnet lattice and all excess material went into ceramic second phases. These phases show up clearly in the photomicrographs as regions of approximately the size of a few crystallites. The phases observed were $YFeO_3$ for Y excess, Fe_2O_3 for Fe excess samples fired in oxidizing atmospheres, and Fe_3O_4 for samples fired in neutral atmospheres.

Theoretical values for the saturation magnetization, g-value and linewidth of the samples were calculated.

2000

Stanford U. Microwave Lab., Calif.

HIGH-POWER EFFECTS IN FERRIMAGNETIC RESONANCE, by P. E. Seiden and H. J. Shaw. Mar. 1959 [2]p. (ML rept. no. 586) (AF 49(638)415)
                    Unclassified

Also published in Jour. Appl. Phys., v. 31: 432-433, Feb. 1960.

During ferrimagnetic resonance experiments at high power levels in yttrium iron garnet (YIG), small, sharp discontinuities in susceptibility, superimposed upon the continuous decline with increased power seen by earlier workers, have been noted as many as 9 discontinuities in 1 sample. The size of the discontinuity, and the numbers are roughly inversely proportional to the sample line width. The occurrence follows the empirical relation $h^2 = k\exp(n/c)$, where n is the no. of the discontinuity, in order of occurrence; k and c are constants. For most samples having a large no. of discontinuities, c lies between 1.2 and 3.2. Two other associated effects have also been noted. One is a similar effect when the RF power level is set at a value above the 1st discontinuity and the frequency varied. The other is the occurrence of a region of instability just after the 1st discontinuity.

2001

Stanford U. Microwave Lab., Calif.

HIGH-POWER EFFECTS IN FERRITE DEVICES, by P. E. Seiden and H. J. Shaw. Apr. 1959 [2]p. (ML rept. no. 602) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)415 and Lockheed Missiles and Space Division)   Unclassified

Also published in Proc. Inst. Radio Engineers, v. 48: 122-123, Jan. 1960.

The performance of ferrite devices deteriorates at power levels much lower than would be expected by analogy with saturation in effects in paramagnetic resonance. The effect is due to unstable growth of spin waves which extract energy from the uniform procession. The threshold for the onset of susceptibility decrease depends on the RF field, the linewidth of the sample, the saturation magnetization and the linewidth of the spinwave which becomes unstable. Measurements of linewidth and threshold were made and spinwave linewidth calculated. Values of the critical field threshold power are derived and compared with experimental results.

2002

Stanford U. Microwave Lab., Calif.

INTERPRETATION OF THE RESULTS OF THE RF

CONFINEMENT EXPERIMENT, by P. A. Sturrock. Oct. 1959, 25p. incl. diagrs. table. (Scientific rept. no. 3; ML rept. no. 638) (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)5226 and Air Force Office of Scientific Research under [AF 49-(638)415]) Unclassified

The results of certain experiments upon the confining action of low frequency (about 10 mc/s) rf fields upon plasmas are reviewed. Attempts at theoretical explanation of these results by various confinement mechanisms also are reviewed. The theories are not found acceptable, and there are certain general reasons for believing that the experiments do not represent true confinement. Investigation of the electric field configuration necessary to explain the observed plasma configuration leads one to interpret the experiment in terms of "pseudo-confinement". Surface charges build up on the inner wall of the glass tube in such a way that electrons experience a radially inward force at the surface of the plasma over almost all of the surface of the plasma almost all of the time; ions therefore experience an outward force almost everywhere most all of the time. The effect of the rf electric field is therefore to promote the formation of a high-voltage sheath separating the plasma from the glass tube. This interpretation appears to be fully compatible with observations so far made with various electric-field patterns; it also offers an explanation of the dark deposits on the glass tube noted in certain experiments. Further experiments which may be conducted to verify this theory are proposed. (Contractor's abstract)

2003

Stanford U. Microwave Lab., Calif.

THE DESIGN AND CHARACTERISTIC OF A MEGA-WATT SPACE-HARMONIC TRAVELING-WAVE TUBE, by M. Chodorow, E. J. Nalos and others. [1959] [5]p. incl. illus. diagrs. refs. [ML rept. no. 501] (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Research, and Signal Corps under [N6onr-25123]) Unclassified

Published in I.R.E. Trans. on Electron Devices, v. ED-6: 48-53, Jan. 1959.

The tube described has a pulsed output power of 1 megawatt with 9.6% bandwidth, where bandwidth is defined as the 3 db points for saturation power. Saturation gain is about 20 db, which is 6 db below the low-level gain. This is a space-harmonic S-band structure, designed to operate at a beam voltage of 10^5 v and perveance of 2×10^{-6}. Field configurations for the lowest and next higher pass bands are drawn, based upon a field analysis and cold measurements. The impedance determined by perturbation measurements is compared to the impedance for the forced sinusoid inside a closed region, and it is found that the tube has about 4 times the minimum storage energy necessary to obtain the same bandwidth. (Contractor's abstract)

2004

Stanford U. Microwave Lab., Calif.

DEVELOPMENT OF HIGH-POWER PULSED KLYSTRONS FOR PRACTICAL APPLICATIONS, by M. Chodorow, E. L. Ginzton and others. [1959] [10]p. incl. illus. diagrs. tables. (ML rept. no. 496) (Sponsored jointly by Air Force Office of Scientific Research, and Signal Corps under [N6onr-25123]) Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 20-29, Jan. 1959.

The development of 3 practical, sealed-off, tunable klystrons intended for operation in the region of 1 to 2 megawatt at S, L, and X-bands is described. These tubes are an outgrowth of previous development of a 30 megawatt S-band klystron in conjunction with the billion-volt linear electron accelerator program. Similar design principles apply to all these tubes, but the 3 smaller klystrons described make use of cavity tuning methods appropriate to the 3 frequency bands.

2005

Stanford U. Microwave Lab., Calif.

MICROWAVE TUBE RESEARCH, by E. L. Ginzton and M. Chodorow. Final rept. Mar. 1, 1950-Mar. 30, 1959, 79p. incl. illus. (ML rept. no. 590) (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Research, and Signal Corps under N6onr-25123) AD 213845 Unclassified

An historical survey of the purposes and accomplishments of Contract N6onr-25123 is presented. Also presented are a list of the Technical Reports which have been issued under this contract; a list of the Doctoral degrees which have been awarded to graduate students whose thesis research has been wholly or partially sponsored by this contract; and a list of the scientific personnel who have been associated with the contract. Illustrations of some of the devices and schemes which have been developed or investigated under this contract are also presented. (Contractor's abstract)

2006

Stanford U. Microwave Lab., Calif.

ON THE BOUNDARY VALUE PROBLEM OF WAVE-GUIDE WINDOWS, by M. P. Forrer. Mar. 1959, 111p. incl. illus. tables, refs. (ML rept. no. 579) (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Research, and Signal Corps under N6onr-25123) AD 215820 Unclassified

The mode conversion theory is generalized to the case of arbitrary dielectric obstacles, and applied to the problem of the vicinity of dielectric waveguide windows

of general shape. Results are compared with experi-- mental measurements to determine the validity of the approximate methods used. The mathematical method is that of a normal mode expansion of the electromag- netic fields. The contribution of individual waveguide modes to the total field may be determined by succes- sive approximations. The theory is applied to several specific window geometries where a perturbation pro- cedure is used, based on an expansion of the fields in powers of (ϵ - 1). The comparison between theory and experiment is done by way of the reflection coefficient. First-order solutions are accurate for windows of low dielectric constant (ϵ < 4) and small length. Improve- ments obtainable by second-order approximation are illustrated. For windows of high dielectric constant ($\epsilon \approx 10$) and a length of the order of a guide wavelength, there is strong modal interaction, so that the first- order solutions are only qualitatively correct. Accu- rate results for this case must be obtained by numeri- cal integration of the coupled differential equations of several modes. This problem is well adapted to pro- gramming on a computer. The phenomenon of ghost- modes in dielectric windows is discussed. (Contrac- tor's abstract)

2007

Stanford U. Microwave Lab., Calif.

COUPLING OF MULTIPLE-CAVITY SYSTEMS, by M. A. Allen. Apr. 1959, 161p. incl. illus. tables, refs. (ML rept. no. 584) (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Re- search, and Signal Corps under N6onr-25123) AD 215455   Unclassified

Cavity resonators, coupled together by various methods, were used as circuits in a number of high- power TWT. The resonators are coupled together in a long array with a means provided for an electron beam to pass through a region of strong longitudinal electric field. Work is concerned primarily with the type of coupling obtained through long resonant slots. In particular, new types of structures which employ slots of lower resonant frequency than the uncoupled cavities are considered, and it is shown that they have very large bandwidths and high impedance, and are therefore desirable circuits for use in wide-band high- power TWT. An electromagnetic field theory is given which successfully predicts the important propagation characteristics of these structures. It is shown how the quantity $E^2(O)/W$ for the structures may be evalu- ated, where E(O) is the value of the longitudinal com- ponent of the electric field on the axis, and W is the energy stored per periodic length. With this informa- tion, the usefulness of the structures as traveling- wave tube circuits may be assessed. (Contractor's abstract)

2008

Stanford U. Microwave Lab., Calif.

EXTENDED INTERACTION KLYSTRONS WITH TRAV- ELING-WAVE CAVITIES, by H. Golde. Apr. 1959, 131p. incl. illus. diagrs. tables, refs. (ML rept. no. 582) (Sponsored jointly by Air Force [Office of Scientific Re- search], Office of Naval Research, and Signal Corps under N6onr-25123) AD 215453   Unclassified

Study was made of a new type of extended interaction cavity for klystrons. The interaction cavity consists of a closed transmission line loop which will support a traveling wave if the loop is properly excited. Two meth- ods of excitation, both using a directional coupler, are described. A general theory of the traveling-wave reso- nator in the absence of an electron beam is given. The important parameters for interaction with an elec- tron beam are derived. Measurements on an experi- mental cavity agree well with theory. A discussion is given of the effects of electron beams on the field dis- tribution in the cavity. The beam-coupling coefficient and the beam-loading admittance under small-signal conditions were calculated and presented in graphical form. The stability of operation of a klystron using traveling-wave cavities is compared with 1 using stand- ing-wave cavities. A number of numerical examples for a connnected-ring structure as the beam-interac- tion line were worked out and are presented in tabular form. These examples are given for a proposed multi- cavity klystron operating at an RF power level of about 1 megawatt. The results indicate that the pro- posed amplifier has a larger bandwidth for substantially the same gain than conventional klystrons.

2009

Stanford U. Microwave Lab., Calif.

THE THEORY OF THE SINUOUS WAVEGUIDE BEAM- COUPLER FOR MILLIMETER WAVE GENERATION, by A. L. Cullen. [1959] [15]p. (ML rept. no. 633) (Spon- sored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr- 22548) AD 228207   Unclassified

The theory of the sinuous waveguide beam-coupler is de- veloped without recourse to the theory of relativity. The analysis is based on the idea that the sinuous waveguide can be regarded as a slow-wave structure capable of supporting space harmonics with phase constants β + $2\pi n/1$. The zero-order mode n = 0 and the condition for synchronous interaction is $\beta_e = \beta$, where $\beta_e = \omega/u_0$, and β differs from β' for the straight guide because of the increased path length along the sinuous axis. The 1st- order mode is n = 1 and $\beta_e = \beta + 2\pi/1$, and the 2nd-or- der mode, n = 2 and $\beta_e = \beta + 4\pi/1$. The characteristics of these various modes of interaction are discussed, and formulae for power output are given. Higher- order interactions are not investigated, as they are likely to be very inefficient. (Contractor's abstract)

2010

Stanford U. [Radio Propagation Lab.] Calif.

PARIS SYMPOSIUM ON RADIO ASTRONOMY, Cité Universitaire (France) (July 30-Aug. 6, 1958), ed. by R. N. Bracewell. Stanford, University Press, 1959, 612p. incl. illus. diagrs. tables, refs. (ISRU: Symposium no. 1; IAU: Symposium no. 9) (AFOSR-4512) (AF 18(603)-53)   Unclassified

The book consists of the research results reported at the symposium as subsequently submitted with the benefit of revision; and together with the several introductory surveys, discussions, and the concluding assessments. It provides a comprehensive account of the current state of development of the basic aspects of radio astronomy. The 6 organizers and sponsors of this symposium are briefly described. The major topics are as follows: Radio emission and reflections from planets, comets and the moon; solar radio emission and the quiet and active sun; radio study of individual objects (external to solar system); radio evidence on the large-scale structure of our own and external galaxies; source surveys, identifications, and other studies related to cosmological problems; and theory, mechanism of solar and cosmic radio emission. An author index is given for the 500 papers cited.

2011

Stanford U. Radio Propagation Lab., Calif.

INTERFEROMETER PHASING PROBLEMS AT MICROWAVE FREQUENCIES, by G. Swarup and K. S. Yang. [1959] [8]p. incl. diagrs. (AF 18(603)53)   Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 18-21, 1959.

Published in I.R.E. WESCON Convention Record, Pt. 1, p. 17-24, 1959.

The electric field distribution required to realize a desired radiation pattern is sometimes quickly visualized by means of a transfer function (the spectral sensitivity function) which measures the response of the antenna system to the spatial frequencies of a 2-dimensional distribution of brightness. The effects of amplitude and phase errors of individual elements on the directivity and side radiation pattern of an interferometer system are discussed. In the case of phase-switched interferometers it is also important to evaluate the effect of fixed phase error of the switch and feeder system, and phase throw error of the switch, on the radiation pattern. It is shown that these phase errors affect the shape of the radiation pattern only if there exists an odd component in the 2-dimensional electric field distribution over an aperture. Details of construction of the transmission line system of a cross-antenna built at Stanford for operation at 9 cm wavelength are described. The antenna has 16 paraboloidal

reflectors in each arm of the cross and provides a pencil beam of nearly 4 min of arc width. The experimental technique employed in adjusting amplitude and phase of the field, impressed on each element of the interferometer is also described.

2012

Stanford U. [Stanford Electronics Labs.] Calif.

SOME PROPERTIES OF LIGHTNING IMPULSES WHICH PRODUCE WHISTLERS, by R. A. Helliwell, A. G. Jean, and W. L. Taylor. [1958] [3]p. incl. diagrs. (AF 18(603)-126)   Unclassified

Published in Proc. Inst. Radio Engineers, v. 46: 1760-1762, Oct. 1958.

Conclusions drawn from the result of simultaneous observations of storms at Boulder and at Stanford are given. (1) It is found that a characteristic waveform is often associated with the impulse that produces a whistler. It possesses an intense energy peak near 5 kc/s and occurs infrequently compared with other atmospherics. (2) Whistler-producing discharges are most frequent over sea than over land. (3) The time of the origin of a whistler should not be calculated from the Eckersley dispersion law. Identification of the causative impulse should be based on waveform analysis as well as the time of occurrence.

2013

Stanford U. Stanford Electronics Labs., Calif.

TRAVELING-WAVE AMPLIFICATION IN THE IONOSPHERE, by T. F. Bell and R. A. Helliwell. Sept. 15, 1959, 8p. incl. diagrs. (Technical rept. no. 2) (AFOSR-TN-59-1099) (AF 18(600)126) AD 229793; PB 145321   Unclassified

A traveling-wave type of amplification of electromagnetic waves propagating in the "whistler-mode" is presumed to exist in the ionosphere. Streams of electrons moving down the earth's magnetic field lines can enter ionospheric regions in which the stream-velocity spectrum matches approximately the phase velocity of "whistler-mode" waves in that region. Under these conditions amplification of the wave may occur. This paper deals with the investigation of an analogous, but simplified, situation: a plasma, consisting of a uniform distribution of electrons and positive ions, exists in an extensive zero-temperature region well removed from boundaries. This plasma is permeated by a uniform and static magnetic field and also by a second plasma which moves with some constant velocity parallel to the magnetic field lines. In addition, a plane wave is assumed to be propagating through the composite medium, which is considered to be electrically neutral. For the above model, the modes of propagation of the wave are obtained, and the conditions necessary for wave amplification are studied. Application

is made to conditions existing in the ionosphere and the consequent implications of the theory are discussed. (Contractor's abstract)

2014

Stanford U. [Stanford Electronics Labs.] Calif.

HYBRID WHISTLERS (Abstract), by R. A. Helliwell. [1959] [1]p. (AF 18(603)126) Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., May 4-7, 1959.

Published in I.R.E. Trans. on Antennas and Propagation, v. AP-7: 287, July 1959.

Whistlers frequently exhibit many well-defined components which are thought to result from the existence of separate paths of propagation. It has been suggested that such paths might be defined by columns of enhanced ionization which are aligned with the earth's magnetic field and which reach from one hemisphere to the other. Another possibility is that whistler energy is permitted to emerge from the ionosphere only at specific locations where conditions are favorable. A test to differentiate these 2 models would be to excite whistler paths simultaneously in opposite hemispheres from the same source. At a receiver in either hemisphere the result would be the superposition of long and short whistlers— a hybrid whistler. The dispersion ratios of a hybrid whistler and its echoes would be 1:2:3:4:5, etc., if the paths were the same for both directions of propagation. A search of records from the IGY Whistlers-West project has revealed several examples of what appear to be genuine hybrids. Their existence argues strongly for the field-aligned column hypothesis of whistler paths.

2015

Stanford U. [Stanford Electronics Labs.] Calif.

THE TRAPPING OF WHISTLERS BY COLUMNAR IRREGULARITIES IN THE OUTER IONOSPHERE (Abstract), by R. L. Smith, R. A. Helliwell, and I. Yarbroff. [1959] [2]p. (AF 18(603)126) Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., May 4-7, 1959.

Published in I.R.E. Trans. on Antennas and Propagation, v. AP-7: 287-288, July 1959.

Storey showed that whistlers should follow approximately the lines of force of the earth's field because of the anisotropy of the ionized medium. It has been suggested that columns or shells of enhanced ionization aligned with the earth's field might effectively trap the waves as in a waveguide. The conditions for such trapping are developed, assuming that ray theory applies and that the refractive index is large. It is found that waves

can be trapped not only in enhanced columns but also in columns of reduced ionization. The conditions for trapping are given in terms of the ratio of wave frequency to gyro-frequency, the initial wave normal angle, and the degree of enhancement. As an example, a 10 kc ray path is computed for a column with 20% enhancement of ionization with respect to the background level. The path exhibits small snakelike excursions from the axis of the column and satisfies the criteria which have been developed. Applications of this theory to the interpretation of whistler data are discussed.

2016

Stanford U. [Stanford Electronics Labs.] Calif.

OBLIQUE ECHOES FROM OVER-DENSE METEOR TRAILS, by L. A. Manning. Feb. 28, 1958, 20p. incl. diagrs. (Technical rept. no. 29) (Sponsored jointly by Air Force [Office of Scientific Research] Office of Naval Research, and Signal Corps under Nonr-22524) Unclassified

Also published in Jour. Atm. and Terrest. Phys., v. 14: 82-93, Apr. 1959.

For abstract see item no. STA.06:041, Vol. II.

2017

Stanford U. Stanford Electronics Labs., Calif.

AN INVESTIGATION OF THE MAGNETRON AMPLIFIER, by B. A. Wightman. Feb. 9, 1959, 87p. incl. illus. table. (Technical rept. no. 52) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 211869 Unclassified

The magnetron amplifier is investigated on account of its promise of efficiencies in excess of > 50%. (1) An analytical investigation of the interaction at small signal levels, and (2) an experimental effort to adapt the zig-zag line for the higher power requirements in the amplifier are studied. The model for the space-charge-wave interaction postulated by Heffner and Unotoro is inserted into the Pierce analysis of the amplifier. The result includes a determinantal equation for the space-charge-wave interaction which is the same as Gould's, but the analysis embraces all interactions, which are examined with respect to the energy exchange between beam and circuit in order to determine which interactions are useful. Some new and different conclusions are drawn. The selection of a slow-wave circuit for the amplifier is discussed, and the zig-zag line is chosen for its low dispersion. This circuit was adapted for higher powers by mounting on a ceramic of high thermal conductivity which was undercut to minimize dielectric loading. The circuit was successfully fabricated by an impact-grinding technique. The thermal capacity was satisfactory. However, the effect of the undercutting was not as great as anticipated;

the coupling impedance was reduced and the attenuation increased excessively. This circuit had an efficiency of 12%. Some alternative proposals for a circuit was made. (Contractor's abstract)

2018

Stanford U. Stanford Electronics Labs., Calif.

PHYSICAL PRINCIPLES OF AVALANCHE TRANSISTOR PULSE CIRCUITS, by D. J. Hamilton, J. K. Gibbons, and W. Shockley. Feb. 17, 1959, 19p. incl. diagrs. tables. (Technical rept. no. 53) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 213153   Unclassified

Also published in Proc. Inst. Radio Engineers, v. 47: 1102-1108, June, 1959.

A simple physical theory is developed which permits a calculation of the significant points of avalanche transistor transient behavior. A model for the transistor is defined in terms of charge variables and the physical parameters of the device. The transient performance of the model is calculated by focusing attention on the minority carrier charge stored in the base region and the influence of base-width modulation upon this stored charge. In the charge formulation of the problem, the physical details of the avalanche multiplication process need not be considered; multiplication is accounted for by the boundary conditions which it imposes upon the stored charge. Good agreement has been obtained between calculated and experimentally observed data for a simple avalanche transistor relaxation oscillator. (Contractor's abstract)

2019

Stanford U. Stanford Electronics Labs., Calif.

A CLASS OF MULTIPLE-ERROR-CORRECTING BINARY CODES FOR NON-INDEPENDENT ERRORS, by P. Fire. Apr. 24, 1959, 47p. incl. illus. tables. (Technical rept. no. 55) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 219307
                                    Unclassified

In many data transmission and processing systems, the occurrence of multiple errors within a word is known to be a nonindependent phenomenon, i.e., the probability of an error occurring in a particular binary digit (binit) of the word is conditional on whether any errors occurred in some number of preceding binits. A class of parity-check error-correcting codes, specifically designed to cope with this situation, is described. These codes have the peculiar property that the check word derived in the normal decoding process is composed of 2 subwords, one defining the errors' pattern and the other indicating the error pattern's location within the word. The corrupted word is corrected merely by ad-

ding the shifted error-pattern subword to the indicated incorrect portion of the received word. A particular code of the proposed class may be designed in a straight forward manner to correct any number of information binits for any error pattern up to some specific maximum binit with, r. For example, a code for which r is equal to 3 will correct any one of the following: single error, double-adjacent error, 3-binit-wide double error, and triple-adjacent error. The codes may be instrumented simply by the use of a pair of linear feedback shift registers which generate the decoding table. Since shift-register feedback logic is fixed for a given code, table-lookup methods are not required for automatic decoding. Furthermore, since the codes afford a significant saving of parity binits, compared to codes correcting an equivalent number of independent errors, instrumentation is further simplified. The detection of error patterns including more than r errors is possible for those cases where the error-pattern width is no greater than the number of binits in the error-pattern subword. This is done merely by determining the number of ones in the error-pattern subword. (Contractor's abstract)

2020

Stanford U. Stanford Electronics Labs., Calif.

A THEORY FOR THE TRANSIENT ANALYSIS OF AVALANCHE TRANSISTOR PULSE CIRCUITS, by D. J. Hamilton. June 15, 1959, 62p. incl. illus. tables, refs. (Technical rept. no. 1701-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 218575; AD 230700   Unclassified

A simple physical theory is developed which describes the transient behavior of an avalanche transistor in terms of its physical parameters. The consideration of the minority carrier charge stored in the base during the transient process is an important factor in this development, and major emphasis is placed upon the use of charge variables in describing the model for the transistor. The theory is applied in the analysis of 2 classes of avalanche transistor pulse circuits: that in which the transistor is used with a capacitive load, or with a resistive load. Regardless of the load type used, a certain minimum value of avalanche multiplication must exist in the transistor if a regenerative build-up of current is to occur. It is shown that a rapid build-up rate requires a large multiplication value, and a theoretical limit of the maximum value can be derived from thermal considerations. With a capacitive load, the theory is used to obtain the critical values of load capacitance, the peak value of the current, an estimation of the rise time of the current pulse, and the effects of a small resistance in series with the capacitor. With resistive load, the theory is used to determine the current as a function of time. The validity of the theory is verified by the good agreement between the calculated and measured data. A more significant contribution of the theory. however, is the understanding which it conveys of the important factors that govern the behavior of avalanche transistors. (Contractor's abstract, modified)

2021

Stanford U. Stanford Electronics Labs., Calif.

THEORETICAL LIMITATIONS ON THE GAIN-BAND-WIDTH PRODUCT OF THREE-TERMINAL NETWORKS, by J. J. Spilker, Jr. [1959] [5]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [Nonr-22524])   Unclassified

Published in I.R.E. Trans. on Circuit Theory, v. CT-6: 224-228, June 1959.

Wherever parasitic impedances are found shunting the terminals of a network, certain limitations on the electrical behavior of this network can be found. Typically, these parasitic impedances might represent a transistor, vacuum tube, or some other loading effect. Theoretical limitations are derived for the gain-bandwidth product of passive linear 3-terminal networks (not necessarily lossless) used as low-pass filters. An important use of these limitations is in determining the upper bonds on the performance of video amplifiers. Bode has considered limitations of this type for an important but restricted class of networks where the parasitic elements are purely capacitive, whereas, limitations are shown here for arbitrarily parasitic impedances. One important application of this new generality is that limitations can now be established for transistor amplifiers. This development has required the use of a general resistance integral theorem, the derivation of which is given. Different limitations are indicated for RLC networks and those allowing mutual inductance. Examples are given.

2022

Stanford U. Stanford Electronics Labs., Calif.

A STUDY OF THE EMITTING-SOLE LINEAR MAG-NETRON AMPLIFIER, by D. Chen. July 14, 1959, 109p. incl. illus. tables. (Technical rept. no. 207-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 220571   Unclassified

A thick non re-entrant beam under Brillouin flow conditions, with the lower beam boundary in contact with the sole is explored. The analytical part of this study is to extend Buneman's small-signal theory of magnetrons to the case of the emitting-sole amplifier. The transverse normalized acceptance of the beam, R_b, at

the upper beam boundary is derived. Computations of the complex R_b as a function of the complex propagation constant, in the region of interest, for 3 typical frequencies are given. Four asymptotic forms of R_b to cover the entire complex plane of the propagation constant are derived. The use of these asymptotic forms of R_b simplifies the procedure of susceptance matching between the beam and the circuit: from tedious graph-

ical method to the obtaining of the solutions of 4 algebraic equations. The wave solutions for matching the emitting-sole beam to free space and also to a conducting plate at 3 different distances above the beam are computed in detail through the use of these 4 asymptotic forms of R_b. Some discussions regarding the matching of the emitting-sole beam to a periodic circuit are also given. A method of calculating the dc equilibrium position of a general thick beam in crossed-field, under Brillouin flow conditions, has been given. The electronic efficiency of a re-entrant-type emitting-sole beam is also estimated and compared to that of a thin beam. An experimental amplifier is designed and constructed. It employed a smooth conducting plate as a circuit, facing an emitting-sole beam which fills up 3/4 of the spacing between the circuit and the sole. Results on the dc beam transmission test are fairly satisfactory. However, the measurements on the r-f amplification suffer a serious drawback from the excessive beam noise whenever the cathode emission is under space-charge-limited conditions. Measurements taken with the cathode operated under temperature-limited conditions give a rate of gain of 1.1 db/cm. This compares fairly closely with the theoretical predicted value of 1.4 db/cm, where space-charge-limited emission is assumed. (Contractor's abstract)

2023

Stanford U. Stanford Electronics Labs., Calif.

DESIGN OF A SAMPLED DATA CONTROLLER USING TRANSISTOR LOGIC, by M. Cavestany. Aug. 13, 1959, 46p. incl. illus. (Technical rept. no. 2100-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 225011   Unclassified

The design and construction of a digital controller for use in the study of sampled-data control systems are described in detail. The device is a hybrid computer combining digital and analog techniques to take advantage of the special properties of each. A novel feature of this controller is the use of special modulators to convert the analog voltages to frequency information which is the form in which the data is stored on a magnetic drum. Section I, gives an exposition of the principles of digital compensation in sampled-data systems. The different steps leading to the conception and utilization of a digital controller are covered. Section II, presents a brief description of the present system, which is based on the utilization of a magnetic drum as data hold, storage, and delay element, with transistor digital logic circuits to perform the necessary switching. The last section gives the design of the switching block. It is concluded that since all the system is strongly dependent upon the characteristics of the drum, the range of utilization of this controller is perfectly defined. (Contractor's abstract, modified)

2024

Stanford U. [Stanford Electronics Labs.] Calif.

CIRCUIT CONSIDERATIONS IN TRAVELING-WAVE
PARAMETRIC AMPLIFIERS, by C.   Bell and G.
Wade. [1959] [8]p. incl. illus. diagrs. (Sponsored
jointly by Air Force Office of Scientific Research,
Office of Naval Research, and Signal Corps under
[Nonr-22524])   Unclassified

Presented at Western Electronic Show and Convention,
San Francisco, Calif., Aug. 18-21, 1959.

Published in I.R.E. WESCON Convention Record, Pt. 2,
p. 75-82, 1959.

Circuit considerations appropriate to wide-band opera-
tion in a traveling-wave parametric amplifier are de-
scribed. The model analyzed is a transmission line
periodically loaded with parametric diodes. The diodes
constitute the variable elements. Across each diode is
fed a large pumping voltage which produces a time-
varying capacitance. A Brillouin diagram for the struc-
ture (i.e. a plot of ω vs β) can be computed from the
analysis. The conditions for high gain, wide band, and
other desirable characteristics are conveniently deter-
mined from this diagram. (Contractor's abstract,
modified)

2025

Stanford U. Stanford Electronics Labs., Calif.

VARIABLE CAPACITANCE WITH LARGE CAPACITY
CHANGE, by J. L. Moll. [1959] [5]p. incl. diag s.
(Sponsored jointly by Air Force [Office of Scientific
Research], Office of Naval Research, and Signal Corps
under Nonr-22524)   Unclassified

Presented at Western Electronic Show and Convention,
San Francisco, Calif., Aug. 18-21, 1959.

Published in I.R.E. WESCON Convention Record, Pt. 3:
32-36, 1959.

The capacitor described is an improved version of the
Si crystal diode which utilizes the variation in barrier
thickness with voltage to achieve a voltage-controlled
capacitance. In the present construction a thin film of
oxide is created on the surface of n-type Si and a small
counterelectrode evaporated on to the oxide. As a re-
sult, a higher capacitance is achieved at low voltage
while the capacitance at high reverse voltages is un-
changed. The range is thus increased.

2026

Stanford U. Stanford Electronics Labs., Calif.

ALUMINO-SILICATE GLASS-TO-MOLYBDENUM-
DISC SEAL, by J. F. Margiotta. Sept. 1, 1959, 5p. incl.

illus. (Bull. no. 102) ([Sponsored jointly by Air Force
Office of Scientific Research, Office of Naval Research,
and Signal Corps under] Nonr-22524) AD 225955
                                               Unclassified

A description is presented of the preparation of a Mo-
glass seal for a TWT envelope. Corning no. 1720 glass
tubing was cut to size with a conventional water-cooled
cut-off wheel; the ends were hand-ground on a glass
plate, immersed in 49% CP-grade HF for 5 sec, and
rinsed successively in tap H_2O, distilled H_2O, acetone,
distilled H_2O, and EtOH. The Mo disks were given a
high polish with extra-fine rubberized abrasive, de-
greased and rinsed, and fired at 900°C in wet H for 15
min. The surface to be sealed was deplated in a weak
H_2CrO_4-H_2SO_4 solution and the part was rinsed in the
same manner as was the glass tube. The Mo piece was
oxidized by heating with an RF concentrator in air for
3 min at 550°C to form a yellowish-white MoO_3 coat-
ing, then heated in a bell jar with a He atmosphere at
increasing temperatures up to 1000°C until the MoO_3
disappeared. The glass was jigged into place, the bell
jar was refilled with He, and the temperature was
raised to 1000°C (brightness) where the glass began to
soften. The temperature was increased to 1200°C and
held there for 2 or 3 min until the Mo disk dropped
into place and the seal was completed. The assembly
was allowed to cool, then placed in an annealing oven
idling at 450°C with either at 75% N-25% H or a N at-
mosphere. The atmosphere was switched to line H;
the temperature was raised to the annealing point of
the glass (715°C), held for 15 min, then allowed to drop
to room temperature in 1½ hr.

2027

Stanford U. Stanford Electronics Labs., Calif.

CERAMIC METALIZING MIXES, by R. Keller. Sept. 1,
1959, 2p. (Bull. no. 101) (Sponsored jointly by Air
Force of Scientific Research, Office of Naval Research,
and Signal Corps under Nonr-22524) AD 234514
                                               Unclassified

Two metalizing mixes are used to make satisfactory
ceramic-to-metal seals. One is the Stanford Micro-
wave Lab. mix no. 2A used in the large klystrons for
the linear acceleratory. It is composed of the follow-
ing: Mo, Mn and Fe powders; SiO_2, CaO, nitrocellulose
mix, acetone, methyl ethyl ketone and Cellosolve. The
nitrocellulose mix contains nitrocellulose, toluene,
methyl ethyl ketone, and ethyl acetate. Mix no. 101 re-
quires less critical control of temperature and atmos-
phere. However, there are indications that this mix
deteriorates on standing. It is composed of the fol-
lowing Mo, Mn, Fe, alumina powders; SiO_2; titanium
hydride; and nitrocellulose mix.

2028

Stanford U. Stanford Electronics Labs., Calif.

A MODIFIED FORM OF THE MELLIN TRANSFORM
AND ITS APPLICATION TO THE OPTIMUM FINAL
VALUE CONTROL PROBLEM, by J. Peshon. Nov. 3,
1959, 146p. incl. illus. tables. (Technical rept. no. 2102-
1) (Sponsored jointly by Air Force Office of Scientific
Research, Office of Naval Research, and Signal Corps
under Nonr-22524) AD 229111   Unclassified

The class of systems investigated is characterized by
the requirement that all the plant (the device to be con-
trolled) states (the output and output derivatives) assume
a prescribed value at some normalized time 'one'. The
linear, time-varying systems investigated have the
property of moving the plant to the desired final state
in spite of most disturbances and parameter changes.
A modified form of the Mellin Transform provides a
convenient tool to analyze and synthesize such final-
value systems; this transform is applied to time-vary-
ing systems in a manner quite similar to the Laplace
Transform in linear constant-coefficient systems. In
addition to the final-value requirement, it is often de-
sired to make the plant output follow a trajectory which
is optimum in some sense. If this optimum trajectory
is described by a linear differential equation, such as
an Euler equation, the modified form of the Mellin
Transform can be used to synthesize a control-system
in which the plant-out approximately follows this opti-
mum trajectory, regardless of the values of the given
initial and the desired final states. (Contractor's
abstract)

2029

Stanford U. Stanford Electronics Labs., Calif.

SERIES SOLUTIONS FOR PERTURBATIONS ON
CROSSED-FIELD BEAMS, by B. A. Wightman and D.
Chen. Nov. 9, 1959, 19p. incl. illus. table. (Technical
rept. no. 207-2) (Sponsored jointly by Air Force Office
of Scientific Research, Office of Naval Research, and
Signal Corps under Nonr-22524) AD 229950
                                        Unclassified

The differential equation of perturbations on the
Brillouin state of a rectilinear beam in crossed fields
is presented. The solutions of this differential equa-
tion have limited value for computational purposes.
Series developments are given of these solutions, and
the numerical values of the coefficients are tabulated
in a form adapted to high-speed digital computation.
The same information is given for a determinantal
function formed from these solutions and applicable to
boundary-value problems involving such a beam. An
example problem is solved using this determinantal
function. (Contractor's abstract)

2030

Stanford U. Stanford Electronics Labs., Calif.

STUDY OF SEMICONDUCTOR DEVICES BY ANA-
LOGUE TECHNIQUES, by R. Bharat. Nov. 16, 1959,
83p. incl. illus. refs. (Technical rept. no. 1502-1)
(Sponsored jointly by Air Force Office of Scientific
Research, Office of Naval Research, and Signal Cors
under Nonr-22524) AD 229532   Unclassified

Analogue techniques are applied to the study of semi-
conductor devices in pulse circuits, enabling one to
make a transient analysis of models which describe
both the internal and the terminal behavior of the de-
vices. Physical phenomena in semiconductor devices
are described in terms of lumped models and an ana-
logue computer is set up to simulate the equations de-
rived from these models. Equations relating the vari-
ables in the model of the device to the variables de-
scribing the circuit in which the device is operating are
also simulated on the computer, and transient solutions
are obtained for all the variables. Computer and elec-
tric-circuit analogues of several physical phenomena
frequently encountered in semiconductor devices are
developed. Both linear and nonlinear phenomena are
considered and various methods of simulating them are
described. Analogue computer solutions are obtained
for transistor pulse circuits in which interacting non-
linear phenomena influence the operation of the circuit.
Solutions for a drift-transistor switching circuit and
for an avalanche-transistor relaxation-oscillator cir-
cuit are presented. (Contractor's abstract in part)

2031

Stanford U. Stanford Electronics Labs., Calif.

INVESTIGATIONS OF THE HELITRON OSCILLATOR,
by B. P. Israelsen. Nov. 23, 1959, 205p. incl. illus.
(Technical rept. no. 404-1) (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval Re-
search, and Signal Corps under Nonr-22524) AD 232289
                                        Unclassified

Investigations, aimed at providing a better understand-
ing of the helitron, are described. The feasibility of
the 1st experimental model, built in 1956, is discussed
with respect to operating characteristics: (1) spurious
oscillations, and (2) ripples in the backward-wave gain
vs frequency curve when operated as an amplifier. The
results of (1) indicated that the variation of the spurious
level with collector current, interaction length, and
anode voltage showed possible existence of a coaxial
mode between circuit and sole, the influence of trajec-
tory perturbations, and the effect of beam collector
configuration. As for (2), the gain measurements
pointed to a relation between the multiply-peaked gain
curve and spurious oscillation modes. A 2nd experi-
mental helitron was constructed, the r-f circuit con-
sisted of 2 rather than 4 segments with an internal ter-
mination. The beam was injected from a slalom focus-
ing structure, in contrast to the 1st experimental tube

which used a snout-like extension of the anode. Performance was not as good as obtained with the 1st helitron, due to limitations in the mechanism of slalom injection. A small-signal field theory based on expansion in normal modes is presented. This theory shows that azimuthal beam bunching (in the direction of electron motion) is the primary interaction mechanism. Thus the helitron behaves as an O-type device. A study of space charge effects indicates that 1 of the 2 space charge waves grows exponentially, even in the absence of circuit fields. An equation for backward-wave gain is given in which 2 circuit waves and 2 beam waves are considered. Numerical evaluation of this equation shows that interference between the backward circuit wave and the growing space charge wave produces the observed gain ripple. Theoretical starting current is within a factor of 2 of the measured value. (Contractor's abstract, modified)

2032

Stanford U. Stanford Electronics Labs., Calif.

THE ANALYSIS AND SYNTHESIS OF NONLINEAR CONTINUOUS AND SAMPLED-DATA SYSTEMS INVOLVING SATURATION, by F. Kurzweil, Jr. Nov. 30, 1959, 97p. incl. illus. refs. (Technical rept. 2101-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 231411   Unclassified

The saturating systems studied are either continuous or discrete. Initially, they are broken into classes in which the representative member is the physical plant in Jordan normal form. The equations describing the plant are written in terms of its impulse response matrix $G(t)$ and the forcing function $m(t)f$. The constraint on the forcing function, $|m(t)| < 1$, categorizes the system as a saturating system. The optimum saturating system is defined to be that system which returns to equilibrium in minimum time subject to the constraint on the forcing function, and from theoretical consideration, it is a system that requires the maximum of the forcing function be applied at all times. The synthesis problem is that of construction of the optimum switching surfaces in n-dimensional space. The method proposed here consists in the construction of a linear region by means of a subspace generator, then the placement of the point $x(0)$ on a boundary of the linear region. Analysis in the sampled-data realm is considerably simpler than in the continuous case since a given sampling period T automatically fixes the lag-time between the physical plant and the tracking subspace generator and places bounds on the quantity $(Dev)_{opt}$. As T is decreased, the system approaches the optimum continuous system. (Contractor's abstract)

2033

Stanford U. Stanford Electronics Labs., Calif.

A METHOD FOR SOLUTION OF NONLINEAR NET-

WORK PROBLEMS BY DIGITAL COMPUTERS, by W. F. Gillmore, Jr., Dec. 30, 1959, 171p. incl. tables, refs. (Technical rept. no. 2051-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research and Signal Corps under Nonr-22524) AD 233022   Unclassified

This study is concerned primarily with a special 'Taylor' approximation method. Contents can be outlined as follows: (1) The evolution of the approximation method: Prony's method; Tuttle's method; and alternate procedures. (2) Calculation by continued fractions: expansion of a series in a continued fraction; converting fractions to ordinary fractions; simple approximations; a complete table of approximations; and questions of convergence. (3) Relation to Hilbert space theory; two special continued fractions; a related linear operator; eigenfunctions of the linear operator; and inversion of the Stieltjes transform. (4) Approximate solution of nonlinear differential equations; nature of the approximation; and calculation of the initial derivatives. (5) Other applications and examples; digital computer programming; network synthesis from time response, analog computer function generators; and approximations from discrete data.

2034

Stevens Inst. of Tech. Dept. of Physics, Hoboken, N. J.

PLASMA MOTORS: THE PROPULSION OF PLASMA BY MAGNETIC MEANS, by W. H. Bostick. [1958] [15]p. incl. illus. diagrs. refs. (AFOSR-1653) [AF 49(638)-156] AD 265302   Unclassified

Published in Proc. Ninth Internat'l. Astronaut. Congress, Amsterdam (Netherlands) (Aug. 25-30, 1958), Vienna, Springer-Verlag, v. 2: 794-803, 1959.

It has been experimentally demonstrated that speeds of the order of 10^7 cm/sec can be obtained by the propulsion of plasmas by magnetic forces resulting from high electrical current passed through the plasma. In order to increase the efficiency of energy transfer from the capacitor in which the energy is stored to the kinetic energy of the plasma, it is desirable that the gun be spread out over a distance of a large fraction of a meter in order that a discharged current can act upon the plasma for an appreciable length of time. This report examines the relationships for energy transfer in various types of rail-type plasma guns and motors. Also discussed is the efficiency of energy transfer in the induction or electrodeless type of gun. It is shown that with the rail-type guns with a length of the order of a meter with currents of the order of 10^4 amp and externally excited fields of the order of 10,000 gauss, speeds of the order of 10^8 cm/sec and a back emf of the order of 20 kv can be expected. This high a back emf suggests that it is possible to extract most of the energy of the capacitor and transform it into kinetic energy of the plasma in the first half cycle of current. (Contractor's abstract)

2035

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

EXPERIMENTAL STUDIES ON PLASMA DYNAMICS, by
W. H. Bostick, J. Nankivell and others. [1959] [9]p.
incl. illus. diagrs. (AFOSR-1654) (Sponsored jointly
by Air Force Cambridge Research Center, Air Force
Office of Scientific Research under [AF 49(638)156],
Atomic Energy Commission, and Republic Aviation
Corp.) AD 265302   Unclassified

Also published in Proc. Third Biennial Gas Dynamics
Symposium on Dynamics of Conducting Gases, Evan-
ston, Ill. (Aug. 24-26, 1959), Evanston, Northwestern
U. Press, 1960, p. 107-111. (AFOSR-TR-60-87)

The mechanics of the extraction of electrical power
from a moving plasma can be studied by using two par-
allel plates between which the plasma can be projected
across a magnetic field. This electromagnetic brake
can then be used to measure the internal resistance of
the plasma between these plates. Once the internal re-
sistance has been measured, it is then possible to de-
termine the plasma density from the measured RC de-
cay time. Two limited area probes utilizing the elec-
tric field as the driving potential may be used to meas-
ure the saturated ion current. Also, two probes may be
used to measure the Hall electric field. Experimental
verification of the above techniques has been made and,
although additional refinement is necessary, the ex-
perimental results agree with calculated values within
an order of magnitude consideration.

2036

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

ACCELERATION OF A PLASMA BY MEANS OF A
RAIL TYPE GUN (Abstract), by G. Schmidt, W. H.
Bostick and others. [1959] [1]p. (Sponsored jointly by
Air Force Office of Scientific Research under
[AF 49(638)156], Atomic Energy Commission, and Gen-
eral Electric Co.)   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
236, Apr. 30, 1959.

The principle and operation of a rail type plasma gun is
described. An electric discharge ionizes the gas in the
gun while the em field of the discharge circuit accel-
erates this plasma along the rails projecting it into a
high vacuum region. Velocity and momentum measure-
ments are made in this region with time-of-flight be-
tween two probes for the velocity and a ballistic pendu-
lum measurement for the momentum. High plasma
speeds are observed. Some possible applications of
fast plasmas are discussed.

2037

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

EXPERIMENTAL STUDIES ON PLASMA DYNAMICS
(Abstract), by S. Koslov, W. H. Bostick and others.
[1959] [1]p. (Sponsored jointly by Air Force Cambridge
Research Center, Air Force Office of Scientific Re-
search under [AF 49(638)156], Atomic Energy Commis-
sion, and Republic Aviation Corp.)   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
236, Apr. 30, 1959.

A new technique for measuring the mass of a plasmoid
projected across a magnetic field employs an electro-

magnetic brake. Plasmoid masses of the order of 10^{-9}
g can readily be measured. The electromagnetic brake
places the plasmoid in a decelerated frame of refer-
ence. A bipolar probe technique has been developed for
measuring not only the electric field associated with the
Lorentz transformation but the electric field due to the
decelerated frame of reference. The bipolar probe
technique can also be used to measure ion densities
over small volumes, and can be used to verify previous
measurements which indicated that under some condi-
tions hollow plasmoids can be produced. Measurements
with this technique indicate that hollow plasmoids do not
spin. These results lay to rest the previous hypothesis
that spin is responsible for the hollowness of plasmoids.

2038

Stevens Inst. of Tech. Dept. of Physics, Hoboken, N. J.

STATIONARY NONEQUILIBRIUM GIBBSIAN ENSEM-
BLES, by J. L. Lebowitz. [1959] [11]p. incl. refs.
(AFOSR-TN-59-5) [AF 49(638)352] AD 208185
                    Unclassified

Also published in Phys. Rev., v. 114: 1192-1202, June
1, 1959.

The general theory of a Gibbs ensemble representing a
system in contact with its surroundings is applied to
several concrete situations of interest. By an appropri-
ate choice of heat reservoirs a simply modified
Liouville equation is found to describe a heat conduct-
ing system. The stationary nonequilibrium Γ-space en-
sembles which describe such a system are found ex-
plicitly for some cases. In the simplest cases these en-
sembles turn out to be canonical with a temperature that
is a weighted average of the reservoir temperatures.
For other systems, such as Brownian particles inside a
fluid whose temperature is not uniform, the stationary
ensemble to terms linear in the temperature gradient
is found. Next, ensembles that will approximately rep-
resent an arbitrary heat conducting fluid are discussed.

A more general proof than previously given for the asymptotic approach of the Γ-space distribution to its stationary value is also presented.

2039

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

STATISTICAL MECHANICS OF RIGID SPHERES, by H. Reiss, H. L. Frisch, and J. L. Lebowitz. [1959] [52]p. incl. diagrs. refs. (AFOSR-TN-59-140) (AF 49(638)352) AD 210864   Unclassified

Also published in Jour. Chem. Phys., v. 31: 369-380, Aug. 1959.

An equilibrium theory of rigid sphere fluids is developed based on the properties of a new distribution function G(r) which measures the density of rigid sphere molecules in contact with a rigid sphere solute of arbitrary size. A number of exact relations which describe rather fully the functional form of G(r) are derived. These are based on both geometrical considerations and the virial theorem. A knowledge of G(a) where a is the diameter of a rigid sphere enables one to arrive at the equation of state. The resulting analytical expression which is exact up to the third virial coefficient gives the fourth virial coefficient within 2% and the fifth, insofar as it is known, within 5%. Furthermore over the entire range of fluid density, the equation of state derived from theory agrees with that computed using machine methods. Theory also gives an expression for the surface tension of a hard sphere fluid in contact with a perfectly repelling wall. The dependence of surface tension on curvature is also given. The expressions obtained correlate nicely with those adduced by other thermodynamic and statistical mechanical theories. It is also suggested that macroscopic consideration on surface tension can sometimes be successfully extrapolated to molecular dimensions.

2040

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

THE EQUATION OF STATE OF A FLUID, by J. L. Lebowitz, H. L. Frisch, and H. Reiss. [1959] [15]p. incl. diagrs. table. (AFOSR-TN-59-511) (AF 49(638)-352) AD 241256   Unclassified

Also published in Proc. Tenth Internat'l. Cong. of Refrig., Prog. in Refrig. Sci. and Tech., Copenhagen (Denmark) (Aug. 10-26, 1959), New York Pergamon Press, v. 1: 164-170, 1960.

The work required to form a cavity in a field is intimately related to its equation of state. This work is also related to the probability of finding such a cavity at equilibrium. For a fluid consisting of molecules possessing an impenetrable core this probability is known for sufficiently small cavities, while (in general) for sufficiently large cavities the work is essentially

given by a pressure-volume term. This and certain thermodynamic considerations suggest an approximate interpolation formula for the work to form a cavity of any size. For the case of a hard sphere fluid (no attractive forces) this yields a simple analytic equation of state in excellent agreement with that obtained empirically by machine computations and the virial expansion. When the attractive forces are not neglected one obtained from   previous theory expressions for the surface tension, Henry's law solubility coefficient and the "high temperature" equation of state. These results agree reasonably well with experimental measurements on simple fluids. Extension of these relations to fluids at very low temperatures where quantum fluctuations play a decisive role are of great interest. While some of the previously derived relations require but small changes, others i.e., the relation between work and probability must be drastically modified. (Contractor's abstract)

2041

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

ASPECTS OF THE STATISTICAL THERMODYNAMICS OF REAL FLUIDS, by H. Reiss, H. L. Frisch and others. [1959] [6]p. incl. tables, refs. (AFOSR-TN-59-693) [AF 49(638)352] AD 241007   Unclassified

Also published in Jour. Chem. Phys., v. 32: 119-124, Jan. 1960.

By extending the ideas previously applied to the statistical mechanical theory of hard sphere fluids of Reiss, Frisch, and Lebowitz (Jour. Chem. Phys., v. 31: 369, 1959), an approximate expression has been determined for the work of creating a spherical cavity in a real fluid. In turn the knowledge of this entity permits an evaluation of properties such as the surface tension and the normal heats of vaporization of fluids and the Henry's law constants of fluid mixtures. The agreement between the calculated and experimental properties is satisfactory. (Contractor's abstract)

2042

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

[THEORETICAL RESEARCH IN THE STATISTICAL MECHANICS OF PHYSICAL PROCESSES], by J. L. Lebowitz. Final rept. June 15-Sept. 15, 1959 [21]p. incl. refs. (AFOSR-TR-59-150) (AF 49(638)352) AD 227146; PB 145714   Unclassified

The investigations reported in this final report lie in the broad field of statistical mechanics which concerns itself with the explanation of the observed properties of macroscopic matter in terms of the properties of its constituent molecules. Both the equilibrium and nonequilibrium processes are studied. It is reported that the area of nonequilibrium, unlike the equilibrium studies, has no adequate theory to

help explain the phenomenon. It is impossible to predict even in principle all the properties of a metal rod, or a cylinder filled with liquid, 1 side of which is in contact with a steam bath and the other with an ice bath. Progress made in the efforts to develop a theory for such systems is also reported here.

2043

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

ASYMPTOTIC VALUE OF THE PAIR DISTRIBUTION FUNCTION AT A WALL (Abstract), by J. L. Lebowitz. [1959] [1]p. [AF 49(638)352]   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 14, Jan. 28, 1959.

It is shown that the conditional probability density $p^w(r_2/r_1)$ finding a particle in the neighborhood of a point r_2 in the interior of a fluid when it is known that there is a particle at r_1 in contact with the rigid walls of the container, approaches the value $p-(\rho^2 kT/pN)$ for r_2 far from the wall. Here ρ is the number density at r_2, p the pressure, and N the total number of particles in the box. This relation is to be contrasted with the well known Orenstein-Zernike expression for the asymptotic value of $p(r_2/r_1) = p(|r_2-r_1|)$ when both r_1 and r_2 are in the interior of the fluid, $\lim_{r_{12}\to\infty} p(r_{12}) = \rho - \rho^2 (hT\chi_T/N)$, where χ_T is the isothermal compressibility. The derivation of the asymptotic value of $p^w(r_2/r_1)$ is based on the virial theorem for the fluctuations in the total momentum in an equilibrium ensemble. Since it appears that these fluctuations behave classically even for liquid helium II our considerations apply also to quantum systems.

2044

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

EQUATION OF STATE OF HARD SPHERE FLUIDS (Abstract), by H. Reiss, H. L. Frisch, and J. L. Lebowitz. [1960] [1]p. [AF 49(638)352]   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 15, Jan. 28, 1959.

A set of relations has been discovered which deter-

mines to within a high degree of approximation the value of the radial distribution function for hard spheres in contact. In the case of hard spheres this one value, g, of the radial distribution function suffices to determine the equation of state and so the aforementioned relations yield the equation of state to the same degree of approximation. The principle relation is obtained by computing the pressure in two different ways and equating the results. First, the pressure is computed using the virial theorem leading to a relation containing g. Alternatively, the pressure can be computed in terms of an integral involving the radial distribution function G at contact for a normal hard sphere molecule around a hard sphere solute molecule of smaller size. The integral is over the radius r of the solute as it passes from zero to the size of the other hard spheres.

2045

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

BROWNIAN PARTICLES IN A NONUNIFORM FLUID (Abstract), by J. L. Lebowitz. [1959] [1]p. [AF 49(638)-352]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 243, Apr. 30, 1959.

The time evolution of the distribution function for a Brownian particle in a fluid is described by the Fokker-Planck equation. When the temperature of the fluid is uniform this equation leads to the Brownian particle achieving a Maxwell-Boltzmann distribution asymptotically in time. We have now found the stationary distribution of the Brownian particles for the case when the temperature and pressure of the fluid are not uniform, to terms linear in the gradients. We can also show that this solution is approached asymptotically in time.

2046

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

STATISTICAL MECHANICS OF REAL FLUIDS (Abstract), by H. Reiss, H. L. Frisch, and J. L. Lebowitz. [1959] [1]p. [AF 49(638)352]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 243-244, Apr. 30, 1959.

The techniques applied by the authors to rigid spheres have been extended to the treatment of certain real substances (Ne, A, He, H_2, N_2, O_2, Cl_2, C_6H_6, and solutions of these) with good results. The surface tensions of these substances as well as the Henry's law

constants for certain solutions of them have been calculated. In addition the equations of state of the more simple fluids are derived and compare well with experiment.

2047

[Sundstrand Machine Tool Co.] Sundstrand Turbo Div. [Pacoima, Calif.]

SCALING PROCEDURES FOR ROCKETS UTILIZING LIQUID PROPELLANTS OF VARIABLE COMPOSITION AND MIXTURE RATIO, by S. S. Penner. Aug. 31, 1959, 18p. incl. table, refs. (Rept. no. S/TD 1733; technical note no. 7) (AFOSR-TN-59-908) (AF 18-(603)107) AD 227923; PB 144012   Unclassified

Inherent contradictions in scaling requirements for liquid-fuel rocket engines are removed by introducing new degrees of freedom through controlled variations in mixture ratio, propellant type, or injection temperature. It is not possible to predict the dependence of effective conversion time on these parameters for the complex combustion processes in liquid-fuel rocket engines. However, examination of theoretical results derived for the overall (laminar) burning rate in 1-dimensional, dilute sprays suggests that relative propellant volatility and injector design, as well as total calorific values for the propellants, should dominate the effective dependence of conversion time on propellant type and mixture composition. A satisfactory quantitative evaluation of these ideas requires extensive empirical measurements of effective conversion time, preferably under conditions simulating rocket-engine combustion conditions. Representative simplified examples of scaling procedures have been worked out in which, for example, changes in mixture ratio must alter the effective conversion time by the square-root of the thrust scale factor.   (ASTIA abstract)

2048

Sundstrand Machine Tool Co. Sundstrand Turbo Div., Pacoima, Calif.

FOURTH SYMPOSIUM ON COMBUSTION INSTABILITY IN LIQUID ROCKET MOTORS (Unclassified title), ed. by R. G. Langlois. Dec. 9-10, 1957, 197p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-51) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)107 and Bureau of Aeronautics) AD 307046
Confidential

2049

Syracuse U. Dept. of Chemistry, N. Y.

EFFECT OF TEMPERATURE ON CARBONYL AND NITRILE STRETCHING FREQUENCIES IN SOLUTION,

by E. Fishman and N. Krascella. July 1, 1959 [20]p. incl. diagrs. table, refs. (AFOSR-TN-59-660) (AF 49(638)3) AD 220725; PB 143169   Unclassified

Presented at meeting of Molecular Spectroscopy, Bologna (Italy), Sept. 12, 1959.

Efforts were made to separate empirically dipole-dipole interactions from other types of intermolecular forces responsible for frequency shifts. It was not possible to find simple relationships from these data which accomplish this. Graphs were prepared relating the frequency shift to the density and to the square of the density of the solvent; the resultant curves do not show consistent differences between polar and non-polar solvents. The results do show that $C \equiv N$ does have much smaller frequency shifts than $C = O$, indicating that the electric moment and the polarizability of a bond are not decisive factors. However, the derivatives of the bond moments and polarizabilities with respect to inter-atomic distance are much larger for $C = O$ than for $C \equiv N$, indicating that these may be more significant properties. In chloroform, nitrobenzene, benzene, CCl_4 and $\emptyset CH_3$ acetonitrile's frequency shifts either not at all or slightly toward the blue with decreasing temperature, thought to be unique for lowering temperatures. It is interpreted that this blue shift results from repulsive electrical forces operating on the nitrile group when the entire molecule assumes its optimal orientation. Benzonitrile exhibits a blue shift equal to or slightly greater than that of acetonitrile in the 5 above solvents. In the alkyl polar halide solvents, the latter exhibits its strongest red shift, while the former undergoes a blue shift. These results may be due to changes in the nitrile bond when attached to an aromatic system, but they are consistent with the orientation hypothesis.

2050

[Syracuse U. Dept. of Mathematics, N. Y.]

ON A QUESTION OF PAUL LÉVY, by R. V. Chacon. [1959] [6]p. (AF 18(600)760)   Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 460-465, June 1959.

A matrix $\{p_{ij}(t)\}$, i, j = 1, 2,..., $0 < t < \infty$, of functions is a (stationary) transition matrix (of a Markov chain) if (1) $p_{ij}(t) \geq 0$, i, j = 1, 2,..., (2) $\sum_r p_{ir}(t) = 1$, i = 1, 2,..., and (3) $\sum_r p_{ir}(t)p_{rj}(s) = p_{ij}(t + s)$, i, j = 1, 2,..., $0 < s < \infty$, $0 < t < \infty$. The question examined is whether each such transition function, which is not measurable, must be a transition function of a Markov chain obtained by combining a Markov chain having measurable transition functions with one having a transition matrix of nonmeasurable functions which takes only the values of zero or one. It is shown that if each of the transition functions is strictly positive or identically zero, then the equation

$\lim\limits_{t \to \infty} p_{ij}(t) = \lim\limits_{t \to \infty} p_{ij}(t)$ or $p_{ji}(t) \equiv 0$, holds without measura-

ble assumptions, and without assuming an affirmative answer to the question. The limiting behavior of the transition functions which would be expected if the question has an affirmative answer is described.

2051

Syracuse U. [Dept. of Mathematics] N. Y.

ON THE ANALYTIC STRUCTURE OF SEMI-GROUPS OF POSITIVE MATRICES, by W. B. Jurkat. Oct. 1959, 31p. incl. refs. (Research rept. no. 22) (AFOSR-TN-59-1263) (AF 49(638)265) AD 233135; PB 146731
Unclassified

Also published in Math. Zeitschr., v. 73: 346-365, 1960.

The dual of the first entrance formula is obtained from which general differentiability properties are deduced. (Contractor's abstract)

2052

Syracuse U. [Dept. of Mathematics] N. Y.

ON LAST EXIT TIMES, by K. L. Chung. Oct. 1959, 16p. (Research rept. no. 23) (AFOSR-TN-59-1264) (AF 49(638)265) AD 233092; PB 146730 Unclassified

Also published in Illinois Jour. Math., v. 4: 629-639, Dec. 1960.

The last exit time from a given state before a given time is studied. Its properties related to the analytic properties of the transition matrix and the reversed nonstationary chains are also discussed. (Contractor's abstract)

2053

[Syracuse U. Dept. of Mathematics, N. Y.]

THE DIFFERENTIABILITY OF TRANSITION FUNCTIONS, by D. Ornstein. [1959] 7p. [Research rept. no. 24] (AFOSR-TN-59-1265) (AF 49(638)265) AD 233105; PB 146732 Unclassified

Also published in Bull. Amer. Math. Soc., v. 66: 36-39, Jan. 1960.

A proof is presented that the transition functions of a denumerable Markoff chain are differentiable, or equivalently, given a matrix of real valued functions $P_{ij}(t)$ ($i, j = 1, 2,...$) satisfying (1) $P_{ij}(t)$ is non-negative and continuous; (2) $P_{ij}(0) \begin{cases} = 1 \text{ if } i = j, \text{ and} \\ = 0 \text{ if } i \neq j; \end{cases}$

(3) $P_{ij}(t_1 + t_2) = \sum\limits_{k=1}^{\infty} P_{ik}(t_1) P_{kj}(t_2)$; and (4) $\sum\limits_{j=1}^{\infty} P_{ij}(t) = 1$.

Then $P_{ij}(t)$ has a finite continuous derivative for all $t > 0$. (Contractor's abstract)

2054

Syracuse U. [Dept. of Mathematics] N. Y.

ON THE ANALYTIC STRUCTURE OF MARKOV PROCESSES, by W. B. Jurkat. Oct. 1959, 5p. (Research rept. no. 25) (AFOSR-TN-59-1266) (AF 49-(638)265) AD 233106; PB 146733 Unclassified

A general solution to the backward Kolmogorov equation is constructed under the hypothesis of a finite number of exits. (Contractor's abstract)

2055

Syracuse U. [Dept. of Mathematics] N. Y.

A GENERAL ERGODIC THEOREM, by R. V. Chacon and D. S. Ornstein. Oct. 1959, 11p. (Research rept. no. 26) (AFOSR-TN-59-1267) (AF 49(638)265) AD 233107; PB 146734 Unclassified

Also published in Illinois Jour. Math., v. 4: 153-160, June 1960.

The following theorem is proved: Let T be a positive linear operator on L_1 of a positive measure space (S, G, μ) and let T have L_1 norm less than or equal to one. Then if t and p are functions in L_1 and if p is non-negative, the limit $\lim\limits_{n \to \infty} \dfrac{\sum\limits_{k=0}^{n} T^k f}{\sum\limits_{k=0}^{n} T^k p}$ exists and is finite almost every where on the set A = {s: $T^k p > 0$ for some $k \geq 0$}.

2056

Syracuse U. [Dept. of Mathematics] N. Y.

ON THE LIPSCHITZ'S CONDITION FOR BROWNIAN MOTION, by K. L. Chung, P. Erdös, and T. Sirao. [1959] [12]p. [AF 49(638)265] Unclassified

Published in Jour. Math. Soc. Japan, v. 11: 263-274, Oct. 1959.

Let ψ throughout be a non-negative monotone, non-decreasing function on some (varying) interval (T,∞). ψ is said to belong to the "upper class" if, for almost every Brownian path X(t) in [0, 1], there exists $\epsilon > 0$ such that $|s-t| \leq \epsilon$ implies $|X(s)-X(t)| \leq \psi(|s-t|^{-1})$

$|s-t|^{\frac{1}{2}}$. If, on the other hand, there is, for almost every
Brownian path, no such ϵ, then ψ is said to belong to the
"lower class". The following theorem has been stated
without proof by P. Levy in his book Le mouvement
brownien, and it is proved here. ψ is upper or lower,
according as $\int_T^\infty \psi^3(t) \exp(-\frac{1}{2} \psi^2(t)) dt$ is finite or infi-
nite. Then ψ is upper or lower according as $c > 2$ or
$c \leq 2$. (Math. Rev. abstract)

2057

Syracuse U. [Dept. of Mathematics] N. Y.

POLYNOMIAL APPROXIMATION OF CONTINUOUS
FUNCTIONS ON LINEAR SPACES, by W. B. Jurkat.
Dec. 17, 1959, 10p. (AFOSR-TN-59-1235) (AF 49-
(638)619) AD 231608; PB 145554   Unclassified

Also published in Math. Zeitschr., v. 74: 99-104, 1960.

A study is presented on the approximation of continu-
ous functions on separable closed subsets of a
Frechet space X by polynomials with coefficients in X.
(Contractor's abstract)

2058

Syracuse U. [Dept. of Mathematics] N. Y.

RELATIONS BETWEEN FUNCTION SPACES, by G. G.
Lorentz. Dec. 17, 1959, 7p. (AFOSR-TN-59-1286)
(AF 49(638)619) AD 231609; PB 145505 Unclassified

Also published in Proc. Amer. Math. Soc., v. 12: 127-
132, Feb. 1961.

Necessary and sufficient conditions are given, in terms
of the functions Φ and W, in order that an Orlicz space
L_Φ be isomorphic to a space $\Lambda(W)$. (Contractor's
abstract)

2059

Syracuse U. [Dept. of Mathematics] N. Y.

ON UNIFORM APPROXIMATION BY POSITIVE LINEAR
COMBINATIONS OR POLYNOMIALS OF A GIVEN SYS-
TEM OF FUNCTIONS, by W. B. Jurkat and G. G.
Lorentz. Dec. 17, 1959, 12p. (AFOSR-TN-59-1287)
(AF 49(638)619) AD 231597; PB 145506
                                        Unclassified

The main theorem gives necessary and sufficient con-
ditions in order that each positive continuous function
on [0, 1] be approximable by polynomials with posi-
tive coefficients in 2 given functions. Fairly general
necessary conditions are found for such approxima-
tion by positive linear combinations of given func-
tions or by powers of given functions.

2060

Syracuse U. [Dept. of Physics] N. Y.

ELECTRON SPIN-LATTICE RELAXATION IN
PHOSPHORUS DOPED SILICON, by A. Honig and E.
Stupp. June 30, 1959 [45]p. incl. diagrs. tables, refs.
(Technical rept. no. 1) (AFOSR-TN-59-715) (AF 18-
(603)50) AD 218352; PB 143023   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II,
v. 4: 261, Apr. 30, 1959. (Title varies)

Also published in Phys. Rev., v. 117: 69-83, Jan. 1,
1960.

Electron spin-lattice relaxation in phosphorus doped
silicon was investigated over a magnetic field range of
0 - 11,000 oersteds, a temperature range of $1.25°K$ to
$4.2°K$, and a concentration range of 10^{14} P/cc to
3×10^{16} P/cc. Three distinct τ_S ($\Delta m_S = \pm 1$, $\Delta m_1 = 0$)
relaxation mechanisms were identified, and their func-
tional dependence on magnetic field, temperature and
concentration were determined. The theoretical origins
of the mechanisms are discussed. A theory is proposed
to explain the concentration dependent τ_S mechanism,
according to which rapidly relaxing close pairs of phos-
phorus atoms, which are few in number, relax the spins
of the large number of isolated phosphorus atoms via a
spin diffusion process. Experiments supporting this
hypothesis are presented.

2061

Syracuse U. Dept. of Physics, N. Y.

STUDY OF THE MIGRATION AND DESORPTION OF
A DIMORPHIC ADSORBATE USING THE FIELD EMIS-
SION MICROSCOPE: TITANIUM ON TUNGSTEN, by
R. C. Abbott and A. M. Russell. June 1959, 49p. incl.
refs. (AFOSR-TR-59-89) (AF 49(638)93) AD 220827;
PB 143678   Unclassified

The migration and desorption of titanium on tungsten
was measured by the field emission technique and the
activation energies for these processes were deter-
mined. In addition, estimates were made for the aver-
age number of titanium-titanium and titanium-tungsten
bonds broken during migration and desorption. Two dis-
tinct migrations were observed: an early stage of mi-
gration that took relatively little time to go to comple-
tion and a later stage migration with a much longer
($\sim$ factor of 10) completion time. The early stage mi-
gration has 2 values of activation energy: 2.4 ± 0.1 ev
above $T = 847°C$ and 2.6 ± 0.2 ev below this temperature.
The characteristic time necessary for the early stage
migration to achieve a given degree of completion
changes discontinuously at $T = 847°C$ by a factor of 2.3.

The later stage migration activation energy is 2.0 ± 0.1 ev. The desorption activation energy is 6.4 ± 0.2 ev. A possible explanation for this abrupt change in characteristic time, involving the dimorphism of the adsorbate, is discussed. It is postulated that this abrupt change is caused by the excellent fit of the adsorbed titanium layer to the b.c.c. structure of the tungsten substrate when $T > 847°C$. Pure titanium transforms from a low temperature h.c.p. to a b.c.c. structure at 883°C. Comparison of calculated bond strengths with the experimentally determined activation energies indicates that an average of 2 Ti-W bonds are broken during early stage migration, while 1 Ti-W and 1 Ti-Ti bond are broken during later stage migration. An average of 4 Ti-W and 2 Ti-Ti bonds are broken during desorption. (Contractor's abstract)

2062

Syracuse U. Dept. of Physics, N. Y.

DIPOLE MOMENT FUNCTION OF DIATOMIC MOLECULES, by J. Trischka and H. Salwen. [1959] [8]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)93] and Office of Naval Research) Unclassified

Published in Jour. Chem. Phys., v. 31: 218-225, July 1959.

The connection between the dipole moment function (dipole moment as a function of internuclear distance). $M(u)$, and its matrix elements were studied for the 1-dimensional model of a diatomic molecule. It is shown that $M(u)$ is completely determined by a single row or column of the matrix $<y|M(u)|v>$, but that the diagonal matrix elements do not completely determine $M(u)$. Attention is given to the problem of approximating $M(u)$ when a finite number of matrix elements are known. The usual method (called the "polynomial approximation") is compared with a new approximation scheme which is called the "wave function approximation." These methods are equivalent for a harmonic oscillator, but not in general. Estimates of the errors of the 2 methods are obtained in the case where the anharmonicity of the potential is small. The "wave-function expansion" of $M(u)$ which is developed and used to carry out the calculations is a new way of relating matrix elements to $M(u)$ which makes it much easier to calculate the dipole moment function from its matrix elements. This method has been used to obtain explicit formulas relating the dipole moment function to its matrix elements for the harmonic oscillator and for the Morse oscillator. (Contractor's abstract)

2063

Syracuse U. Dept. of Physics, N. Y.

DIPOLE MOMENT FUNCTION OF $CO(^1\Sigma^+)$, by H. Salwen and J. Trischka. [1959] [3]p. incl. tables.

(Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)93] and Office of Naval Research) Unclassified

Published in Jour. Chem. Phys., v. 31: 541-543, Aug. 1959.

The possible dipole moment functions of $CO(^1\Sigma^+)$ are calculated by means of the wave function approximation with wave functions for a Morse potential. The dipole moment functions are expressed as polynomials whose coefficients through the quartic terms are given in a table. The accuracy of the dipole moment functions is discussed for the case in which only the 1st 2 vibrational matrix elements are known. This discussion is based on calculations made by both the wave function approximation and an older method, the polynomial approximation. A Morse potential and a polynomial potential are compared to determine their relative suitability for the calculation of the dipole moment function of $CO(^1\Sigma^+)$. (Contractor's abstract)

2064

Syracuse U. Dept. of Physics, N. Y.

NEW POTENTIAL FOR IRREVERSIBLE PROCESSES, by P. G. Bergmann and E. Morris. [1959] 11p. (AFOSR-TN-59-510) (AF 49(638)461) AD 264065 Unclassified

Also published in Ann. Phys., v. 8: 266-270, Oct. 1959.

If a system is driven by several reservoirs, then 2 different Gibbsian distributions, both of which obey the Liouville equation with additional stochastic terms will approach each other in the course of time. A whole class of positive-definite functionals of these 2 distributions, which decrease monotonically in the course of time is given. A result is the construction of a functional of a single distribution, also positive-definite, which tends to zero monotonically in the course of time and which will equal zero only if the distribution is stationary. (Contractor's abstract)

2065

Syracuse U. [Dept. of Physics] N. Y.

VARIATIONAL PRINCIPLE FOR STATIONARY IRREVERSIBLE PROCESSES (Abstract), by P. G. Bergmann. [1959] [1]p. [AF 49(638)461] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 244, Apr. 30, 1959.

If a system which internally obeys the laws of classical

mechanics is exposed to continuing contact with several inexhaustible reservoirs, its Gibbsian distribution in phase space will tend asymptotically to a stationary distribution, which is independent of the initial distribution and which will not be canonical if the driving reservoirs are at different temperatures. It will be shown that the quantity $K = \int \mu^{-1} \dot{\mu}^2 dX$, which is positive definite, decreases monotonically in the course of time and approaches zero asymptotically. Accordingly, it is suggested that K is a natural expression for the determination of how close a given distribution is to the stationary distribution, and that it may be suitable for the construction of approximation procedures leading to the stationary distribution.

2066

Syracuse U. [Dept. of Physics] N. Y.

COMMUTATION RELATIONS BETWEEN OBSERVABLES IN GENERAL RELATIVITY (Abstract), by A. Komar and P. G. Bergmann. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)461] and National Science Foundation)
Unclassified

A method for constructing a complete set of observables in general relativity was described previously (Phys. Rev., v. 111: 1182, 1958). Commutators (Poisson brackets) between 2 observables may be interpreted as the (infinitesimal) change in 1 observable induced by the infinitesimal invariant canonical transformation generated by the other. As this interpretation will serve as an unambiguous definition in either a Hamiltonian or a Lagrangian formalism, a Lagrangian approach is chosen. As the generating observable an integral is used over a 3-dimensional hyper-surface whose integrand is a linear combination of the components of the curvature tensor; the coefficients are functions arbitrary throughout the domain of integration. This calculation yields commutators between components of the curvature tensor and components of the metric tensor and its derivatives in an "intrinsic" coordinate system. It is believed that the method can be extended to different generators as well, so that it will lead to commutators between any pairs of observables.

2067

Technical Research Group, New York.

RESEARCH ON NUCLEAR MAGNETIC RESONANCE
TECHNIQUES, by M. Newstein. Final rept. Apr. 1959,
96p. incl. diagrs. table, refs. (AFOSR-TR-59-26)
(AF 18(600)1313) AD 212008; PB 140624

Unclassified

Shimming an inhomogeneous magnetic field in nuclear
resonance by pulses is reviewed. Results indicate that
there is a combination of shimming pulses that can be
applied to a liquid sample which can make the linewidth
of the sample independent of the degree of homogeneity
of the external static magnetic field. A mathematical
analysis is presented of the behavior of the transient
solution, and integral of the transient solution, under
various conditions of excitation. A technique is de-
scribed and analyzed by means of which a steady state
signal may be obtained using 2 resonating nuclei in-
stead of one. A new type of Maser, the traveling-wave
gas cell Maser, is reviewed and analyzed. An explana-
tion and analysis is included regarding certain pulse
experiments which lead to the production of undesired
signals. Experimental and theoretical work on optical
detection of magnetic resonance is reviewed. The use
of optical pumping and optical detection has permitted
the observance of both Zeeman and field-independent
magnetic resonances in alkali vapors.

2068

Technion - Israel Inst. of Tech., Haifa.

RESEARCH ON CROSS-STRESSES IN THE FLOW OF
LIQUIDS, by M. Reiner. Technical rept. Oct. 1, 1957-
Sept. 30, 1958 [27]p. incl. illus. diagrs. tables, refs.
(AFOSR-TN-59-37) (AF 61(052)10) AD 209209;
PB 145166   Unclassified

An instrument is described which works as a centripe-
tal vacuum pump. It consists of two circular metal
plates, one stationary, the other rotating opposite it.
The stator has an opening in the centre. The rotor
can be freely displaced along the axis of rotation. By
centripetal pumping action it is kept floating on an air
cushion of thickness D. The relation between D and
the speed of rotation was determined for different
weights of the rotor to be supported. The results are
interpreted on the basis of Maxwell's theory of the
elasticoviscosity of air. Also, an instrument is de-
scribed which works as a centripetal pressure pump
with incompressible liquids. (Contractor's abstract)

2069

Technion - Israel Inst. of Tech., Haifa.

BUCKLING OF CONICAL SHELLS UNDER EXTERNAL
PRESSURE AND THERMAL STRESSES, by J. Singer

and N. J. Hoff. Final technical rept. Dec. 1959 [82]p.
incl. diagrs. refs. (AFOSR-TR-59-203) (AF 61(052)-
123) AD 236855; PB 147497   Unclassified

Simplified differential equations governing the deforma-
tions of deep thin circular conical shells subjected to
arbitrary loads and arbitrary temperature distributions
are derived by the principle of the minimum total po-
tential energy. The equations reduce to Donnell's
[NACA Rept. No. 479, 1933] equations (extended to in-
clude an arbitrary temperature distribution) when the
cone angle approaches zero. An asymptotic solution of
these simplified equations is then obtained for a truncat-
ed conical shell subjected to an axisymmetrical temper-
ature distribution. The equations are then extended to
include problems of elastic stability. The stability equa-
tions are solved for loading under lateral and under hy-
drostatic pressure in the presence of slightly relaxed
boundary conditions for the u and v displacements; for
the w (radial) displacements the usual conditions of
simple support are enforced rigorously. The same
method of solution, with the slightly relaxed boundary
conditions for the u and v displacements, is then ap-
plied to the thermal buckling problem of truncated coni-
cal shells subjected to axisymmetrical temperature dis-
tributions. A typical example is analyzed in detail.
(Contractor's abstract)

2070

Technion - Israel Inst. of Tech., Haifa.

BOUNDS FOR SUMS OF RECIPROCALS OF EIGEN-
VALUES, by B. Schwarz. July 1959 [18]p. incl. refs.
(Technical scientific note no. 1) (AFOSR-TN-59-620)
(AF 61(052)194) AD 217684; PB 145298

Unclassified

Also published in Bull. Research Council, Israel,
v. 8F: 91-102, Dec. 1959.

The differential system $y''(x) + \lambda p(x)y(x) = 0$ is con-
sidered where $y(\pm a) = 0$, $0 < a < \infty$, $p(x) > 0$, and $p(x) \in C$.
Denoting the eigenvalues by $\lambda_n(p)$ ($n = 1, 2, ...$), bounds
are found for $\sum_{n=1}^{\infty} \frac{1}{\lambda_n(p)}$. These bounds are given by
the analogous sums for the systems in which $p(x)$ is
replaced by its symmetrical rearrangements in $[-a,a]$.
An analogous system for $q(x)$ is considered. If
$\int_{-a}^{a} p(x)dx \le \int_{-a}^{a} q(x)dx$, and if there exists a value b,
$0 < b < a$, such that $q(x) \ge p(x)$ in $[-b,b]$ and $q(x) \le p(x)$
in $[-a, -b]$, then $\sum_{n=1}^{\infty} \frac{1}{\lambda_n(p)} \le \sum_{n=1}^{\infty} \frac{1}{\lambda_n(q)}$. Similar rela-
tions are proved for other differential systems. Finite
sums of the reciprocals of the eigenvalues $\lambda_n(p)$ are
considered only under certain conditions on $p(x)$. For
each positive integer N a lower bound for the sum of the
reciprocals of the first N eigenvlues is given. (Con-
tractor's abstract)

2071

Technion - Israel Inst. of Tech., Haifa.

THE PHYSICS OF AIR-VISCOSITY AS RELATED TO
GAS-BEARING DESIGN, by M. Reiner. [1959] [12]p.
incl. illus. diagrs. (AFOSR-1000) (AF 61(052)223)
AD 277352   Unclassified

Also published in Proc. First Internat'l. Symposium
on Gas Lubricated Bearings, Washington, D. C. (Oct.
26-28, 1959), Washington,Office of Naval Research,
1959, p. 307-318.

This study is concerned with that action of gases
which permits the development of positive pressure
when (a) the bearing surfaces are parallel, and, at
the same time, (b) there is no supply of air under pres-
sure from an external pump. The action described is
the result of a hitherto unknown effect in the laminar
flow of fluids which may be named cross-effect, be-
cause it is a manifestation of normal stresses in cross-
wise directions, i.e., in the direction of flow, in the di-
rection of the velocity gradient, and in the direction
normal to both. An instrument showing the effect is
described and an outline of the theoretical background
is given. (Contractor's abstract)

2072

Technion - Israel Inst. of Tech. Dept. of Aeronautical
Engineering, Haifa.

ON 2-DIMENSIONAL SHOCK-WAVES FOR NEAR-
DETACHMENT FLOW, by A. Kogan. [1958] [6]p.
incl. diagr. table. (AF 61(052)06)   Unclassified

Published in Bull. Research Council Israel., v. 7F:
127-128, Nov. 1958.

Crocco's stream function equation is transformed by
choosing the stream function as an independent varia-
ble. It is shown that in the case of near shock-detach-
ment flow, the transformed equation can be well approx-
imated by an ordinary differential equation which is
readily integrated. Approximate relations between
temperature and pressure distributions along the air-
foil and the shock-wave form are derived. (Contrac-
tor's abstract)

2073

Technion - Israel Inst. of Tech. Dept. of Aeronautical
Engineering, Haifa.

ON ROTATIONAL FLOW PAST THICK AIRFOILS, by
A. Kogan. Final rept. Feb. 1959 [37]p. incl. diagrs.
table. (AFOSR-TR-59-64) (AF 61(052)06) AD 217033
                                            Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 504-508,
July 1960. (Title varies)

The inviscid rotational supersonic flow behind the shock
wave attached to the sharp leading edge of an airfoil is
studied by a transformation of coordinates which intro-
duces the Crocco stream function ψ as independent vari-
able. Using expansions in power series of ψ an iterative
process is developed for the determination of pressure
distribution along the airfoil surface. For the special
case of near-shock-detachment flow a simple approxi-
mation is derived for the flow in the whole region be-
tween the airfoil and the shock wave. (Contractor's
abstract)

2074

Technion - Israel Inst. of Tech. Dept. of Mathematics,
Haifa.

ON FUNCTIONS ALMOST ALL OF WHOSE MO-
MENTS VANISH, by J. Steinberg. [1959] [4]p. (AF 61-
(052)192)   Unclassified

Published in Bull. Research Council Israel, v. 8F: 129-
132, Dec. 1959.

The zeroes and asymptotic behavior of certain functions
is discussed. Except for a finite number of them, all
moments along the real axis vanish.

2075

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

GRAVITATIONAL MOTION AND RADIATION. I., by A.
Peres. [1959] [11]p. incl. refs. [AF 61(052)428]
                                            Unclassified

Published in Nuovo Cimento, Series X, v. 11: 617-627,
Mar. 1, 1959.

A method is established to solve Einstein's equations
by successive approximations, uniqueness and compati-
bility at each step being secured by imposing
de Donder's condition on the field. This turns out to
restrict the freedom of choice of the sources in a way
that determines their laws of motion, directly from the
field quantities, without any use of integration around
singularities. If the approximation parameter is the
reciprocal velocity of light, the 1st non trivial approxi-
mation results in the constancy of the rest mass, and
in Newton's law of attraction. The next step shows that
there is no 1st-order correction to these laws. The 3rd
approximation then gives a small correction to the rest
mass, which is found to be increased by the presence of
other bodies. There is also a 2nd-order correction to
the acceleration (not explicitly evaluated here) which
causes the perihelion advance in the 2-body problem.
The 4th approximation involves a contribution from the
radiation field. It is found that in order to fulfill de
Donder's condition, we must introduce into the field a
term which is linear in the sources, although it does
not appear in the so-called "linear approximation".
This result may cast some doubts on the validity of the

latter. In a further paper, we shall solve still higher approximations by means of an improved technique, and find that the 5th-order correction to the acceleration involves a non-conservative term. This last result may be taken as evidence for the reality of gravitational radiation. (Contractor's abstract)

2076

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

GRAVITATIONAL MOTION AND RADIATION. II., by A. Peres. [1959] [12]p. incl. refs. [AF 61(052)428]
Unclassified

Published in Nuovo Cimento, Series X, v. 11: 644-655, Mar. 1, 1959.

General relativistic laws of motion for slow particles are deduced from successive approximate solutions of Einstein's equations, subject to de Donder's conditions. The 1st 3 approximations give results identical with those of the previous paper (item no. 2075) (Newtonian and post-Newtonian equations of motion). Higher approximations involve contributions from the radiation field. It is found that they can be treated independently of other relativistic effects, and cause 5th-order corrections to the rest-masses and accelerations of the particles. In particular, it is shown that as a consequence of gravitational radiation, a system of particles gains energy, thus implying that gravitational waves carry away a negative amount of energy. This is made plausible by showing that the energy density of the gravitational field is also a negative quantity. An electromagnetic analogy of these results is proposed.

2077

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

GRAVITATIONAL MOTION AND RADIATION. III, by A. Peres. [1959] [3]p. [AF 61(052)428]   Unclassified

Published in Nuovo Cimento, Series X, v. 13: 439-441, July 16, 1959.

It is shown that the secular change of the total gravitational mass of a system of 2 bodies, uniformly rotating around each other, is exactly equal to minus the radiated energy (independently computed in the previous part of this paper. (Contractor's abstract)

2078

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

ON CAUCHY'S PROBLEM IN GENERAL RELATIVITY, by A. Peres and N. Rosen. [1959] [9]p. incl. refs. [AF 61(052)428]   Unclassified

Published in Nuovo Cimento, Series X, v. 13: 430-438, July 16, 1959.

It is shown that a suitable set of Cauchy's conditions for Einstein's equations in vacuo consists in specifying the values of g_{kl} and $g_{kl,0}$ on a hypersurface $x^0 = 0$. The corresponding g_{0k} are to be found by solving 3 spatial 2nd order differential equations, and g_{00} is then given by an algebraic relation. The 1st and higher time derivatives of $g_{0\mu}$ remain completely undetermined by the field equations, thus leaving room for arbitrary coordinate transformations. It is further shown that even if the g_{kl} are chosen close to their Galilean values, and if the $g_{kl,0}$ are small, the remaining $g_{\mu\nu}$ will in general not be close to their Galilean values. However, a detailed investigation of the physical components of the curvature tensor shows that the field can nevertheless be weak, thus implying that the large discrepancies between the $g_{0\mu}$ and their Galilean values are only a coordinate effect. The field is really strong only close to domains where the determinant of the $g_{\mu\nu}$ vanishes. By a suitable coordinate transformation, those domains can be made to shrink to points, and the resulting singularities may be interpreted as representing matter. This supports Einstein's view that matter should not be considered as something foreign to the metric field itself. (Contractor's abstract)

2079

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

ON GRAVITATIONAL RADIATION, by A. Peres. [1959] [1]p. [AF 61(052)428]   Unclassified

Published in Nuovo Cimento, Series X, v. 13: 670, July 16, 1959.

A criterion is given which partly removes the ambiguity which arises in connection with the solutions (in previous studies) of Einstein's equation representing incoming gravitational waves, the presence of which account for the negative radiated energy previously obtained.

2080

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

NONLINEAR EFFECTS OF GRAVITATIONAL RADIATION, by A. Peres and N. Rosen. [1959] [2]p. [AF 61-(052)428]   Unclassified

Published in Phys. Rev., v. 115: 1085-1086, Aug. 15, 1959.

It is shown that the cumulative effects of the nonlinear terms in Einstein's equations rule out the possibility

of stable small oscillations of a gravitational field about an equllibrlum state, if the latter is supposed to be Minkowskian at lnfinity. The perturbation, lf unlimited in time, rather tends to take infinite values at large distances from its source. This can be interpreted as an lnstabllity of gravltational radiation fields, and ralses doubts concerning the validity of the linearized theory at large distances from the source. (Contractor's abstract)

2081

Technion - israel Inst. of Tech. Dept. of Physics, Halfa.

SOME GRAVITATIONAL WAVES, by A. Perez. [1959] [2]p. [AF 61(052)428]   Unclassified

Publlshed ln Phys. Rev. Ltrs., v. 3: 571-572, Dec. 1959.

By considering the metric $ds^2 = -dx^2 - dy^2 - dz^2 + dt^2 - 2f(x,y,z + t)(dz + dt)^2$, a new class of solutions of the Einsteln gravitational equations is derived. Some particular cases of the function f are briefly examined.

2082

Technische Hochschule. Inst. für Mechanik, Aachen (Germany).

MEASUREMENTS OF THE DIFFUSION OF ELECTRONS OUT OF STRONG SHOCK WAVES, by H. Groenig. Flnal rept. June 1959 [42]p. incl. lllus. diagrs. refs. (AFOSR-TR-59-160) (AF 61(514)1046) AD 232219; PB 145680   Unclassified

The diffusion processes whlch occur with the transition of strong shock waves in gases were lnvestigated by means of a gas discharge probe developed for these purposes. It was found theoretically and experimentally that ahead of strong, lonizing shocks electrons can be measured whlch escape the shock region by diffuslon. The experimentally obtained diffusion profiles are in good agreement with the solution of the diffusion equation. It is posslble to determine the diffusion coefficient for electrons in argon from the measurements. The diffusion coefficient exhibits the correct pressure dependence. The experiments were performed ln argon of different degrees of impurities. No difference with the various degrees of impurlties can be observed. The Mach numbers were restricted to the range of 5 to 10, where the experiments are most interesting due to the relatively small degree of ionization. (Contractor's abstract)

2083

Technische Hochschule. Inst. für Aerodynamik, Braunschweig (Germany).

THEORETICAL AND EXPERIMENTAL CASCADE

FLOW INVESTIGATIONS AT HIGH SUBSONIC MACH NUMBERS (PRESSURE DISTRIBUTIONS AND WAKE MEASUREMENTS), by U. Hopkes. June 26, 1959, 55p. incl. diagrs. tables, refs. (Rept. no. 59/21) (AFOSR-TR-59-45) (AF 61(052)105) AD 214810; PB 145501
Unclassified

Extensive experimental investigations on 2-dimensional cascades at hlgh subsonic Mach numbers were carried out ln the varlable density high speed cascade wind tunnel. Varying the cascade geometry and the Mach number the following quantities were measured up to the choking Mach number for 2 different blade profiles (NACA 0010 and NACA 8410): (1) pressure distribution on the blade. (2) loss coefficient and (3) deflection of flow and static pressure difference across the cascade. The loss coefficient and the deflection are nearly constant up to the crltical Mach number, but the statlc pressure difference varies with the Mach number. The experimental pressure distributions were compared with different theoretical methods ior calculating pressure distributions in compressible flow.

2084

Technische Hochschule, Hannover (Germany).

DYNAMICS OF STRUCTURES BY TRANSFER MATRICES, by E. Pestel. June 1959 [184]p. incl. diagrs. tables, refs. (Technical rept. no. 1) (AFOSR-TR-59-95) (AF 61(052)33) AD 223677; PB 144294
Unclassified

This report descrlbes in detail the dynamics of transfer matrices from a structural viewpoint. The 1st chapter reviews briefly the method of transfer-matrlces with an example of the free plane bending vibration of a stralght beam on 2 supports. Each chapter after that deals with a particular phase of the subject. The 2nd discusses calculation of rotating disks under transfer-matrices by examining stresses and strains, free bending vibration, and forced vibration. The 3rd deals wlth the catalogue of transfer matrices of which there are 3: straight beams, curved and twisted beams, and beams with special intermediate conditions. The 4th discusses the coupling of beams. Delta-matrices and other modifications of the use of transfer matrices are examined in the next chapter. The following chapter, concerned also with the static and dynamlc analysis of various elastomechanical problems, discusses the modified transfer matrix method. The next chapter, analysls of aircraft components structurally, presenting for perhaps the 1st time, an investigation of stresses and strains in a thin-walled aircraft. The last chapter is an application of transfer matrices to plates.

2085

Technische Hochschule. Inst. für Statik, Hannover (Germany).

THIN-WALLED COMPRESSION MEMBERS, by A.

Pflüger. Dec. 1958, 37p. incl. diagrs. tables, refs. (Rept. no. 1) (AFOSR-TN-59-291) (AF 61(514)1140) AD 212923; PB 140693   Unclassified

All the main problems arising in the calculation of centrally loaded thin-walled columns are considered. In particular formulas and graphs are worked out for buckling by torsion and flexure, for local buckling of the walls and for behavior beyond the buckling load, either compiled from existing sources or from new investigations. To clarify certain questions it was necessary to carry out tests. This report treats, however, only problems which could be solved theoretically and embraces mainly the relations within the range of elasticity and up to the buckling strength.

2086

Technische Hochschule. Inst. für Statik, Hannover (Germany).

THIN WALLED COMPRESSION MEMBERS, by A. Pflüger. Final rept. July 1959, 14p. incl. diagrs. refs. (Rept. no. 2) (AFOSR-TR-59-138) (AF 61(514)1140) AD 227149; PB 144313   Unclassified

Test results indicated that the ideal local buckling stress on thin-walled compression members can be reduced in the same way as was done for column buckling. The magnitude of the deformations occurring as a result of the buckling process was investigated. As a consequence of inaccuracies of shape and of the application of the load, deformations probably will occur before the buckling limit is reached. The statistical evaluation of the measurements showed that these deformations do not exceed the permissible limits within the scope of reasonable demands regarding the outer appearance of a construction. When the critical value is exceeded, the deformations increase rapidly. Consequently, the necessary safety factor must be related to the buckling limit. The yield stress values to be introduced into the buckling formula when making allowances for the difference between compressive and tensile yield stress as well as for the effect exercised by the manufacturing process are discussed. Allowances for the cladding effect may be achieved by multiplying the buckling stress with a corrective factor involving the cladding thickness, sheet thickness and the yield stress of the cladding material.

2087

Technische Hochschule. Inst. für Angewandte Matematik, Karlsruhe (Germany).

RING AIRFOIL THEORY PROBLEMS OF INTER-FERENCE AND BOUNDARY LAYER, by J. Weissinger. Jan. 1959 [105]p. incl. diagrs. tables, refs. (AFOSR-TN-59-226) (AF 61(514)1207) AD 211809; PB 140694   Unclassified

The investigations of a recent report (TEK.02:001,

Vol. ll) were continued. As a new subject the interference of the ring with a strut (of small chord length) is studied. The theory of ring body interference is extended to (slender) bodies of finite length whose diameter is small compared with the ring diameter. In this report also the shape parameter $\lambda = L/D$ is assumed to be small. The lift of the body and of the wing as well as the pitching moment of the body were determined; explicit formulas and numerical results are given for ellipsoids of revolution. In boundary layer theory the methods were improved by introducing the Mangler transformation and some minor refinements. (Contractor's abstract)

2088

Technische Hochschule. [Mathematical Inst.] Munich (Germany).

SUPERSONIC FLOW PAST OSCILLATING BODIES OF REVOLUTION WITH A FREQUENCY NOT NECESSARI-LY SMALL, by J. Muench. June 24, 1959, 13p. incl. diagrs. (Technical note no. 8) (AFOSR-TN-59-452) (AF 61(514)1080) AD 215027; PB 143965   Unclassified

A representation is given of the potential of linearized flow past bodies of revolution executing elliptic oscillations of arbitrary frequency. The potential is given in terms of Bessel and Legendre functions. (Contractor's abstract)

2089

Technische Hochschule. [Mathematical Inst.] Munich (Germany).

THE NUMERICAL SOLUTION OF BOUNDARY-VALUE PROBLEMS FOR CERTAIN HYPERBOLIC LINEAR EQUATIONS, by H. J. Stetter. Apr. 24, 1959 [33]p. incl. diagrs. refs. (Technical note no. 7) (AFOSR-TN-59-673) (AF 61(514)1080) AD 218385. PB 143164   Unclassified

A detailed investigation is given of procedures yielding a numerical solution of certain boundary-value problems of a linear partial differential equation related to the wave equation. After the statement of the problem and the presentation of some analytic results, the characteristic system of the equation is transcribed into a system of difference equations in a characteristic grid, using an ADAMS-interpolation difference scheme. It is shown how these difference equations may be conveniently solved in each point of the grid. A method is presented to take care of discontinuities in the boundary data. The numerical procedures necessary to get the computations on the difference equations started are also described. The stability and convergence of these numerical methods is discussed. Stability is investigated experimentally through the propagation of unit-errors; convergence is theoretically and experimentally found to be of $O(h^3)$, h being the mesh-size. The

results of computations on a practical example origi-
nating from aerodynamics are presented. (Contrac-
tor's abstract)

2090

Technische Hochschule. [Mathematical Inst.] Munich
(Germany).

RIEMANN'S PROBLEM FOR A LAVAL-NOZZLE. I.
HYDRAULIC APPROXIMATION, by R. Schätz. Aug. 12,
1959 [23]p. incl. diagrs. (Technical note no. 9)
(AFOSR-TN-59-709) (AF 61(514)1080) AD 230223;
PB 145296   Unclassified

Hydraulic approximation is discussed of Riemann's
problem, i.e., the determination of flow arising from
discontinucus initial pressure distribution, for Laval
nozzles, and a detailed analysis is presented of numeri-
cal features of difference methods employed. (Contrac-
tor's abstract)

2091

Technische Hochschule. Mathematical Inst., Munich
(Germany).

LINEAR SUPERSONIC FLOW PAST COMBINATIONS
OF A CYLINDRICAL BODY AND TRIANGULAR WINGS,
by F. Peischl and H. J. Stetter. Nov. 24, 1959, 28p.
incl. diagrs. refs. (Technical note no. 11) (AFOSR-
TN-59-1160) (AF 61(514)1080) AD 233274; PB 146737
                                         Unclassified

The normalized pressure-distribution has been com-
puted for wing-body combinations consisting of an in-
finite (rotational) cylindrical body and plane delta-
wings with supersonic leading edges. Linear super-
sonic theory was used without further approximations.
After an introduction on quasi-cylindrical wing-body
interference theory and the statement of the problem
the non- trivial 2nd step of the procedure is solved
analytically. This solution is Fourier-analyzed nu-
merically to yield the boundary data for the 3rd step,
the computations of which have been described pre-
viously. (See item no. 2089). The pressure distribution
is shown in several graphical representations and a
discussion of the results is given. All computations
were made on the PERM electronic computer. (Con-
tractor's abstract)

2092

Technische Hochschule, Stuttgart (Germany).

INVESTIGATION OF THREE-DIMENSIONAL VORTEX
INSTABILITY, by F. X. Wortmann. Final technical
rept. Feb. 25, 1959 [17]p. incl. illus. diagrs. table.
(AFOSR-TR-59-59) (AF 61(514)897) AD 216624;
PB 143014   Unclassified

A description is presented of the development and con-
struction of a laminar water tunnel designed for the in-
vestigation of a 3-dimensional vortex instability of the
laminar boundary layer on the concave wall. Both the
assignment and the tellurium method have brought up
problems for the solution of which entirely new ap-
proaches had to be found. Apart from the solution of a
large variety of individual problems a rigid, porous,
corrosion-resistant wall surface was developed for
boundary layer suction. (Contractor's abstract)

2093

Technische Hochschule, Vienna (Austria).

CONDUCT THEORETICAL AND EXPERIMENTAL
INVESTIGATIONS OF THE MIXING OF COOLING AIR
WITH COMBUSTION PRODUCTS IN A COMBUSTION
CHAMBER, by H. Melan. Final technical rept. Oct. 31,
1959 [32]p. incl. illus. diagrs. tables. (AFOSR-TR-59-
197) (AF 61(052)93) AD 241992; PB 150332
                                         Unclassified

A new combustion chamber for gas turbines was tested.
The chamber design included a swirl (vortex) chamber
at the inlet and exhaust of the combustion chamber. The
tests were made with a model derived from a standard
Lucas chamber. Measurements were made of the ve-
locities, pressures, temperatures, mass flow, and com-
bustion efficiencies during the investigation of the flow
of hot gases and cooling air in the chamber. The re-
sults indicated that the flame tube could be successfully
eliminated from the combustion chamber and that wall
temperatures could be diminished by the design. It also
appeared possible to get a similar distribution of the
outlet temperatures over the cross section of the outlet.

2094

Temple U. [Dept. of Physics] Philadelphia, Pa.

NATURE OF ABSORPTION EDGE ELECTRON
TRANSITIONS IN β-BRASS ALLOYS (Abstract), by L.
Muldawer. [1959] [1]p. [AF 49(638)73]   Unclassified

Presented at meeting of the Amer. Phys. Soc., New
York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
46, Jan. 28, 1959.

Spectral reflectivity measurements at room tempera-
ture of β-brass alloys show a shift of the edge to lower
energy with increasing zinc content. A similar effect
is seen in β-AgCd alloys. This indicates the operation
of an electron transition from the top of the Fermi sea
to an upper band and not from the underlying d band
to the surface of the Fermi sea. The latter is the re-
sponsible mechanism in the α-brasses. The observed
reflectivity edge shift in β-brass is -0.031 ev/% Zn. A
simple calculation assuming only electron-atom ratio

and lattice parameter changes gives a Fermi level shift of $+ 0.029$ ev/% Zn; this is in good agreement with the above scheme providing the electron band structure undergoes negligible changes.

2095

Temple U. Research Inst., Philadelphia, Pa.

THE FASTEST BURNING FLAME—THE PRE-MIXED HYDROGEN-FLUORINE FLAME, by A. V. Grosse and A. D. Kirshenbaum. Feb. 2, 1959, 72p. incl. illus. diagrs. tables, refs. (Technical note no. 8) (AFOSR-TN-59-621) (AF 18(600)1475) AD 228782; PB 144981   Unclassified

Techniques for premixing pure hydrogen and fluorine gas were developed. Burning velocities, both at 77 and 90°K of various hydrogen-fluorine mixtures, with and without helium dilution, were determined. The hydrogen-fluorine flame is the fastest flame known and burning velocities up to 2100 cm/sec at 77°K were measured. Under the same conditions the hydrogen-oxygen flame has a velocity of approximately 200 cm/sec or 10 times smaller. The hydrogen-fluorine flame is also characterized by an unusually high flame pressure; a maximum of 60 mm Hg has been determined. (Contractor's abstract)

2096

Temple U. Research Inst., Philadelphia, Pa.

AN EXPERIMENTAL DETERMINATION OF THE DENSITIES OF MOLTEN METAL FLUORIDES IN THE RANGE OF 1600° TO 2500°K, by A. D. Kirshenbaum and J. A. Cahill. Apr. 30, 1959, 45p. incl. illus. diagrs. tables, refs. (Technical note no. 9) (AFOSR-TN-59-844) (AF 18(600)1475) AD 231147; PB 145363
                                        Unclassified

Using a graphite crucible and a tungsten sinker, the liquid densities of the alkaline earths and 2 rare earth fluorides were determined by the loss in weight of an immersed sinker method over a temperature range of 1600° to 2500°K. The density equations for these molten fluorides are given in table form.

2097

Temple U. Research Inst., Philadelphia, Pa.

STUDY OF ULTRA HIGH TEMPERATURES, by A. V. Grosse and C. S. Stokes. Final rept. May 1, 1955-Apr. 30, 1959, 26p. incl. diagr. tables, refs. (AFOSR-TR-59-168) (AF 18(600)1475) AD 231063; PB 161460
                                        Unclassified

This final rept. covers such topics as: The production of high temperature flames; Systems of carbon, nitrogen and oxygen; The cyanogen-oxygen flame as a high

temperature tool; Systems using fluorine; The fastest burning flame - the premixed hydrogen-fluorine flame; Systems using ozone; Imaging of the oxygen-aluminum flame and its use as an artificial sun furnace; Two phase reactions at high temperatures; The reaction of beryllium with aluminum oxide; Combustion of beryllium in oxygen; The temperature of the zirconium-oxygen flame; An experimental determination of the densities of molten metal fluorides in the range of 1600° to 2500°K; Preparation of carbon-phosphorus compounds.

2098

Texas A. and M. Coll. [Dept. of Physics] College Station.

SOME FEATURES OF THE VIBRONIC ABSORPTION SPECTRUM OF CHLORINE DIOXIDE (Abstract), by J. B. Coon and C. M. Loyd. [1955] [1]p. [AF 18(600)-439]   Unclassified

Presented at the Symposium on Molecular Structure and Spectroscopy, Ohio State U., Columbus, June 1955.

A critical list of 143 bands of the 3000-5000A absorption system of $Cl^{35}O_2$ has been compiled. This list is based on published data supplemented by the present authors. A vibrational analysis yields accurate values for 3 fundamental frequencies and all 6 anharmonicity constants of the excited electronic state. In addition, accurate values are obtained for the frequencies of the 2 symmetrical modes of the ground state and the 3 anharmonicity constants associated with these frequencies. Most of the assigned bands are arranged in 13 v_1' progressions. The 4 most intense progressions designated by $a(v)$, $b(v)$, $c(v)$ and $d(v)$ are given the following assignments: $a(v)$, very strong, $(v00)' - (000)''$; $b(v)$, strong, $(v10)' - (000)''$; $c(v)$, strong, $(v02)' - (000)''$; and $d(v)$, medium, $(v04)' - (000)''$. A weak progression designated by m is given the assignment $(v12)' - (000)''$. The band intervals of any one of these progressions plotted versus v_1' should give a straight line of slope $2x_{11}'$. This is observed to be the case above $v_1' = 4$ where the slope is close to -4.88 for all 5 progressions. However, below $v_1' = 4$ the slope is about -6.5 for progressions a and b, while the slope for progressions c, d, and m is approximately -3 at low v_1'. This means that excited state vibrational levels with $v_1' < 4$ are perturbed. The relative values of the peak extinction coefficients have been determined for the bands of the 4 principle progressions. The most intense band of each progression is respectively: $a(12)$, $b(11)^2$, $c(8)$, $d(3)$. Condon overlap integrals calculated to the harmonic approximation give maximum intensity in all 4 progressions at the same value of v_1' namely $v_1' = 6$ and 7.

2099

Texas A. and M. Coll. [Dept. of Physics] College Station.

INTENSITY OF VIBRONIC BANDS IN 3000-5000A
ABSORPTION SYSTEM OF CHLORINE DIOXIDE (Abstract), by J. K. Ward and C. M. Loyd. [1955] [1]p.
[AF 18(600)439]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Mexico
City, Mexico, Aug. 29-31, 1955.

Published in Phys. Rev., v. 100: 963, Nov. 1, 1955.

The Franck-Condon principle relates the relative intensities of the vibronic bands of an absorption system
to the change in geometry of the molecule during the
associated electronic transition. The vibrational frequencies and the geometry of both ground and excited
state of the chlorine dioxide molecule are known. On
the basis of this information, the Condon overlap integrals were evaluated to the harmonic approximation,
giving theoretical relative intensities for the bands of
progressions (a) $(\nu_1'00) \rightarrow (000)$ and (b) $(\nu_1'10) \rightarrow (000)$.

Measurements of the relative intensities of the bands of
these progressions were made photographically at
several different concentrations and path lengths. A
rotating sector was used for plate calibration. About 20
determinations with optical densities of 0.1 to 0.6 were
made for each band, avoiding extreme densitometer
readings. Background intensities were subtracted. The
close agreement between theory and experiment for the
(b) progression suggests that the harmonic approximation permits reasonably accurate calculated intensities.
For the (a) progression, the experimental intensities
are considerably larger, after $\nu_1' = 8$, than those theo-

retically predicted. This indicates some additional
intensity effect.

2100

Texas A. and M. Coll. [Dept. of Physics] College Station.

THE 2000-2400A ABSORPTION REGION OF SO_2 VAPOR

(Abstract), by J. W. Riggs and J. B. Coon. [1958] [1]p.
[AF 18(600)439]   Unclassified

Presented at the Symposium on Molecular Struc, ·re and
Spectroscopy, Ohio State U., Columbus, June 19

Duchesne and Rosen have suggested that the vibr.
bands of this region belong to several separate electronic transitions. The present paper presents evidence
that all these bands belong to a single transition. Spectrograms taken in the 3rd order of a 2-m grating spectrograph show at least 30 partly resolved bands distributed throughout this region which show similar structure. These bands exhibit q and r branches degrading
to the red with a 2nd difference corresponding to $\Delta(A-$
$\bar{B}) \approx -0.70$ cm^{-1}. Each sub-band is characterized by a

sharp intensity peak which is probably a Q branch. For
most bands a weak subhead extends 8-14 cm^{-1} toward
the violet side of the principal head. Interpretation of
these subheads in terms of R branches leads to $\Delta\bar{B} \approx$
-0.01 cm^{-1}. These results indicate a fairly large increase in band distance and a significant decrease of
angle. This corresponds to Walsh's predictions for a
$^1B_1 - {}^1A_1$ transition in this region. The large change
is geometry indicated by the rotational structure is consistent with the interpretation that the corresponding
band system extends over a considerable wavelength
range. Although the bands have sharp heads which can
usually be isolated from each other, the system resists
interpretation in terms of symmetrical frequencies
alone. Some progress is being made in the vibrational
analysis by assuming that bands involving the antisymmetrical mode appear because of a double minimum potential in the antisymmetrical coordinate.

2101

Texas A. and M. Coll. Dept. of Physics, College Station.

THE ELECTRONIC SPECTRA OF SIMPLE MOLECULES, by J. B. Coon. Final rept. Dec. 17, 1959, 24p.
incl. tables, refs. (AFOSR-TR-59-206) (AF 18(600)-
439) AD 232660; PB 145837   Unclassified

An examination is made of the possible methods for obtaining information about excited electronic states of
simple molecules from a study of their ultraviolet absorption spectra. Examples are given to illustrate that
the moments of inertia of the excited states of simple
molecules may be determined from incompletely resolved band envelopes. A method of applying the Franck-
Condon principle to the determination of the geometry
of the excited state of a molecule is outlined and an illustration is worked out. A study of the vibrational
structure of several vibronic band systems not only
yields excited state vibrational constants, but also indicates that double minimum potential functions occur
frequently in excited electronic states. A 2 parameter
double minimum potential function was set up and its
wave functions and energy levels were determined.
With the aid of this model function observed energy
levels or band intensities led to the determination of a
double minimum potential function of a molecule. Several applications for observed energy levels are given.
(Contractor's abstract)

2102

Texas A. and M. Coll. [Dept. of Physics] College Station.

A DOUBLE MINIMUM POTENTIAL FUNCTION
(Abstract), by N. W. Naugle, J. R. Henderson, and J. B.
Coon. [1959] [1]p. [AF 18(600)439]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Texas
U., Austin, Mar. 6-7, 1959.

Recent literature suggests that frequently an excited electronic state of a molecule has a potential function with a double minimum in 1 of the antisymmetrical normal coordinates. Such a potential function may be described approximately by $V = (1/2)\lambda Q^2 + A \exp [-(e^{3/2}\lambda/2A)Q^2]$. The coefficient of the exponent is determined by requiring that the 2 minima be parabolic. Using machine calculations the low-energy levels and the corresponding wave functions of this potential have been obtained in a dimensionless form applicable to any double minimum problem. A linear combinat of the first 12 harmonic oscillator wave functions corresponding to the potential $\frac{1}{2}\lambda Q^2$ is used as a variation function. This approach is appropriate for low potential barriers. The secular determinant is solved by the Jacobi method. As an example, the barrier height in the out-of-plane bending coordinate of the $^1A_2$ state of formaldehyde, as determined from the observed levels, is 550 cm^{-1} for H_2CO and 490 cm^{-1} for D_2CO. The wave functions will permit calculation of band intensities.

2103

Texas A. and M. Coll. [Dept. of Physics] College Station.

THE DOUBLE MINIMUM POTENTIAL OF H_2CO (Abstract), by N. W. Naugle, J. R. Henderson, and J. B. Coon. [1959] [1]p. [AF 18(600)439]   Unclassified

Presented at the Symposium on Molecular Structure and Spectroscopy, Ohio State U., Columbus, June 1959.

The energy levels and wave functions have been obtained for a convenient double minimum potential function with 2 parameters. The problem has been solved in dimensionless form so as to be applicable to any double minimum problem. As a test case the O^+, 1^+, and 1^- levels known for NH_3 lead to a barrier height within 5%, and a displacement of the N atom from the H plane within 10%, of the known values. For the low barrier of H_2CO the present method is expected to give better results than for the high barrier of NH_3. The barrier height B and the angle Θ_m of out-of-plane bending, are determined for the $^1A_2$ electronic state of H_2CO and D_2CO using values of the 0^+, 0^-, and 1^+ levels given by Robinson. The results are $B(H_2CO) = 379$ cm^{-1}, $B(D_2CO) = 376$ cm^{-1}, $\Theta_m(H_2CO) = 30°.94$, and $\Theta_m(D_2CO) = 31°.16$. If the 1^- level is given a weight equal to that of the other levels a barrier more than 100 cm^{-1} higher is obtained. However, it is reasona-

ble that the lower levels should lead to the best barrier height. The levels 0^+, 0^-, and 1^+ known[3] for the $^3A_2$ state of H_2CO lead to a barrier height $B = 793$ cm^{-1} and a bending angle $\Theta_m = 40°.0$.

2104

Texas A. and M. Coll. Dept. of Physics, College Station.

SPIN-LATTICE RELAXATION TIMES IN BINARY SOLUTIONS, by R. W. Mitchell and M. Eisner. Mar. 1959 [35]p. incl. diagrs. tables. (AFOSR-TN-59-286) (AF 18-(600)1300) AD 212919; PB 140813   Unclassified

Spin-lattice relaxation time (T_1) measurements in binary mixtures at 43 gauss are presented. The results are compared to the predictions of the Debye model as well as other models. The method of measuring T_1 consists of establishing an initial magnetization of a sample in a magnetic field, and then suddenly changing the magnetic field to a new value. T_1 is calculated from the growth or decay of the z component of the nuclear magnetic moment of the sample. The z component of the magnetic moment is determined by the amplitude of the resonance absorption signal from the sample. Results for solutions in CS_2 show that $\frac{1}{\eta T_1}$ is not a linear function of concentration even in cases where there is no association. It is concluded that deviations of $\frac{1}{\eta T_1}$ from linearity do not mean of necessity that the solution is associated. The fact that $\frac{1}{T_1}$ plotted against mol fractions is a linear function suggests that the rotational and translational motions are closely related and that diffusion is accompanied by tumbling. The extrapolation of the relaxation times to infinite dilutions yield rotational correlation times which are in good agreement with the Hill theory. The correction of the translatory diffusion by the Hill theory leads to the best internal consistency and underscores the fact that in solutions the interaction of the molecules with its surroundings is best given by a microscopic viscosity, rather than a macroscopic viscosity. (ASTIA abstract)

2105

Texas U. [Dept. of Chemistry] Austin.

INTERACTIONS OF ACETYLENE AND AROMATIC HYDROCARBONS, by R. C. Anderson and R. S. Wallace. June 1959 [13]p. incl. diagr. tables. (Technical note no. 5) (AFOSR-TN-59-611) (AF 18(603)142) AD 217398; PB 143298   Unclassified

The earlier experiments of F. C. Stehling (Ph.D. Dissertation, Texas U., 1957) on thermal reactions of

mixtures of acetylene with aromatic hydrocarbons have been extended to styrene-acetylene mixtures at temperatures of 600-800°C. The data are limited because of the high rate of polymerization of styrene, but they do offer a useful comparison with other hydrocarbon systems because styrene is a very reactive compound. Styrene was found to be quite reactive in polymerization even in gas phase at low pressure. Like the other aromatic hydrocarbons, however, it showed little decomposition up to 800°. With acetylene present, small amounts of addition products were observed; but the chief effects with all the hydrocarbons tested were increased production of decomposition products such as hydrogen and methane. The results indicate that acetylene supplies an activated molecule or diradical which can react so as to open or split the aromatic ring structure. (Contractor's abstract)

2106

Texas U. [Dept. of Chemistry] Austin.

DECOMPOSITION OF VINYLACETYLENE AND DIACETYLENE AND THEIR INTERACTION WITH ACETYLENE, by J. D. Frazee and R. C. Anderson. Aug. 1959, 39p. incl. diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-59-934) (AF 18(603)142) AD 228537; PB 144384   Unclassified

As in the case of the aromatic compounds methane is formed readily and early in reaction. Diacetylene is notable for the fact that methane was not detectable in its decomposition products. (Contractor's abstract)

2107

Texas U. [Dept. of Physics] Austin.

ANNIHILATION OF POSITRONS IN ORGANIC LIQUIDS, by C. R. Hatcher, T. W. Falconer, and W. E. Millett. [1959] [4]p. incl. diagrs. tables. (AFOSR-TN-59-90) (AF 33(038)20661) AD 233951   Unclassified

Presented at meeting of the Amer. Phys. Soc., Texas U., Austin, Mar. 6-7, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 100, Mar. 6, 1959.

Also published in Jour. Chem. Phys., v. 32: 28-31, Jan. 1960.

The mean life τ_2 and fraction I_2 of positrons which form ^{3}S positronium were measured for annihilation in 20 organic liquids—alcohols, glycols, acids, benzene derivatives and others. By using the measured value of τ_2, it is possible to calculate $\langle \sigma v \rangle_{Av}$ where σ is the molecular cross section for annihilating ^{3}S positronium on collision and v is the velocity of the positronium atom. The results show that in general $\langle \sigma v \rangle_{Av}$ is re-

lated to the size of the molecule although there are some consistent exceptions to this rule. There is also a rough correlation between τ_2 and density, τ_2 being shortest for the most dense liquids and longest for the least dense ones. (Contractor's abstract)

2108

[Texas U. Dept. of Physics, Austin].

PRECISION THERMOMETER SYSTEM FOR THE LIQUID HELIUM SYSTEM, by B. J. Sandlin and J. C. Thompson. [1959] [3]p. [AF 33(636)20681]
                                          Unclassified

Published in Rev. Scient. Instr., v. 30: 659-671, Aug. 1959.

This system uses a carbon resistor (Allen-Bradley type) as the sensing element. The resistor is in the frequency determining circuit of a stabilized Wien bridge oscillator. Thus temperature changes are displayed as frequency shifts. The frequency is read directly from a Hewlett-Packard type 523 B counter. When operated in the neighborhood of 100 kc/sec at 4.2°K the sensitivity is approximately 50 kc/sec/°K. This corresponds to a temperature resolution of $20\mu°$, when used with the above counter. Resolution can be improved by observing higher harmonics. The power input to the resistor is of the order of 10^{-2} μW. The time for a temperature measurement is 1 sec, and response times to changes are limited only by equilibrium in the thermometer. Absolute accuracy is essentially limited only by the determination of the helium vapor pressure during calibration.

2109

Texas U. Dept. of Physics, Austin.

EFFECTS OF HIGH PRESSURE ON THE NEAR ULTRAVIOLET VAPOR ABSORPTION SPECTRUM OF BENZENE IN A NUMBER OF DILUENT GASES, by S. E. Babb, Jr., J. M. Robinson, and W. W. Robertson. [1959] [30]p. incl. diagrs. table, refs. (AFOSR-TN-59-22) (AF 49(638)35) AD 208752   Unclassified

Also published in Jour. Chem. Phys., v. 30: 427-434, Feb. 1959.

The absorption spectrum of benzene vapor in a number of gaseous diluents over a wide range of diluent densities has been obtained. The wave length of absorption shifts to the red in the gases A, H_2, N_2, CO_2, O_2, CO, C_2H_6 and C_2H_4, to the blue in the diluents He and Ne. Since the light absorber is the same in each case, the relative rates of shift with density should be a function of the physical properties of the diluents. However, no simple correlation has been found to exist between

relative shift and such properties of the solvents as polarizability or dielectric constant. Dispersion theory predicts only roughly the relative shifts. No satisfactory explanation has been found for the blue shift obtained in He and Ne. (Contractor's abstract)

2110

Texas U. Dept. of Physics, Austin.

THE RELATIVE INTENSITIES OF ABSORPTION BANDS IN LIQUID AND GAS PHASES FROM DISPERSION THEORY, by E. E. Ferguson. [1959] 6p. (AFOSR-TN-59-287) (AF 49(638)35) AD 213031
Unclassified

Also published in Jour. Chem. Phys., v. 30: 1059-1060, Apr. 1959.

The well-known expression for the ratio of liquid-gas intensities of absorption bands is derived from the point of view of dispersion theory which shows clearly several assumptions implicit in the expression, the most important being the restriction to weak bands. The manner in which liquid and gas oscillator strengths can be determined from liquid dispersion data is discussed and the infrared dispersion data of CS_2 is

analyzed in this way. (Contractor's abstract)

2111

Texas U. Dept. of Physics, Austin.

SPECTROSCOPIC EVIDENCE FOR LONG-RANGE REPULSIVE INTERMOLECULAR FORCES, by W. W. Robertson and A. D. King, Jr. [1959] [16]p. incl. diagrs. table, refs. (AFOSR-TN-59-688) (AF 49(638)35) AD 219402; PB 143021
Unclassified

Also published in Jour. Chem. Phys., v. 31: 473-476, Aug. 1959.

Experimental results are presented on the shift of wavelength of absorption of benzene, naphthalene, pyrene and phenanthrene with density of the diluents helium and nitrogen. Arguments are presented to show that the blue shift observed in the ^1L_b spectrum in

helium is neither due to short-range repulsive forces nor to long-range dispersive forces. It is presumed that there are weak, long-range, nondispersive forces present in the benzene-helium interaction that have the character of repulsive forces. (Contractor's abstract)

2112

Texas U. Dept. of Physics, Austin.

VIBRATION PERTURBATIONS IN ELECTRON-

ICALLY EXCITED MOLECULES, by O. E. Weigang, Jr. and W. W. Robertson. [1959] [5]p. incl. diagrs. table, refs. (AF 49(638)35)
Unclassified

Presented at meeting of the Phys. Chem. Div. of the Amer. Chem. Soc., Chicago, Ill., Sept. 7-12, 1958.

Abstract published in 134th meeting of the Amer. Chem. Soc., Abstracts of Papers, 1958, p. 46-S.

Also published in Jour. Chem. Phys., v. 30: 1413-1417, June 1959.

Small vibration shifts of usually 10 to 50 cm^{-1} can be observed superimposed on the electronic shifts of 200 to 1000 cm^{-1} which occur on solvation of aromatic polynuclear hydrocarbons. Vibration assignments for benzene indicate that the observed behavior of its vibration bands is due to the perturbation of a single vibration in the electronically excited benzene molecule. The change corresponds to an increase of frequency for the excited state E_g^+ 3080-cm^{-1} C–H vibration. A similar phenomenon can be detected in the naphthalene spectrum. The results are compared to the recent work of Fishman, Benson, Wiederkehr, and Drickamer on pressure perturbations of vibrations in electronic ground state molecules in solution. (Contractor's abstract)

2113

Texas U. Dept. of Physics, Austin.

INFRARED DISPERSION DUE TO THE ASYMMETRIC STRETCHING VIBRATION OF CS_2, by E. E. Ferguson and R. E. Kagarise. [1959] [3]p. incl. refs. (AF 49-(638)35)
Unclassified

Published in Jour. Chem. Phys., v. 31: 236-238, July 1959.

Infrared dispersion data on liquid CS_2 in the wavelength range 2-15μ have been analyzed according to classical dispersion theory to yield both gas and liquid oscillator strengths for the asymmetric stretching vibration. The calculated gas intensity for this vibration is 7000 x 10^{10} cm^{-1} sec^{-1} (STP) as compared to directly measured values around 7500 x 10^{10}. The intensity of the bending vibration of CS_2 which has not yet been measured is inferred to be 275 x 10^{10} cm^{-1} sec^{-1}. The CS bond dipole moment is calculated to be 1.24 debye which gives a quadrupole moment in reasonable agreement with experiment. (Contractor's abstract)

2114

Texas U. [Dept. of Psychology] Austin.

THE INHIBITION OF AGGRESSION UNDER NON-
ARBITRARY FRUSTRATION, by P. Rothaus and P.
Worchel. [1959] [10]p. incl. tables, refs. (AFOSR-
TN-59-989) (AF 49(638)460) AD 238651
Unclassified

Also published in Jour. Personality, v. 28: 108-117,
Mar. 1960.

The present study was designed to test the hypothesis
that the reduction of hostile responses under reasonable
or nonarbitrary frustration is due to the inhibitions
aroused by the nature of the social situation. In addi-
tion, it was proposed to investigate the relationship of
sex and the discrepancy between self and ideal concepts
to the expression of aggression under different de-
grees of arbitrariness of frustration. The results
showed: (1) The 218 subjects under an arbitrary set of
frustration reported significantly greater hostile feel-
ings, actions, and percentage of actions to feelings than
those under the nonarbitrary frustration. (2) The sub-
jects under the projective nonarbitrary frustration re-
ported significantly greater number of hostile feelings,
actions, and percentages of actions to feelings than
those under the nonarbitrary frustration. (3) Though
there was no significant difference between the sexes
in the number of hostile feelings, the males reported
greater hostile actions and percentage of hostile ac-
tions to feelings than did the females. (4) On both ac-
tions and percentage, subjects with high self-ideal dis-
crepancy reported significantly higher hostility than
those with low self-ideal discrepancy. (5) On feeling,
however, the significant triple interaction showed that
under arbitrary frustration, males with low self-ideal
(SI) discrepancy reported higher hostile feelings than
those with high discrepancy. For the females under the
same condition, it was the reverse; that is, those with
high SI discrepancy reported more hostile feelings than
those with low discrepancy. Under nonarbitrary condi-
tions, all the subjects with high SI discrepancy, on the
average, reported more hostile feelings than those with
low discrepancy. (Contractor's abstract)

2115

Thiokol Chemical Corp. Reaction Motors Div., Denville,
N. J.

IONS IN ROCKET COMBUSTION PRODUCTS (Ab-
stract), by R. W. Ellison. [1959] [1]p. (Bound with its
AFOSR-TN-59-770; AD 241053) (AF 49(638)305)
Unclassified

Presented at Second AFOSR Contractors meeting on
Ion and Plasma Propulsion, North American Aviation,
Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9,
1959.

Two phases of this research are discussed: (1) the

possibility of steering a missile in powered flight by
electric fields, and (2) the concentrations of ions that
are available in rocket chambers and exhausts. An
ionization of at least 0.1% in a rocket exhaust is shown
to be of interest in the application of electric fields to
produce useful macroscopic effects. An example based
on electric steering is derived for a simple no collision
model and compared with a calculation recognizing col-
lisions. The significance of fringing fields is discussed.
Experimental data on the ionization in rocket chambers
and exhausts are presented for hydrogen-oxygen combus-
tion and for a flame salted with cesium compounds. The
experimental results are compared with calculated ion
concentrations, and some new theoretical results are
shown to illustrate the effects of combustion pressure on
salted flames and the influence of various percentages of
alkali-earth additive on ion concentrations.

2116

Thiokol Chemical Corp. Reaction Motors Div., Denville,
N. J.

HEAVY PARTICLE PROPULSION RESEARCH (Ab-
stract), by R. E. Wiech, Jr. [1959] [1]p. (Bound with
its AFOSR-TN-59-770; AD 241053) (AF 49(638)657)
Unclassified

Presented at Second AFOSR Contractors meeting on
Ion and Plasma Propulsion, North American Aviation,
Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9,
1959.

The objectives of this program are to conduct basic
studies on the possibility of using heavy particles of
micron dimensions as the working fluid in an ion pro-
pulsion system. The problem areas under investigation
are: (1) particle generation; (2) particle ionizing (charg-
ing); (3) control and acceleration; and (4) measurement.
A literature search has been undertaken to cover these
areas. Related fields, such as air pollution studies,
precipitators, etc., are proving to be the best sources
of information on charged particles. Various charging
methods are available which include combustion, fric-
tion, direct charging, radiation, interface effects and
other similar systems. The various charging mechan-
isms are discussed. Aluminum flow rates of approxi-
mately 0.1 g/sec were recorded. The flow rate was
found to be sensitive to particle size and electric field
gradient. The particles emerge from the charging unit
with a velocity of several hundred cm/sec.

2117

Toronto U. Inst. of Aerophysics (Canada).

PRESSURE PROBES IN FREE MOLECULE FLOW, by
K. R. Enkenhus, E. L. Harris, and G. N. Patterson.
June 1959 [18]p. incl. diagrs. (UTIA rept. no. 62)
(AFOSR-TR-59-120) (AF 18(600)1185) AD 240553
Unclassified

When the mean free path becomes a significant fraction of a characteristic dimension of a pressure probe, the continuum formulae relating the measured pressure to the free-stream pressure and Mach number are no longer valid. The case is treated where the mean free path is so large compared with the probe diameter that intermolecular collisions may be neglected. This is the condition for free molecule flow. Theoretical expressions are given for the pressure measured in a flowing gas with an orifice probe and a long-tube pressure probe. Experimental investigations were conducted using a low-density wind tunnel and a rotating-arm apparatus. Agreement between theory and experiment was quite satisfactory. (Contractor's abstract)

2118

Toronto U. Inst. of Aerophysics (Canada).

AN EXPERIMENTAL INVESTIGATION OF THE NOISE GENERATED BY THE TURBULENT FLOW AROUND A ROTATING CYLINDER, by L. N. Wilson. Apr. 1959 [73]p. incl. illus. diagrs. refs. (UTIA rept. no. 57) (AFOSR-TN-59-487) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)249 and Canadian Defence Research Board) AD 228504
Unclassified

Also published in Jour. Acoust. Soc. Amer., v. 32: 1203-1207, Oct. 1960.

The near and far field noise from the turbulent boundary layer developed on a rotating cylinder was studied; both smooth and artificially roughened surfaces were employed. The cylinder walls were sufficiently thick to inhibit appreciable boundary-layer excited vibration noise. The mean square pressure followed a U_0^4 law in the near field, and approximated a U_0^6 law, as did the acoustic power, in the far field. Drag calculations from hot wire measurements allowed an estimate of the efficiency (acoustic power/mechanical power) of the far field radiation, resulting in an efficiency about 10 times that for the quadrupole radiation from a jet at a Mach number of .228. Even so, the measured noise power from the boundary layer over a rigid wall appears to be relatively small in any practical application to the noise in aircraft. (Contractor's abstract)

2119

Toronto U. Inst. of Aerophysics (Canada).

THE SOUND GENERATED BY INTERACTION OF A SINGLE VORTEX WITH A SHOCK WAVE, by H. S. Ribner. June 1959 [20]p. incl. illus. diagrs. (UTIA rept. no. 61) (AFOSR-TN-59-1166) (AF 49(638)249) AD 230719   Unclassified

Presented at 1959 Heat Transfer and Fluid Mechanics Inst., Calif. Inst. of Tech., June 19-21, 1957.

The passage of a columnar vortex broadside through a shock is investigated. The vortex is decomposed (by Fourier transform) into plane sinusoidal shear waves disposed with radial symmetry. The plane sound waves produced by each shear wave-shock interaction, known from previous work, are recombined in the Fourier integral. The waves possess an envelope that is essentially a growing cylindrical sound wave, partly cut off by the shock. The sound wave is centered at the transmitted (and modified) vortex and the peak pressure attenuates inversely as the square root of the growing radius. The strength varies smoothly around the arc, from compression at one shock intersections to rarefaction at the other shock intersection. (Contractor's abstract)

2120

Toronto U. Inst. of Aerophysics (Canada).

RECENT TRENDS IN THE MECHANICS OF HIGHLY RAREFIED GASES, by G. N. Patterson. Jan. 1960 [39]p. incl. illus. diagrs. table, refs. (UTIA review no. 16) (AFOSR-TN-59-790) [AF 49(638)281] AD 241337
Unclassified

Also published in Proc. Durand Centennial Conf. on Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-8, 1959), New York, Pergamon Press, 1960, p. 122-152. (AFOSR-TR-59-108)

A review of some recent investigations in the flow of highly rarefied gases is presented. The basic nature of the transport process in free molecule flow is deduced from the Boltzmann equation for the molecular velocity distribution function. The present semi-empirical state of our knowledge of the reflection of molecules from the surface of a solid is summarized, and some directions for research are indicated. The aerodynamic properties of bodies in highly rarefied flows is considered with emphasis on the long cylinder as a case of special interest. The theory is extrapolated to the limit of very high speed ratios or Mach numbers, and the results are compared with those deduced from the Newtonian flow theory. The application of recent studies of rarefied gas flows to the development of instruments for the measurement of the pressure, temperature and density of such flows is reviewed in some detail. The use of free molecule probes for the study of boundary layers and shock waves is outlined. The review is brought to a close with a very brief consideration of some factors involved in the collision-free flow of a plasma. (Contractor's abstract)

2121

Training Center for Experimental Aerodynamics,
Brussels (Belgium).

EXPERIMENTAL EVIDENCE OF THREE-DIMEN-
SIONAL PERTURBATIONS IN THE REATTACHMENT
OF A TWO-DIMENSIONAL LAMINAR BOUNDARY
LAYER AT M = 2.05, by J. J. Ginoux. Nov. 1958 [31]p.
incl. illus. diagrs. refs. (Technical note no. 1)
(AFOSR-TN-59-169) (AF 61(514)993) AD 211148;
PB 140235   Unclassified

The reattachment of a laminar boundary-layer after
separation was investigated at a Mach number of 2.05.
Backward facing step models were used that complete-
ly spanned the working section. Surface flow was ob-
served by a sublimation technique, and detailed span-
wise surveys were made in the reattachment region of
the flow with total head probes. Strong, regular and
repeatable span-wise perturbations were observed
which could not be explained by irregularities either in
the airflow upstream of the models or in the models
themselves. This document includes an appendix en-
titled: Axial Vorticity In Steady Ideal Fluid Flow, by J.
Smolderen.

2122

Trinity Coll., Hartford, Conn.

CONTRIBUTIONS TO THE THEORY OF CHARACTER-
ISTIC FUNCTIONS OF THE DIFFERENTIAL OPER-
ATOR z^N-d^2/dz^2, by W. J. Klimczak. Dec. 31, 1958,
6p. (AFOSR-TR-59-2) (AF 18(600)1397) AD 261904
                                            Unclassified

Research is summarized on certain aspects of the
theory of series of the form $f(z) = \sum_{n=0}^{\infty} f_n w_n(z)$, where
z is a complex variable and the $w_n(z)$ are characteris-

tic functions of the differential operator $\delta_z = z^N-d^2/dz^2$,
N being a positive integer.

2123

Tufts U. Dept. of Chemistry, Medford, Mass.

INITIAL REACTION INTERMEDIATES IN THE
OZONATION OF ALKENES, by A. A. Santilli and F. L.
Greenwood. [1959] [40]p. incl. diagrs. refs. (AFOSR-
TN-59-903) (AF 49(638)292) AD 244737
                                            Unclassified

The reactions of 3-octene, 3-hexene, 2-methyl-2-
pentene and 2,3-dimethyl-2-butene in n-pentane at -75°
with equivalent amounts of ozone are described. The
reactions of the last 3 olefins in methanol at -75° with
equivalent amounts of ozone also have been studied. Ap-
paratus was constructed which permitted taking the in-
frared spectra of these cold, ozonized solutions before
allowing the reaction solutions to warm. Identification
of molecular species present in the cold ozonized solu-
tions permitted us to distinguish between heat cleavage
and ozonation cleavage products. Three previously un-
reported products, 3-octene ozonide, 2-methyl-2-pen-
tene ozonide and 1-hydroperoxypropyl methyl ether
were prepared and characterized. The spectral re-
sults can best be interpreted by assuming the formation
of a very reactive initial ozonide as the 1st product in
each of the above reactions. The initial ozonide of each
olefin is apparently unstable even at -75° in both n-pen-
tane and methanol and decomposes to form a peroxidic
zwitterion and carbonyl compound. Evidence is pre-
sented for the formation of the zwitterion and carbonyl
compound. The final products are formed when these
species react chemically with each other or the solvent
or undergo self condensation. The conclusion is that
the products reported in the text do, indeed, result from
ozone cleavage and not from heat decomposition or re-
arrangement during the workup procedure. (Contrac-
tor's abstract)

Universita di Roma (Italy) see
   Rome U. (Italy)

Université Libre de Bruxelles (Belgium) see
   Free U. of Brussels (Belgium).

2124

Uppsala U. Gustaf Werner Inst. for Nuclear Chemistry (Sweden).

RESEARCH ON "LOCALIZED RADIO-LESIONS."
PART II. EFFECT OF HIGH ENERGY PROTONS ON
THE BRAIN OF THE RABBIT, by B. Rexed, W. Mair
and others. May 1, 1959 [16]p. incl. illus. (Technical
rept. no. 1) (AFOSR-TN-59-976) (AF 61(514)1247)
AD 226389; PB 143586   Unclassified

Also published in Acta Radiol., v. 53: 289-299, 1960.

The effect of irradiation by 185 mev proton beam on the
central nervous system was investigated. The upper
anterior part of the brain of rabbits was irradiated with
a beam 1.5 mm broad and a dose of 20,000 rad. A well-
defined lesion occurred and was confined to the path of
the beam for a period up to 3 mo and slightly wider
than the beam at subsequent periods after irradiation.
The histological change following irradiation at inter-
vals from 2 to 56 wk are presented. Destruction of
nerve cells, myelin sheaths and axons was evident.
Thick walled capillaries, small perivascular hemor-
rhages and macrophages appeared in the early stages
of the lesion. Proliferation of astrocytes occurred.
Astrocytes with nuclei 3 or 4 times the normal size
appeared at 4 wk and subsequently giant cells with 1 or
more nuclei were frequently seen, always within the
irradiated region. Ten wk after irradiation small cav-
ities occurred in some animals. Large thin walled
capillaries were seen at 23 wk and all later periods up
to 1 yr after irradiation. No large hemorrhages were
ever seen.

2125

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF $Ni_{12}P_5$, by S.
Rundqvist and E. Larsson. Nov. 22, 1958 [12]p.
incl. diagrs. tables, refs. (Technical note no. 4)
(AFOSR-TN-59-35) (AF 61(052)40) AD 209207
                                        Unclassified

Also published in Acta Chem. Scand., v. 13: 551-560,
1959.

The crystal structure of $Ni_{12}P_5$ has been determined
with single-crystal methods. The unit cell, containing
2 formula units, is tetragonal, $a = 8.646$ A; $c = 5.070$ A.

The space group is $I\ 4/m - (C_{4h}^5)$ with 16 Ni in 16(i):

$\underline{x} = 0.116_0$; $\underline{y} = 0.182_2$; $\underline{z} = 0.248$; 8 Ni in 8(h): $\underline{x} = 0.368$;
$y = 0.060$; 8 P in 8(h): $x = 0.195$; $y = 0.415$; and 2 P in
$2(\underline{a})$. A comparison of $Ni_{12}P_5$ with related structures
is made. Some phase-analytical observations in the
Ni-P system are reported. NiP_3 is cubic, $\underline{a} = 7.819$ A;
and isostructural with CoP_3. $\underline{a} = 7.706$ A. Both NiP_3
and CoP_3 belong to the $\underline{D}2$ ($CoAs_3$) structure type.
(Contractor's abstract)

2126

Uppsala U. Inst. of Chemistry (Sweden).

RESEARCH ON METALLIC PHASES IN SYSTEMS OF
TRANSITION METALS WITH NON-METALS, by G.
Hagg. Annual technical summary rept. no. 1, Dec. 31,
1958, 6p. incl. tables. (AFOSR-TN-59-225) (AF 61-
(052)40) AD 211607; PB 139572   Unclassified

Investigations were made of metallic phases formed in
systems of the 8th group metals with B, Si, and P. The
investigations included the determination of the compo-
sitions and equilibria of binary and ternary phases as
well as studies of their crystal structures. In the Ni-B
system, 2 phases with compositions close to Ni_4B_3
were prepared. The 2-phase regions $Ni_2B-\alpha-Ni_4B_3$
and $\beta-Ni_4B_3-NiB$ existed between $800°$ and $1000°C$.
The existence of Rh_7B_3, isostructural with RuB_3 and
with Hexagonal unit cell dimensions, was noted in in-
vestigations of the Rh-B system. The crystal structure
of Ru_2Si was determined. Rh_2Si was found to be iso-
structural with Ru_2Si. The crystal structure of Fe_2P,
Mn_2P, and Ni_2P were reexamined. The Fe-P-B ternary
system was studied by x-ray methods. B substituted
for P to a large extent in Fe_2P and Fe_3P, but no exten-
sion of the homogeneity ranges of Fe_2B and FeB was de-
tected. Two ternary phases of Fe_5PB_2 and $Fe_3B_xP_{1-x}$
were found. The Co-B-P and the Mn-B-P systems were
similar to the Fe-B-P system. In the Co-B-P system,
ternary phases isostructural with Fe_3P and with
$Fe_3B_xP_{1-x}$ $(0.5 < x < 1)$ were noted. (ASTIA abstract)

2127

Uppsala U. Inst. of Chemistry (Sweden).

BORIDES AND SILICIDES OF THE PLATINUM METALS,
by B. Aronsson, J. Aselius, and E. Stenberg. July 3,
1959 [5]p. incl. table. (Technical note no. 5) (AFOSR-
TN-59-414) (AF 61(052)40) AD 214561; PB 142971
                                        Unclassified

Also published in Nature, v. 183: 1318-1319, May 9, 1959.

X-ray crystallographic studies of Pt metal borides were initiated. Three structure types, tentatively notated as Ru_7B_3-, RhB-, and IrB_{1-2}, were determined. Evidence indicated that the Rh_2B phase with C 23 structure reported by Mooney and Welch (Acta Cryst., v. 7: 49, 1954) might have been Rh_2Si. The alloys were prepared by melting mixtures of the elements (99.7 to 99.8%) in an arc furnace. Crystal structures were determined with single crystal methods while the lattice parameters were obtained from powder photographs. The Ru_7B_3 structure was hexagonal; the space group was P 6_3 m c with 2 formula units in the unit cell. The most probable space group of the RhB orthorhombic structure is C m c m. The 4 Rh atoms of the unit cell are situated in 4(c) with y = 0.167. The B atoms occupy the 4(b) position. The final R-value of the 45 observed 0 k l reflexions was 8.9%. The space group for the IrB_{1-2} structure is I $4_1/$a m d with 4 Ir atoms in 4(a). An R-value of 9% was obtained for the 30 observed h 0 l reflexions with sin $\theta/x > 0.8$. Intermediate phases of the C 23 type were found to exist in the Ru-Si and Rh-Si systems.

2128

Uppsala U. Inst. of Chemistry (Sweden).

AN X-RAY INVESTIGATION OF THE NICKEL-BORON SYSTEM. THE CRYSTAL STRUCTURES OF ORTHORHOMBIC AND MONOCLINIC Ni_4B_3, by S. Rundqvist. Mar. 14, 1959 [24]p. incl. diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-59-415) (AF 61(052)40) AD 214562   Unclassified

Also published in Acta Chem. Scand., v. 13: 1193-1208, 1959.

The Ni-B system was investigated with x-ray powder and single-crystal methods in the range Ni_3B-NiB. In addition to the previously known intermediate phases, Ni_3B, Ni_2B and NiB, the existence of 2 other phases, both with the ideal compositions Ni_4B_3 but one orthorhombic and the other monoclinic, was established. The crystal structures of the 2 new phases were determined and refined from single-crystal intensity data. The space group of orthorhombic Ni_4B_3 is P n m a; the unit cell contains 16 nickel atoms and 12 boron atoms situated in 4(c) positions. Two-thirds of the boron atoms form infinite zig-zag chains, while one-third have no close boron contacts. There are probably boron vacancies in the structure. The space group of monoclinic Ni_4B_3 is C 2/c. Sixteen nickel atoms are situated in two 8(f) positions, 8 boron atoms in one

8(f) position and 4 boron atoms in one 4(e) position. All boron atoms are connected in infinite chains. (Contractor's abstract)

2129

Uppsala U. Inst. of Chemistry (Sweden).

AN X-RAY STUDY OF PHOSPHIDES OF THE PLATINUM METALS, by S. Rundqvist. July 29, 1959, 4p. incl. table, refs. (Technical note no. 7) (AFOSR-TN-59-656) (AF 61(052)40) AD 226385; PB 143919   Unclassified

Some phosphides of the platinum metals have been investigated with x-ray powder methods. The earlier crystal structure determinations of Rh_2P, IrP and PtP_2 have been confirmed, and the unit cell dimensions redetermined. In addition, the unit cell dimensions and crystal structure types have been determined for Ru_2P, RuP, RuP_2, OsP_2, RhP_3, IrP_3 and PdP_3. Ru_2P belongs to the C 23 (anti-$PbCl_2$) type; RuP to the B 31 (MnP) type; RuP_2 and OsP_2 to the C 18 (marcasite) type; RhP_3, IrP_3 and PdP_3 to the D 2 (skutterdite) type. (ASTIA abstract)

2130

Uppsala U. Inst. of Chemistry (Sweden).

BORIDES OF RHENIUM AND THE PLATINUM METALS. THE CRYSTAL STRUCTURE OF Re_7B_3, ReB, Rh_7B_3, $RhB_{\sim1.1}$, $IrB_{\sim1.1}$ AND PtB, by B. Aronsson, E. Stenberg, and J. Aselius. Dec. 15, 1959 [19]p. incl. tables, refs. (Technical note no. 8) (AFOSR-TN-59-1138) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)40 and Swedish Technical Science Research Council) AD 233272; PB 145866   Unclassified

Also published in Acta Chem. Scand., v. 14: 733-741, 1960.

Some features of the binary systems of B with Rh and the Pt metals are reported. Re_7B_3 and Rh_7B_3 are isomorphous with Ru_7B_3 (Th_7Fe_3 (D10_2)-type). The structure of ReB_3 is closely related to those of Mo_2B_5 and W_2B_5. $RhB_{\sim1.1}$ and PtB crystallize in the anti-NiAs structure, and a phase with the approximate composition $IrB_{\sim1.1}$ is isomorphous with $ThSi_2$ (C_c- type. (Contractor's abstract)

2131

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF Pd_3Si, by B.

Aronsson and A. Nylund. Jan. 7, 1960 [15]p. incl.
tables, refs. (Technical note no. 9) (AFOSR-TN-59-
1269) (Sponsored jointly by Air Force Office of Sci-
entific Research under AF 61(052)40 and Swedish Tech-
nical Science Research Council) AD 233277; PB 146129
Unclassified

Also published in Acta Chem. Scand., v. 14: 1011-1018,
1960.

The crystal structure of Pd_3Si was established from
single crystal data. The space-group is Pnma, and
there are 4 formula units in the elementary cell which
has the dimensions a = 5.735A, b = 7.555A, and c =
5.260A. The 12 palladium atoms are situated in 8 (d)
(x = 0.1810, y = 0.0508, z = 0.3217) and 4 (c) (x =
0.0053, z = 0.9036) positions, and the silicon atoms oc-
cupy a 4 (c) position (x = 0.897_6, z = 0.469_6). Pd_3Si,
thus, crystallizes in the cementite ($\underline{D}O_{11}$) structure.
The atomic arrangement in Pd_3Si is compared with
those in isomorphous phases. (Contractor's abstract)

2132

Uppsala U. inst. of Chemistry (Sweden).

X-RAY INVESTIGATION ON RHODIUM PHOSPHIDES.
THE CRYSTAL STRUCTURE OF Rh_4P_3, by S.

Rundqvist and A. Hede. Jan. 9, 1960 [17]p. incl. diagrs.
tables, refs. (Technical note no. 10) (AFOSR-TN-
59-1270) (AF 61(052)40) AD 233278; PB 145860
Unclassified

Also published in Acta Chem. Scand., v. 14: 893-902,
1960.

The rhodium-phosphorus system was investigated in
the range 0-75 atom % phosphorus using x-ray and
chemical analytical methods. Four intermediate
phases were found, viz. Rh_2P, Rh_4P_3, RhP_2 and RhP_3.
The structure of Rh_2P is of the anti-fluorite ($\underline{C}$ 1) type,
a = 5.498A, and RhP_3 of the skutterudite ($\underline{D}$ 2) type,
a = 7.996A. The crystal structure of Rh_4P_3 was de-
termined and refined by single-crystal x-ray meth-
ods. The space group is Pnma, a = 11.662A; b =
3.317A; c = 9.994A, and the unit cell contains 16 rho-
dium atoms and 12 phosphorus atoms on seven 4(c)
positions. The structure is related to the Fe_2P ($\underline{C}$ 22)
and Co_2P ($\underline{C}$ 23) structures. (Contractor's abstract)

2133

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF Re_3B, by B.

Aronsson, M. Bäckman, and S. Rundqvist. Jan. 22,
1960 [9]p. incl. diagr. tables. (Technical note no. 11)
(AFOSR-TN-59-1290) (Sponsored jointly by Air Force
Office of Scientific Research under AF 61(052)40 and
Swedish Technical Science Research Council)
AD 233279; PB 145859 Unclassified

Also published in Acta Chem. Scand., v. 14: 1001-1005,
1960.

The crystal structure of Re_3B was determined by pow-
der and single crystal methods. The dimensions of the
orthorhombic unit cell are a = 2.890A, b = 9.313A and
c = 7.258A (±0.05%). There are 4 formula units in the
elementary cell, and the space-group is Cmcm. The
12 rhenium atoms are situated in an eightfold position
8(t)(y = 0.1345, z = 0.0620) and a fourfold position
4(c)(y = 0.4262). From space considerations it was
concluded that the boron atoms are also situated in a
4(c) position (y ~ 0.744). (Contractor's abstract)

2134

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF $SeOCl_2 \cdot 2C_5H_5N$, by

G. Nahringbauer and I. Lindqvist. Dec. 20, 1958 [17]p.
incl. diagrs. tables, refs. (Technical note no. 2)
(AFOSR-TN-59-64) (AF 61(052)43) AD 209608;
PB 139710 Unclassified

Also published in Acta Cryst., v. 12: 638-642, Sept.
10, 1959.

The crystal structure of the addition compound
$SeOCl_2 \cdot 2C_5H_5N$ has been determined and refined using
3-dimensional x-ray data. The crystal consists of
molecules in which the coordination polyhedron around
the central selenium atom is a tetragonal pyramid.
The 2 chlorine atoms and the 2 nitrogen atoms of the
pyridine rings are bonded in the basal plane with atoms
of the same kind in trans positions. The oxygen atom
occupies the apex of the pyramid. The molecules
show a certain tendency to secondary dimerization over
weak chlorine bridges. The bridging chlorine atom
completes the distorted octahedron around the central
selenium at a distance of 3.64A. The nature of the
chemical bonds and the problem of chloride ion trans-
fer processes in solutions of pyridine in selenium oxy-
chloride are briefly discussed. (Contractor's abstract)

2135

Uppsala U. [Inst. of Chemistry] (Sweden).

ADDITION COMPOUNDS OF ANTIMONY CHLORIDES
WITH SULFOXIDES AND SULFONES, by I. Lindqvist.
Oct. 20, 1958 [11]p. incl. diagrs. (Technical note no. 1)
(AFOSR-TN-59-116) (AF 61(052)43) AD 210421;
PB 133712   Unclassified

Also published in Acta Chem. Scand., v. 13: 420-424,
1959.

The liquidus curves have been studied for the systems
$SbCl_5-SO(CH_3)_2$, $SbCl_5-SO_2(CH_3)_2$, $SbCl_3-SO(CH_3)_2$
and $SbCl_3-SO_2(CH_3)_2$. The following new compounds
have been prepared: $SbCl_5 \cdot SO(CH_3)_2$, $SbCl_5 \cdot SO(C_6H_5)_2$,
$SbCl_5 \cdot SO_2(CH_3)_2$, $SbCl_5 \cdot SO_2(C_6H_5)_2$, $SbCl_3 \cdot SO(CH_3)_2$
and $SbCl_3 \cdot SO_2(CH_3)_2$. The melting point relations be-
tween these compounds are discussed. (Contractor's
abstract)

2136

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF $SbCl_5 \cdot POCl_3$, by I.
Lindqvist and C.-I. Bränden. Jan. 12, 1959 [13]p. incl.
diagrs. tables, refs. (Technical note no. 3) (AFOSR-
TN-59-154) (AF 61(052)43) AD 211114; PB 140399
                    Unclassified

Also published in Acta Cryst., v. 12: 642-645, Sept. 10,
1959.

The crystal structure of $SbCl_5 \cdot POCl_3$ has been deter-
mined from 3-dimensional x-ray data. This is the first
structure determination of an addition compound with
an oxychloride functioning as donor molecule. The
structure is built up of discrete $SbCl_5 \cdot POCl_3$ mole-
cules. The coordination around Sb is octahedral with
an O atom from $POCl_3$ in the 6th corner. The approx-
imately tetrahedral structure of $POCl_3$ is preserved.
The bond angle Sb-O-P is 143.7°. The structure is
briefly discussed. (Contractor's abstract)

2137

Uppsala U. Inst. of Chemistry (Sweden).

ADDITION COMPOUNDS OF PHOSPHINE OXIDES, by
I. Lindqvist and G. Olofsson. July 17, 1959 [10]p. incl.
diagrs. refs. (Technical note no. 4) (AFOSR-TN-59-
574) (AF 61(052)43) AD 217021; PB 145620
                    Unclassified

Also published in Acta Chem. Scand., v. 13: 1753-
1757, 1959.

The formation of addition compounds with phosphine
oxides as donor molecules has been studied. The
following new compounds have been prepared:
$SbCl_5 \cdot PO(C_6H_5)_3$, $SbCl_5 \cdot PO(CH_3)_3$, $SbCl_3 \cdot PO(CH_3)_3$,
$SbCl_3 \cdot 2PO(CH_3)_3$, $AsCl_3 \cdot PO(CH_3)_3$, $AsCl_5 \cdot PO(CH_3)_3$,
(stabilization of $AsCl_5$), $SeCCl_2 \cdot PO(CH_3)_3$,
$HgCl_2 \cdot PO(C_6H_5)_3$, $HgCl_2 \cdot PO(CH_3)_3$, $3HgCl_2 \cdot 2PO(CH_3)_3$,
and $SO_3 \cdot PO(C_6H_5)_3$. The weak interaction between
$HgCl_2$ and $PO(C_6H_5)_3$ has been revealed by a study of
the infrared spectra of the compounds $HgCl_2 \cdot PO(C_6H_5)_3$.
(Contractor's abstract)

2138

Uppsala U. Inst. of Chemistry (Sweden).

ADDITION COMPOUNDS OF DIPHOSPHORUS TRI-
OXIDE TETRACHLORIDE, by I. Lindqvist, M.
Zackrisson, and S. Eriksson. July 17, 1959 [5]p. incl.
diagrs. (Technical note no. 5) (AFOSR-TN-59-575)
(AF 61(052)43) AD 217022; PB 145619   Unclassified

The formation of addition compounds with diphospho-
rous trioxide tetrachloride as donor molecule has been
studied. The following new compounds have been pre-
pared: $2SbCl_5 \cdot P_2O_3Cl_4$ and $SnCl_4 \cdot P_2O_3Cl_4$, and their
infrared spectra have been recorded. (Contractor's
abstract)

2139

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF $(TiCl_4 \cdot POCl_3)_2$, by
C.-I. Bränden and I. Lindqvist. Aug. 20, 1959 [12]p.
incl. diagr. tables, refs. (Technical note no. 7)
(AFOSR-TN-59-722) (AF 61(052)43) AD 226387;
PB 143918   Unclassified

Also published in Acta Chem. Scand., v. 14: 726-732,
1960.

The crystal structure of $(TiCl_4 \cdot POCl_3)_2$ was deter-
mined from 3-dimensional x-ray data. The structure
is built up of dimeric molecules $(TiCl_4 \cdot POCl_3)_2$ with
double chlorine-bridges between the 2 titanium atoms
of the dimer. The coordination around the titanium
atom is octahedral. The oxygen atom in $POCl_3$ func-
tions as donor atom. The approximately tetrahedral
structure of $POCl_3$ is preserved. The nature of the
acceptor-donor interaction in addition compounds where
oxychlorides function as donor molecules is discussed.
(Contractor's abstract)

2140

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF $SnCl_4 \cdot 2SeOCl_2$, by

Y. Hermodsson. Aug. 20, 1959 [14]p. incl. diagrs.
tables, refs. (Technical note no. 6) (AFOSR-TN-59-
723) (AF 61(052)43) AD 226386; PB 143636

Unclassified

Also published in Acta Cryst., v. 13: 656-659, 1960.

The crystal structure of the addition compound
$SnCl_4 \cdot 2SeOCl_2$ has been determined and refined from

3-dimensional x-ray data. The unit-cell dimensions
are a = 9.24 ± 0.03A; b = 9.24 ± 0.03A; c = 16.26 ±
0.03A:, β = 95°34 ± 10. There are 4 molecules per unit
cell and the space group is C2/c. The crystal consists
of discrete $SnCl_4 \cdot 2SeOCl_2$ molecules. The tin atom is

situated on a twofold axis, surrounded by a distorted
octahedron of 2 oxygen atoms in cis-position and of 4
chlorine atoms. The oxygen atoms form bridges be-
tween the tin and the selenium atoms. The $SeOCl_2$-

parts of the molecules are pyramid-shaped. The angle
Sn-O-Se is 121.5°. A tendency to secondary acceptor-
donor interaction within and between the adduct mole-
cules can be recognized from the interatomic distances.
A distorted octahedral coordination around the seleni-
um atom is obtained, if all nearest neighbors are con-
sidered. In this compound selenium oxychloride acts
as a donor as well as an acceptor molecule, although
the donor action is predominant. (Contractor's
abstract)

2141

Uppsala U. Inst. of Physics (Sweden).

A MICROSCOPE FOR THE SCANNING OF NUCLEAR
RESEARCH EMULSIONS, by A. G. Ekspong and B. E.
Ronre. [1959] [6]p. incl. illus. (AFOSR-TN-59-411)
[AF 61(052)13] AD 261902   Unclassified

A microscope which can handle rather large plates is
described. The area which can be reached without
moving the plate is 25 x 15 cm. The largest plate which
can be examined on the microscope must have one side
less than 49 cm. The use of the microscope is made
comfortable by suitably constructed manual controls.
The stage can be moved rapidly and precisely. (Con-
tractor's abstract)

2142

Uppsala U. Inst. of Physics (Sweden).

ANTIPROTON INTERACTION CROSS SECTIONS, by
A. G. Ekspong and B. E. Ronne. [1959] [32]p. incl

diagrs. tables, refs. (AFOSR-TN-59-412) (Also bound
with its AFOSR-TN-58-1077; AD 207456) [AF 61(052)-
13, phase A] AD 261903   Unclassified

Also published in Nuovo Cimento, Series X, v. 13: 27-
45, July 1, 1959.

Recently obtained antiproton events have been used to
obtain interaction cross sections from 371 events of
which 340 have been well established to be antiproton
annihilation stars. The antiprotons used are in the
energy range from 0 to 250 mev, and the events have
been analyzed in terms of: annihilation in flight, elastic
p-p scattering, elastic and inelastic scattering from
complex nuclei, and charge exchange. The mean free
path in the emulsion and the cross sections for the
various processes are presented.

2143

Uppsala U. Inst. of Physics (Sweden).

A $_\Lambda H^4$ HYPERFRAGMENT EMITTED FROM AN

ANTIPROTON CAPTURE STAR, by A. G. Ekspong, A.
Frisk, and B. E. Ronne. [1959] [8]p. incl. diagrs.
table, refs. (Technical note no. 4) (AFOSR-TN-59-
842) (Sponsored jointly by Air Force Office of Scien-
tific Research under AF 61(052)13, phase D and
Swedish Atomic Committee) AD 225322; PB 145676

Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 103-104,
July 15, 1959.

The observation of a definite case of Λ hyperon emis-
sion from an antiproton annihilation in a heavy nucleus
in nuclear emulsion is reported. The emulsion stack
was exposed to a beam of 740 mev/c antiprotons at the

Bevatron. The Λ hyperon is emitted bound in a $_\Lambda H^4$

hyperfragment. From observational data we calculate
a Λ binding energy of 2.6 ± 1.0 mev. (Contractor's
abstract)

2144

Uppsala U. Inst. of Physics (Sweden).

THE DECAY OF Au^{194}, by G. Bäckström, O. Bergman
and others. [1959] [41]p. incl. diagrs. tables, refs.
(AFOSR-524) (AF 61(052)13) AD 254466

Unclassified

Also published in Nuclear Phys., v. 15: 566-608, Mar.
1960.

The decay of Au^{104} was investigated by the use of high
resolution spectrometers for the measurements of the
conversion spectrum and a double lens spectrometer
for coincidence measurements. By careful analysis of
the conversion spectrum, which was recorded at a

resolution of $\approx 0.2\%$, it was possible to identify more than 100 transitions in Pt^{194}. The use of strong sources and a double counter operated in coincidence made possible the detection of lines of intensity only 10^{-5} times that of the strongest line. Multipolarities could be found from K/L ratios for a few low energy transitions and some information could also be extracted from a comparison with results of previous gamma ray work. Energies of the strongest lines were measured absolutely by means of an iron free double focusing instrument, and further energy determinations were made relatively to these lines. A complete set of energy sums was computed in order to survey the possibilities of cascade-crossover combinations. The reliability of the numerical relationships was investigated statistically, and it was shown that a reasonably unique level scheme could be constructed on the basis of energies, although the positions of transitions remained to some extent ambiguous. The results of 79 coincidence experiments are reported, and when analyzed these data lead to a level scheme in agreement with the conclusions of the other approach. Furthermore, these experiments helped in deciding the location of the transitions. Evidence for at least two O+ states was found. The discovery of a level at 923 kev, probably of 4+ character, revealed a close analogy with the level scheme of Pt^{192}. The interpretation of this level as a 3-phonon state is in agreement with theory. (Contractor's abstract)

2145

Uppsala U. Inst. of Physics (Sweden).

O+ STATES OF Sm^{152} AND Gd^{152}, by I. Marklund, O. Nathan, and O. B. Nielsen. [1959] 15p. incl. diagrs. tables, refs. (In cooperation with Copenhagen U. Inst. of Theoretical Physics) (AFOSR-651) (AF 61(052)13) AD 258323   Unclassified

Also published in Nuclear Phys., v. 15: 199-215, Feb. 1960.

The decay of Eu^{152m}(9.2h) is studied by means of internal and external conversion and $e^- - \gamma$ coincidence measurements with particular interest focused on the possible low-lying O+ levels in the transition region between spherical and non-spherical nuclei. Such levels are now found at 615.3 kev in the near-spherical nucleus Gd^{152} and at 685.0 kev in the strongly deformed nucleus Sm^{152}. The experimental K- conversion coefficients for the O+ → O+ transitions are > 0.770 and > 0.250, respectively. The e_k^-/γ branching ratios μ from the O+ levels to the ground states and to the 1st excited 2+ states are compared with the theoretical values: Gd^{152}: $\mu_{exp} = 0.010 \pm 0.03$, $\mu_{theory} = 0.085$; Sm^{152}: $\mu_{exp} = 0.013 \pm 0.001$, $\mu_{theory} = 0.13$. (Contractor's abstract)

2146

Uppsala U. Inst. of Physics (Sweden).

NUCLEAR MAGNETIC DIPOLE AND ELECTRIC QUADRUPOLE MOMENTS OF RADIOACTIVE BISMUTH ISOTOPES, by I. Lindgren and C. M. Johansson. [1959] [18]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force [Office of Scientific Research under AF 61-(052)13] and Swedish Atomic Committee)
Unclassified

Published in Arkiv Fysik, v. 15: 445-462, 1959.

The hyperfine structure of the neutron-deficient bismuth isotopes $Bi^{203-206}$ were studied by the atomic beam magnetic resonance method by use of 6 pole focusing and radioactive detection. The magnetic dipole moments (μ_I) are calculated from the magnetic dipole interaction constants (a) by means of the known values of (Mc/s) and μ_1 of Bi^{209} and the Fermi-Segré formula, neglecting the hfs anomaly. In order to obtain the electrical quadrupole moments (Q) from the electric quadrupole interaction constants (b), the intermediate state of bismuth was determined from the optically measured energy levels and from the known g_J-value of the ground state. The average of the inverse cube of the distance of the electrons from the nucleus, $<r^{-3}>$, was calculated from the magnetic dipole interaction in Bi^{209} and is compared with the value obtained from the spin-orbit coupling. The quadrupole moments are not corrected for the effect of distortion of the inner electron shells (Sternheimer's correction). The results are compared with theoretical values obtained from the nuclear shell model. (Contractor's abstract)

2147

Utah U. Dept. of Chemical Engineering, Salt Lake City.

IGNITION OF COMPOSITE PROPELLANTS, by A. D. Baer, N. W. Ryan, and D. L. Salt. Mar. 1959, 74p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-516) (AF 49(638)170) AD 216291   Unclassified

An investigation is made of the conditions under which aerodynamic shock will ignite composite solid rocket propellants. Four different propellants, 3 containing ammonium perchlorate and 1 containing ammonium nitrate were exposed in a shock tube to conditions behind reflected shock waves. The 3 perchlorate propellants ignited under much milder conditions when restrictor failure permitted the shock to travel down narrow channels bounded by propellant surface. All evidence gathered points to the conclusion that binder reacts with environmental oxygen, probably after some binder decomposition, the binder-oxygen reaction supplying energy to promote the later oxidant-binder reaction. It is shown that under radiation ignition,

relatively slow and carried out under atmospheric pressure, the perchlorate propellants are very similar, but under high flux ignition the perchlorate propellants are very different indeed. It is concluded that if environmental oxygen is present at a high enough partial pressure, it will burn with binder decomposition products before oxygen is available from the oxidant.

2148

Utah U. [Dept. of Electrical Engineering] Salt Lake City.

CRATERING EXPERIMENT AND THEORY, by E. P. Palmer, R. W. Grow and others. [1959] [19]p. incl. illus. diagrs. tables. (AFOSR-TN-59-1201) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)462] and Air Force Ballistic Missile Division) Unclassified

Published in Proc. Fourth Symposium on Hypervelocity Impact, Eglin Air Force Base, Fla., (Apr. 26-28, 1960), Eglin, Air Proving Ground Center, Sept. 1960, paper no. 13. (APGC-TR-60-39 (I).

In order to determine the importance of various target and projectile characteristics in cratering produced by high-velocity impact, experiments were carried out in which target and projectile materials were systematically varied. In 1 series of experiments, steel spheres were impacted upon targets of copper, lead, aluminum, magnesium, zinc, silver, and steel. In another series, projectiles of nylon, K-monel metal, pyrex glass, stainless steel types 302 and 440, naval brass, copper, aluminum, diamond, magnesium, tungsten, high-carbon chrome steel, and lead were impacted upon lead targets. Velocities up to 2.5 km/sec were used. Crater volume was found to be directly proportional to projectile energy for all targets and projectiles. Results could be correlated by the formula $\frac{V}{E} = k \frac{\rho_p^{\frac{1}{2}}}{P_t}$ where where V = crater volume, E = projectile energy, ρ_p = projectile density, P_t = target shear strength, and k = 7.3×10^{-4} (using MKS units). A comparison is made with other theories which attempt to correlate impact phenomena by means of velocity of sound, heat of fusion, and projectile and target densities. The possibilities of checking the hydrodynamic theory of R. L. Bjork are discussed. (Contractor's abstract)

2149

Utah U. [Dept. of Electrical Engineering] Salt Lake City.

EXPERIMENTAL INVESTIGATION OF SPRAY PARTICLES PRODUCING THE IMPACT FLASH, by R. W. Gray, R. R. Kadesch and others. [1959] [14]p. incl. illus. diagrs. tables. (AFOSR-TN-59-1202) (AF 49-(638)462) Unclassified

Published in Proc. Fourth Symposium on Hypervelocity Impact, Eglin Air Force Base, Fla., (Apr. 26-28, 1960), Eglin, Air Proving Ground Center, Sept. 1960, paper no. 37. (APGC-TR-60-30 (III))

Spectrograph observations were made for copper projectiles impacting into copper targets in various controlled atmospheres. An atomic copper line with a 7.1 ev excitation energy was excited in an argon atmosphere so that an energy of at least this magnitude was available for the excitation of copper atoms. These results indicate that in argon, the light was produced by micron-size copper particles ejected from the target with velocities no less than 7 km/sec. A collision process between copper atoms evaporated from the heated spray particles and atoms of the argon atmosphere can account for the observed copper lines. In a medium of hydrogen, the impact flash was dimmer by at least 2 orders of magnitude with no detectable line structure. The relative velocity between copper atoms and hydrogen molecules required to produce copper lines is greater than 18 km/sec in a collision process. Experimental measurements indicate that at least 3 mechanisms contribute to the observed impact flash. These may be listed as follows: (1) atomic electron transitions, (2) thermal or black-body radiation, and (3) burning or chemical reaction. In order to verify the existence of the fine high velocity spray particles, photo tubes were set up along the path of the particles to measure their arrival time at various points along the path. The initial velocity of the spray particles was calculated from the photo tube measurements. Spray particles with initial velocities as high as 15 km/sec were observed in the impact spray from copper to copper impacts confirming the results obtained with the spectrographic observations. (Contractor's abstract)

2150

Utah U. [Dept. of Metallurgy] Salt Lake City.

MECHANISM OF CRATERING IN ULTRA-HIGH VELOCITY IMPACT, by M. A. Cook. Jan. 30, 1959 [26]p. incl. illus. diagr. tables, refs. (AFOSR-TN-59-50) (AF 18(603)100) AD 209413; PB 142679 Unclassified

Also published in Jour. Appl. Phys., v. 30: 725-735, May 1959.

The equations of the hydrodynamic theory of penetration of targets by shaped charge jets are presented first in general form. These equations are expressed in the ideal form and examined by experimental observations. Then a non-ideal theory is presented that takes into account heat losses by compression, shock heating, and radiated shock waves. The conditions for impact explosions of targets are discussed and a theory extended to cover the entire velocity range of impact from the plastic deformation threshold v_σ to well above the

impact explosion threshold v_c. Some experimental evidence relating to this more general theory is also presented. (Contractor's abstract)

2151

Utah U. [Dept. of Metallurgy] Salt Lake City.

ELECTRICAL FIELDS AND ELECTROMAGNETIC RADIATION FROM CHEMICAL EXPLOSIONS, by R. T. Keyes. Mar. 19, 1959 [54]p. incl. diagrs. table. (AFOSR-TN-59-551) (AF 18(603)100) AD 216691
Unclassified

Electrical fields and electromagnetic radiation generated by chemical detonations of charges ranging in size from 10 g to roughly 25 kg were investigated over a frequency range extending from a few cps to 500 mcps. The electrical energy in all cases was found to cover a broad band of frequencies with the largest potentials occurring in a frequency range below a few hundred cps. Little of the low frequency signals were radiated. Megacycle range signals (predominately radiation) were found to occur in the form of short random bursts. A nonreproducible delay the order of several hundred μsec was found to exist between the time of detonation and the appearance of the first bursts of radiation. The electrical potentials of the expanding explosion products were estimated, and for a 552 g 50/50 pentolite charge the maximum value was determined to be 18,000 v. For bare charges this quantity was considered to vary roughly in direct proportion to the charge weight. Experiments are described which were performed to ascertain the mechanism whereby the electrical fields and EM radiation are generated by chemical detonations, and a model is proposed.

2152

Utah U. [Dept. of Metallurgy] Salt Lake City.

RECOMBINATION SHOCK IN DETONATION-GENERATED PLASMAS, by M. A. Cook and R. T. Keyes. [1959] [5]p. incl. illus. (AFOSR-TN-59-1285) (AF 18(603)100)
Unclassified

Properties of detonation-generated (d-g) plasmas are discussed, and the results previously analyzed are recapitulated. It is pointed out that the d-g plasmas have high cohesion attributed to a quasi-lattice, metallic-like structure in which the cohesive energy ϵ_c is comparable in magnitude to the ionization potential 1 for the product gases in a vacuum. The external d-g plasmas have a lower density and thus lower ϵ_c, yet remain metastable as long as ϵ_c is appreciably greater than kT. At low ϵ_c they decay by thermal agitation, or they explode at higher ϵ_c if their structure is suddenly upset. A μsec/frame sequence of an external d-g plasma with

the associated shock pattern shows that the jet propulsion in the d-g plasma is the cause of its quick separation from the main detonation products and its propagation at superdetonation speed.

2153

Utah U. [Inst. for the Study of Rate Processes] Salt Lake City.

KINETICS OF THE STEAM-CARBON REACTION, by G. Blyholder and H. Eyring. [1959] [4]p. incl. diagrs. (AF 33(038)20839)
Unclassified

Published in Jour. Phys. Chem., v. 63: 693-696, May 1959.

The data for the steam-graphite reaction from 900 to 1300° and in the 5 to 100 μ pressure range are presented as a function of both pressure and temperature. The rate-determining processes are the adsorption of water vapor and the desorption of molecular hydrogen from the surface. Absolute rate theory calculations lead to the conclusion that the adsorbed species have a limited mobility upon the surface. (Contractor's abstract)

2154

Utah U. [Inst. for the Study of Rate Processes] Salt Lake City.

KINETICS OF GRAPHITE OXIDATION. II, by G. Blyholder and H. Eyring. [1959] [5]p. incl. diagrs. tables. (AF 33(038)20839)
Unclassified

Published in Jour. Phys. Chem., v. 63: 1004-1008, June 1959.

The kinetics of the oxygen-graphite reaction in the 800 to 1300° temperature range and 1 to 100 μ pressure range are investigated. Above 1000° the true surface reaction is half order with respect to oxygen and the activation energy is small. The effect of the diffusion of oxygen into the pores of the graphite sample is elucidated. Absolute rate theory together with the observed kinetics is used to develop a mechanism for the reaction. (Contractor's abstract)

2155

Utah U. [Inst. for the Study of Rate Processes] Salt Lake City.

A SENSITIVITY TEST FOR KINETIC DATA, by J. R. Morrey and G. R. Hill. Mar. 31, 1958, 12p. incl. diagrs. tables. (Technical rept. no. 2) (AFOSR-TN-59-1) (AF 49(638)28) AD 208181
Unclassified

A simple test for the sensitivity of kinetic data is presented. Some conclusions that are derived are as follows: (a) unless the dimensionless quantity Φ_n (t) is

greater than a critical value, the rate data are too insensitive to be of any value in determining a reaction order; (b) if a 1st order plot is made with data whose $|\Phi|$ is less than the critical value, then the mechanism may or may not be first order: (c) it is possible to determine whether an order is changing with time or whether the non-variant order has

not been correctly determined by applying the test to any seemingly linear section of an order plot; (d) in the case that planning an experiment form which one can obtain a sensitive rate plot is inconvenient or impossible, order is often obtained by measuring initial rates and determining their dependence on initial concentration.

2156

Virginia Inst. for Scientific Research, Richmond.

THE EFFECT OF FOREIGN METALS ON THE
CORROSION OF TITANIUM IN BOILING 2M HYDRO-
CHLORIC ACID, by W. R. Buck, III, B. Sloope, and H.
Leidheiser, Jr. Dec. 22, 1958 [54]p. incl. diagrs. tables.
(AFOSR-TR-59-5, pt. 1) (AF 18(600)1319) AD 208758;
PB 139592   Unclassified

Abstract also published in Virginia Jour. Sci., v. 10:
265, Sept. 1959.

Also published in Corrosion, v. 15: 26-30, Nov. 1959.

The rate of corrosion of titanium was determined in
boiling 2M HCl when contacted to aluminum, cadmium,
tin, zirconium, lead, bismuth, mercury, silver, copper,
antimony, vanadium, 70:30, 50:50, and 30:70 copper-
nickel alloys, iron, palladium, cobalt, nickel, gold, rho-
dium, platinum, and iridium. Less extensive corrosion
measurements of the same type were also made in 0.6
and 2M H_2SO_4. The potentials of the couple and of the
two members of the couple were determined in boiling
2M HCl for 20 of the systems studied. A plot of the
corrosion rate vs the couple potential yielded a polariza-
tion curve which was similar to the anodic polarization
curve for titanium with an impressed voltage. The
curve exhibited a maximum in corrosion rate at a cou-
ple potential of -0.49 volt vs the saturated calomel
electrode. The potential of titanium in boiling 2M HCl
was also determined as a function of concentration of
the following metallic cations in the acid: copper, sil-
ver, antimony, nickel, gold, palladium, rhodium, plati-
num, and iridium. The influence of the cations on the
corrosion rate was explained in relation to the polari-
zation curve. (Contractor's abstract)

2157

Virginia U. Dept. of Chemistry, Charlottesville.

HIGH TEMPERATURE ANTIOXIDANTS FOR SYN-
THETIC FLUIDS, by J. W. Cole, Jr. Jan. 1959 [11]p.
incl. refs. (AFOSR-TN-59-149) (AF 13(603)103)
AD 210983   Unclassified

Presented at meeting of the Chem. Marketing and Econ.
Div. of the Amer. Chem. Soc., Chicago, Ill., Sept. 7-
12, 1958.

Abstract published in 134th meeting of the Amer. Chem.
Soc. Abstracts of Papers, 1958, p. 4-H.

Studies were made (1) to evaluate antioxidants for pos-
sible use at 400°F and above in synthetic fluids, (2) to
synthesize likely antioxidants related to phenothiazine
(thiodiphenylamine) and other promising types, and
(3) to study modes and mechanisms of antioxidant ac-
tion at elevated temperatures. Over 400 different com-
pounds, representing a broad spectrum of additives,

were examined in selected combinations with about 20
synthetic fluids. The types of fluid included ester fluids,
silicates, silicones, silanes, phosphates, and mineral
oil. About 50 derivatives of phenothiazine were syn-
thesized and characterized, most of which were evalu-
ated as antioxidants. The ring-substituted derivatives
of phenothiazine showed varying degrees of antioxidant
activity. The oxidation behavior of blended fluids was
examined in the presence of metals such as Cu, Ag,
Mg, and alloys of Fe, and Ti. Some metals, like Cu,
appeared to help generate antioxidant species, es-
pecially with amines. Atoms of N, S, and Se are im-
portant elements in antioxidants when located in stra-
tegic positions in the molecule.

2158

Virginia U. Dept. of Mathematics, Charlottesville.

ON THE CONSTRUCTION OF PERIODIC MAPS
WITHOUT FIXED POINTS, by P. E. Conner and E. E.
Floyd. Oct. 1958, 14p. (Technical note no. 9) (AFOSR-
TN-59-81) (AF 49(638)72) AD 210141; PB 140238
                                               Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 354-
360, June 1959.

The existence problem for fixed points of periodic maps
where the period is not a prime power is considered.
Proof is given of the theorem: If r is a positive integer
greater than one which is not a prime power, then there
exists a compact, finite dimensional space X with trivi-
al integral Čech cohomology groups and a map T:X → X
of period r which is without fixed points. If r is de-
scribed as above, then there exists a contractible mani-
fold M and a map T:M → M of period r and without fixed
points.

2159

Virginia U. Dept. of Mathematics, Charlottesville.

OPEN MAPPINGS ON 2-DIMENSIONAL MANIFOLDS,
by G. T. Whyburn. June 1959, 30p. (Technical note
no. 10) (AFOSR-TN-59-581) (AF 49(638)72)
AD 217028; PB 142732   Unclassified

Also published in Jour. Math. and Mech., v. 10: 181-
197, Jan. 1961.

A new localization theorem is presented for light open
mappings in a general setting. This can be and is ap-
plied to obtain the scattered inverse property in a new
way dependent on a reduction-to-boundary method.
This localization theorem makes possible the develop-
ment of results without making use of the scattered in-
verse theorem. As the development proceeds, the scat-
tered inverse theorem itself emerges as a direct con-
sequence of much stronger conclusions concerning local
action of the mapping. (Contractor's abstract)

2160

Virginia U. Dept. of Mathematics, Charlottesville.

MAPPING NORMS, by G. T. Whyburn. July 1959, 12p. (Technical note no. 13) (AFOSR-TN-59-725) (AF 49-(638)72) AD 220353; PB 143506   Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 1431-1436, Sept. 1959.

Certain cases are analyzed of the following general question: for a given metric space X and class T of mappings, under what conditions does there exist a positive constant d(X, T) such that any mapping of the class T operating on X as its domain is necessarily of norm $\geq$ d(X, T)? Results pertain largely with cases in which the spaces X are simple closed curves and the mappings are non-topological open mappings. Application is made to the case where X is an arbitrary 2-dimensional manifold. Proofs for the main theorems are sketched and are complete only for the cases of circles, although the statements are made in their full generality. (Contractor's abstract, modified)

2161

Virginia U. Dept. of Mathematics, Charlottesville.

TRANSFORMATION GROUPS ON A $K(\pi,1)$ [I], by P. E. Conner and D. Montgomery. June 1959, 15p. (Technical note no. 11) (AFOSR-TN-59-733) (AF 49(638)72) AD 220354; PB 143161   Unclassified

Also published in Michigan Math. Jour., v. 6: 405-412, 1959.

Some results are given on transformation groups and fiberings for a finite dimensional Eilenberg-MacLane space $K(\pi,1)$. The eventual developing of extensive relations between homotopy groups and cyclic transformations is desired. If a finite dimensional $K = K(\pi,1)$ is fibered by a connected fiber F with base B, then F is a $K(\pi_1, (F), 1)$ and B is a $K(\pi_2, (B), 1)$. The result concerns those compact manifolds which are aspherical. If a compact connected Lie group acts effectively on such a manifold, the group is shown to be a toral group. If π is abelian, there is a cross-section in the large. The action might then be called a product action. (ASTIA abstract)

2162

Virginia U. Dept. of Mathematics, Charlottesville.

THE ABSOLUTE CONTINUITY OF TOEPLITZ'S MATRICES, by M. Rosenblum. July 1959, 14p. (Technical note no. 14) (AFOSR-TN-59-745) (AF 49(638)-72) AD 220355, PB 143160   Unclassified

Also published in Pacific Jour. Math., v. 10: 987-996, 1960.

If W is real-valued and semi-bounded, T_o defines a semi-bounded symmetric operator in ι^2, whose Friedrichs extension is the Toeplitz operator T(W). The following theorems are proved (1) T(W) is absolutely continuous (that is, the associated spectral measure is Lebesgue absolutely continuous). (2) If W is even and $\Sigma n_{|}w_{n|} < \infty$, then T(W) is unitarily equivalent to the multiplication operator f $\to$ Wf on a subspace $L^2(A)$ where A is a suitable subset of $(0,\pi)$. In the proof of (1) a dependence on the Aronszajn-Donoghue theory of exponential representations of holomorphic functions is shown while for (2) a theorem of the reviewer on perturbation of continuous spectra is used.

2163

Virginia U. [Dept. of Mathematics] Charlottesville.

LINEAR OPERATOR EQUATIONS, by G. Lumer and M. Rosenblum. [1959] [10]p. (AF 49(638)72)
Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 32-41, Feb. 1959.

Similarities are discussed between the present work and papers by Y. L. Laleckii (Uspehi Mat. Nauk, v. 14: 165-168, 1959) and M. Rosenblum (Duke Math. Jour., v. 23: 263-269, 1956). It is pointed out that this paper is more general than that by Daleckii in replacing $P(a,b) = \Sigma^n_{j,k=0} c_{jk}(a_1)^j(b_r)^k$ by $\Sigma^n_{j=1} {}_j a_1 {}_j b_r$ for ${}_j a)$ an arbitrary set of commuting elements of R and likewise for ${}_j b\}$. It is less general, when it considers the special case where the ${}_j a$ are powers of a single "a" and the ${}_j b$ of a single "b", in restricting $\Phi(\lambda,\mu)$ to be of the form $\Sigma^n_{j=1} f_j(\lambda)g_j(\mu)$ with f_j and g_j separately analytic in appropriate domains. With these changes the main results in the two papers are essentially identical. (Math. Rev. abstract)

2164

Virginia U. Dept. of Mathematics, Charlottesville.

TRANSFORMATION GROUPS ON A $K(\pi,1)$, II, by P. E. Conner. [1959] [5]p. [AF 49(638)72]   Unclassified

Published in Michigan Math. Jour., v. 6: 413-417, 1959.

A study is presented on a finite-dimensional $K(\pi,1)$ by methods introduced in a recent study (item no. 2161). Let $(T,(K,x))$ be an involution on K with a fixed base point x, and let T_* be the automorphism of $\pi_1(K,x) = \pi$ induced by T. Let C $= \{\sigma | \sigma \in \pi, T_*(\sigma) = \sigma^{-1}\}$

and define $\sigma_1 \sim \sigma_2$ for $\sigma_1, \sigma_2 \in C$ if there is a $\sigma \in C$ such that $T_* (\sigma)\sigma_1 = \sigma_2\sigma$. $\hat{C}$ denotes the set of equivalence classes of C. Let $H(\sigma) = \{\sigma_1 | \sigma_1 \in \pi, T_* (\sigma_1) = \sigma\sigma_1\sigma^{-1}\}$. It is proven that the components F_c of the fixed-point set F are in one-to-one correspondence with elements of C; and for every F_c, there is an element $\sigma \in C$ such that $H^i(F_c; Z_2) \sim H^i(H(\sigma); Z_2)$. As examples the results apply to a free abelian group π of rank n, and also apply to a question raised by R. H. Fox, about the type of knot which can be imbedded in S^3 in such a way that it is invariant under some involution of the sphere. (Math. Rev. abstract modified)

2165

Virginia U. [Dept. of Physics] Charlottesville.

FAST NEUTRONS FROM TANTALUM AND GOLD, by L. B. Aull, G. C. Reinhardt, and W. D. Whitehead. [1959] [8]p. incl. diagrs. table, refs. (AFOSR-TN-59-666) (AF 49(638)176)   Unclassified

Abstract published in Virginia Jour. Sci., v. 10: 244, Sept. 1959.

Also published in Nuclear Phys., v. 13: 292-299, Oct. 1959.

The photonuclear cross sections for the production of neutrons with energies greater than the $Si^{28}(n,p)Al^{28}$ threshold have been determined for tantalum and gold from a maximum bremsstrahlung energy of 18 to 65 mev. The integrated cross section to 65 mev is about 800 mev · mb for tantalum and 700 mev · mb for gold. The fast neutron integrated cross section is compared with total neutron production cross section at several energies and is about 10% at all energies. (Contractor's abstract)

2166

Virginia U. [Dept. of Physics] Charlottesville.

PHOTONEUTRON CROSS SECTIONS OF Li, N, AND A, by R. W. Fast, P. A. Fluornoy and others. [1960] [5]p. incl. illus. diagrs. table, refs. (AFOSR-TN-59-1172) [AF 49(638)176]   Unclassified

Published in Phys. Rev., v. 118: 535-539, Apr. 15, 1960.

Using a Halpern-type photoneutron detection system, the photoneutron yields from Li, N^{14}, and A^{40} have been measured as a function of the maximum bremsstrahlung energy from threshold to approximately 50 mev. The method of Penfold and Leiss was used to extract from the yield curves the total neutron cross

section: $\sigma_T = \sigma(\gamma,n) + \sigma(\gamma,pn) + 2\sigma(\gamma,2n) + \cdots$. The results are compared with previous findings of other laboratories. No gross structure was detected in the lithium cross section in the giant resonance region. The data indicate that lithium has a high-energy tail on the cross section of considerable magnitude.

2167

Virginia U. [Dept. of Physics] Charlottesville.

PHOTONEUTRONS FROM LITHIUM AND NITROGEN (Abstract), by P. A. Flournoy, R. S. Tickle and others. [1959] [1]p. [AF 49(638)176]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 257, Apr. 30, 1959.

The cross section for photoneutron production has been determined for lithium and nitrogen as a function of x-ray energy from 11 to 55 mev using the bremsstrahlung from the Virginia U. synchroton. The neutrons were detected in a Halpern type counter consisting of six BF3 counters in a moderator which was gated to count between beam pulses. The beam intensity was monitored with a NBS-type thick-walled transmission ion chamber. One 1 1/4-in.-diam stainless steel tube filled with gas to 2100 lb/cm^2 was used as a target for the nitrogen; the lithium target was natural metallic lithium encased in a thin plastic cylinder. The data were taken at 1-mev intervals in the bombarding energy, and the cross sections were extracted from the yield curve using the Leiss-Penfold matrices. The integrated cross sections determined were Li σ int (11-60 mev) 0.090 mev barn; N_2 σ int (13-55 mev) 0.165 mev barn.

2168

Virginia U. [Dept. of Physics] Charlottesville.

YIELD OF FAST PHOTONEUTRONS FROM TANTALUM AND GOLD (Abstract), by L. B. Aull, G. C. Reinhardt, and W. D. Whitehead. [1959] [1]p. [AF 49(638)176]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 257, Apr. 30, 1959.

The yield of neutrons from tantalum and gold with energies above the $Si^{28}(n,p)Al^{28}$ threshold has been determined as a function of the maximum bremsstrahlung energy from 18 to 64 mev at 1-mev intervals using the Virginia U. synchrotron. Silicon powders

packed between two thin-walled concentric plastic cylinders was used as a neutron detection. One-in.-diam cylindrical samples of the metals were mounted axially with the beam and the 2-in.-diam detector was mounted coaxially with the sample. The residual Al^{28} activity was measured with a manifold of 3 Geiger counters. The beam intensity was monitored with the Cu^{62} activity from the $Cu^{63}(\gamma,n)Cu^{62}$ reaction in thin copper disks. The normalized functions for the gold and tantalum are identical within the counting statistics of about 5% and both increase at higher energies, but this might be due to the assumptions concerning the fast neutron spectrum. The integrated cross section to 64 mev is 0.750 mev barns and at 30 mev is about 5% of the total neutron integrated cross section.

2169

Virginia U. [Dept. of Physics] Charlottesville.

PHOTO-PROTON YIELDS FROM LIGHT ELEMENTS (Abstract), by D. C. Worth and G. R. Haste. [1959] [1]p. [AF 49(638)176]   Unclassified

Presented at Thirty-seventh annual meeting of the Virginia Acad. Sci., Charlottesville, May 6-9, 1959.

Published in Virginia Jour. Sci., v. 10: 244-245, Sept. 1959.

Using high energy x-rays from the University of Virginia synchrotron, various investigators are studying "photonuclear" reactions (in which x-ray energy absorbed by a target nucleus results in emission of one or more nucleons). Photoneutrons are generally more abundant than photoprotons from medium and heavy elements, but investigation of how either type of emission varies with x-ray energy can give important information about nuclear processes involved in photo-absorption and emission. This paper outlines experiments

for the direct counting of photoprotons from several light elements (especially carbon and lithium) by means of thin scintillation crystals, and presents some preliminary results.

2170

[Vitro Corp. of America] Vitro Labs., West Orange, N. J.

THE PHYSICAL PROPERTIES OF HIGH INTENSITY ARC PLASMA (Abstract), by L. Mead, J. Cooney, and C. Sheer. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) [AF 49(638)323]   Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

This study was undertaken with a view toward developing methods of accelerating the vapor plasma from a high intensity arc for propulsion applications. The various flame parameters have been investigated (heat flux, mass flow rate, and velocity, as well as some rough measurements of temperature), particularly at low ambient pressures. In addition, methods are currently under investigation to achieve higher plasma source temperatures with the high intensity arc by attempting to achieve stable operation at considerable higher anode current densities. This is being attacked as an analogue of the confinement problem which includes the electrode-discharge boundaries as well as the conduction column. The method under study involves the use of strong magnetic fields at very low operating pressures; wherein the ratio of magnetic to gas pressure might be $\sim 10^4$. Another phase in this program is concerned with the acceleration of the high flux plasma from the high intensity arc from its natural velocity ($\sim 10^2$ ft/sec.) up to velocities useful for a plasma propulsion device ($> 10^4$ ft/sec.). Two techniques for accomplishing acceleration of the free plasma flame are discussed.

2171

Washington U. [Dept. of Mathematics] St. Louis, Mo.

ON THE EXTENSIONS OF POSITIVE DEFINITE FUNC-
TIONS, by A. Devinatz. [1959] [26]p. incl. refs.
(AF 18(600)568)   Unclassified

Published in Acta Mathematica, v. 102: 109-134, 1959.

Let G be an Abelian locally compact group, Q a sym-
metric neighborhood of the identity, and f a continuous
function defined on 2Q and positive definite on Q: for

any set (*)-- $\sum_{j=1}^{n} \sum_{k=1}^{n} \zeta_j \bar{\zeta}_k f(x_j - x_k) \geq 0$. It is possi-

ble to extend f(x) to all of G so as to retain property
(*)? The present paper shows that it is negative for
the circle group, and afiirmative for the discrete group
of integers. The problem is open, however, for
Euclidean space of any dimension. By placing addi-
tional restrictions, it can be affirmative for the (x_1, x_2)-
plane stated as follows: Let Q be the rectangle $|x_i| <$
a_i, i = 1, 2: if (i) $f(x_1, 0)$ and (ii) $f(0, x_2)$ each have unique
positive definite extensions along the x_1-axis and x_2-
axis respectively, then there is a unique non-negative
measure dF such that $f(x_1, x_2) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \exp i(x_1 t_1 + x_2 t_2) dF(t_1, t_2)$. A similar result holds for the discrete
Euclidean space. This is an exact analogue of an earli-
er theorem on the 2-parameter moment problem (see
WAS.02:022, Vol. I). The author proves also that (i)
may be replaced by (ii): there is an $\epsilon > 0$ such that the
restriction of $f(x_1, 0)$ to $(-2a_1 + \epsilon, 2a_1 - \epsilon)$ has a unique
extension. The proofs are based on: Set $g(x) = \Sigma \xi_k f(x -
x_k)$, $h(x) = \Sigma \eta_f f(x - y_j)$, $(g, h) = \Sigma_1^n \Sigma_1^m \zeta \bar{\eta}_f f(y_j - x_k)$.
Thus, a Hilbert space F of functions $g(x)$ defined on Q
is obtained. Let D_1 be the linear manifold in F such
that $\partial g(x)/\partial x_1$ exists and belongs to F, and define the
operator $A_1 g(x) = i\partial g(x)/\partial x_1$ on D_1. It is proven that
the operator A_1^* exists and has self-adjoint extension
H_1, and if dE_1 is the canonical spectral measure of H_1,
$u = (1,0)$ and $U(x_1 u) = \int_{-\infty}^{\infty} \exp (ix_1 t) dE_1(t)$, $-\infty < x_1 < \infty$,
then $U(x_1 u)g(x) = g(x + x_1 u)$ for any $g \in F$, $x + x_1 u - Q$.
Similarly are defined A_2 and $U(x_2 v)$, $v = (0,1)$. If (1)
$U(x_1 u)U(x_2 v) = U(x_2 v)U(x_1 u)$, then $F(x) =$
$(U(x_1 u)U(x_2 v)g_0, g_0)$, $g_0(x) = f(x - 0)$, provides the de-
sired extension of f to the whole plane. The main dif-
ficulty in the problem posed above is the proof of rela-
tion (1). The restrictions (i) or (ii) put on f allow this
relation to be proved by a careful examination of the
domains of the operators.

2172

Washington U. Dept. of Physics, St. Louis, Mo.

[PARAMAGNETIC RESONANCE OF FREE RADICALS]
by R. E. Norberg. Interim final rept. Oct. 1, 1958, 3p.
(AFOSR-TR-59-40) (AF 18(600)1133) AD 214509
                                         Unclassified

A summary is given on the determination of electronic
structure of free radicals by paramagnetic resonance
and studies of dynamical processes such as charge ex-
change and spin exchange. Appended to this report are
10 reprints describing the work accomplished (see
WAS.04:002-008; WAS.04:011-014, Vol. 1, for abstracts)

2173

Washington U. Dept. of Physics. St. Louis, Mo.

MOLECULAR IONS, by R. N. Varney. [1959] [3]p.
incl. diagrs. (AF 18(600)1317)   Unclassified

Published in Jour. Chem. Phys., v. 31: 1314-1316, Nov.
1959.

Physico-chemical analysis of data concerning drift
velocities of ions in nitrogen discloses that N_4^+ ions
are the stable ones at low temperature and E/p_0 and
that the ions dissociate into N_2^+ and N_2 at higher E/p_0,
higher temperature, or lower pressure. The dissocia-
tion behaves identically with thermal dissociation of
molecular gases. The analysis yields the following
numerical data: N_4^+ binding energy against dissocia-
tion into N_2^+ and N_2, 0.50 ev; Ion temperature in °K as
a function of E/p_0 in v/cm/mm Hg, $\theta = 12.5 E/p_0$.
(Contractor's abstract)

2174

Washington U. [Dept. of Physics] St. Louis, Mo.

MUON CAPTURE IN CERTAIN LIGHT NUCLEI, by A.
Fujii and H. Primakoff. Mar. 1959 [29]p. incl. refs.
(Technical rept. no. 20) (AFOSR-TN-59-28) (In
cooperation with Purdue U., Lafayette, Ind.) (AF 18-
(600)1579) (AF 18(603)106) AD 208873 Unclassified

Presented at meeting of the Amer. Phys. Soc., New
York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series
II, v. 4: 39, Jan. 28, 1959.

Also published in Nuovo Cimento, Series X, v. 12: 327-
355, May 1, 1959.

The partial transition rate of the muon-capture reactions
He^3-H^3, Li^6-He^6, and $C^{12}-B^{12}$ in which the daughter

nucleus is found in its ground state is calculated by making use of the comparison with the beta-decay transition rate of the daughter nucleus from the ground state back to the ground state of the parent nucleus. Also the universality in coupling constants and coupling schemes, V-A, between beta decay and muon capture is assumed. The "induced" pseudoscalar interaction and the correction due to "divergenceless" current are both included in the basic Hamiltonian. The nuclear matrix element is evaluated using a variational trial wave function for He^3 and an oscillator potential wave function in LS and jj coupling shell theory for Li^6 and C^{12}, respectively. The calculated partial capture rate is in agreement with experiment which exists only for C^{12} at present. (Same as item no. 1805)

2175

Washington U. Dept. of Physics, St. Louis, Mo.

A SPHERICAL WAVE EXPANSION FOR DOUBLE β-DECAY, by S. P. Rosen. Jan. 1959 [6]p. (Technical rept. no. 18) (AFOSR-TN-59-91) (AF 18(603)108) AD 229980   Unclassified

Also published in Canad. Jour. Phys., v. 37: 780-785, 1959.

Spherical wave solutions of the Dirac equation for a central field and the properties of angular momentum coupling coefficients are used in a general formulation of the theory of neutrino-less double β-decay transitions of arbitrary forbiddenness.

2176

Washington U. Dept. of Physics, St. Louis, Mo.

FREE INDUCTION DECAYS OF ROTATING SOLIDS, by I. J. Lowe. [1959] [3]p. incl. diagrs. (Technical rept. no. 14) (AFOSR-TN-59-160) (AF 18(603)108) AD 211119   Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 285-287, Apr. 1, 1959.

A theoretical argument predicts that the effect of spinning a nuclear resonance sample at a frequency f_e should be to produce periodic signals at a frequency f_s in addition to the normal free induction decay. The corresponding line space should be narrower in the central region but should possess sidebands at frequencies of multiples of $2f_s$. Experiments on the F^{19} resonance in CaF_2 and Teflon confirm this.

2177

Washington U. Dept. of Physics, St. Louis, Mo.

ON THE ELECTRON COINCIDENCE SPECTRUM IN DOUBLE BETA DECAY, by S. P. Rosen. [1959] [13]p. incl. diagrs. table, refs. (Technical rept. no. 33) (AFOSR-TN-59-161) (AF 18(603)108) AD 247257   Unclassified

Also published in Proc. Phys. Soc. (London), v. 74: 350-362, 1959.

Though simple qualitative arguments imply that the electron coincidence spectra for 2-neutrino, and for 0-neutrino double β-decay are broadly peaked at $\frac{1}{2}E_0$ and infinitely sharply peaked at E_0, respectively (E_0 is the energy release), a recent calculation has shown that in some circumstances the 2-neutrino case spectrum may also be broadly peaked in the region of E_0. A simple model, in which only 1 state of the intermediate nucleus gives a non-zero contribution to the matrix element, is used to recalculate these spectra. Two extreme approximations are considered: the energy of the intermediate state is equal to, or much greater than, that of the initial state. In both cases, the qualitative result is confirmed, and the recent calculation mentioned above is regarded as incorrect. The model is applied to the double β-decays of Zr^{96} and Ca^{48}. The relation between the conservation of lepton "charge" and the shape of the spectrum is also considered in some detail. (Contractor's abstract)

2178

Washington U. Dept. of Physics, St. Louis, Mo.

THEORY OF SOLID He^3, by N. Bernardes and H. Primakoff. [1959] [13]p. incl. diagrs. tables, refs. (Technical rept. no. 15; technical rept. no. 36) (AFOSR-TN-59-238) (AF 18(603)108) AD 212101; AD 257507   Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 290-292, Apr. 1, 1959. (Preliminary rept.)

Also published in Phys. Rev., v. 119: 968-980, Aug. 1, 1960.

A theoretical analysis is given of the properties of solid He^3 on the basis of: (1) a gas-phase Lennard-Jones "12-6" potential modified at small interatomic distances; (2) a Heitler-London type variational-trial wave function for all the atoms in the solid constructed from a properly antisymmetrized product of individual atom orbitals localized on the various lattice points; (3) a Dirac vector model to describe the symmetry energy with an exchange integral deduced from (1) and (2); (4) a spin-wave approximation at "low" temperatures and a Kramers-Opechowski approximation at "high" temperatures for calculation of the free energy of the nuclear spins; and

(5) a Debye phonon model for the description of the vibrationally excited states of the solid. On this basis, calculated values at low pressures and temperatures ($p \approx 30$ atm; $T < 1$ °K) are presented for: (a) the cohesive energy per atom; (b) the root mean square deviation of an atom from its lattice site; ≈ 0.36 X nearest neighbor distance; (c) the nuclear magnetic susceptibility which corresponds to an antiferromagnetic behavior with a "paramagnetic" Curie temperature $T_C \approx$ 0.1 °K; (d) the variation (decrease) of T_C with increasing pressure corresponding to a possible nuclear antiferromagnetic to nuclear ferromagnetic transition for $p \approx 150$ atm; (e) the specific heat which exhibits an anomaly at $T \approx 0.1$ °K associated with the alignment of the nuclear spins; (f) the thermal expansion coefficient which becomes negative below about 0.6 °K; (g) the melting curve which is characterized by a minimum at $T \approx 0.37$ °K and a maximum at $T \approx 0.08$ °K. Comparison of the theory is made with available experimental data. (Contractor's abstract)

2179

Washington U. Dept. of Physics, St. Louis, Mo.

AN ITERATION OF THE SCATTERING MATRIX IN FINITE TERMS, by K. Haller. [1959] 10p. incl. refs. (AFOSR-TN-59-521) (AF 18(603)108) AD 261901
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1960.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 5: 81, Jan. 27, 1960.

Computation of collision cross section in quantum field theory are performed by evaluating the T-matrix. The T-matrix is defined when the Hamiltonian can be separated into a free particle interaction. However, the T-matrix not being consistent with requirements for solution to free particle interaction is replaced by the R-matrix. The R-matrix was developed for the Hamiltonian on a free particle interaction. Results indicate that field theories can be classified into 2 varieties: one kind which gives rise to finite weak coupling iterative expansions and another kind which gives rise to infinities. Presumably these latter infinities are indicative of some more deep seated pathology in the field equations or in the approximation by which a nonrelativistic Hamiltonian is obtained from a relativistic one. The gradient coupling theory, for example, gives rise to infinite R-matrix elements, though these don't diverge as badly as the corresponding unrenormalized T-matrix elements evaluated by cut-off methods. (ASTIA abstract)

2180

Washington U. [Dept. of Physics] St. Louis, Mo.

MESONIC "EXCHANGE" EFFECTS IN BETA-DECAY, by R. J. Blin-Stoyle, V. Gupta, and H. Primakoff. [1959] [10]p. incl. diagr. table, refs. (Technical rept. no. 21) (AFOSR- TN-59-522) (AF 18(603)108)
AD 229973 Unclassified

Also published in Nuclear Phys., v. 11: 444-453, May 1959.

An estimate is made, using no-recoil meson theory, of the π-mesonic exchange contributions to the beta-decay of nuclei assuming that such effects only contribute to the axial vector part of the beta-decay interaction. A few % enhancement in the matrix element for the $H^3 \rightarrow He^3$ decay is obtained which is sufficient to account for the discrepancy between the decays of H^3 and n. A similar effect is found for heavier nuclei. (Contractor's abstract)

2181

Washington U. [Dept. of Physics] St. Louis, Mo.

THE CATALYTIC AND PHOTO DECAY MODES OF THE MUON, by S. P. Rosen. [1959] [11]p. incl. diagrs. table, refs. (Technical rept. no. 32) (AFOSR-TN-59-617) (AF 18(603)108) AD 247257 Unclassified

Also published in Nuovo Cimento, Series X, v. 15: 7-17, Jan. 1, 1960.

It is shown that, on the basis of the usual baryon-lepton direct coupling theory, the catalytic ($\mu + \pi \rightarrow e + \pi$) and the photo ($\mu \rightarrow e + \gamma$) decays of the muon are expected to occur as 2nd order processes in the effective weak interaction Hamiltonian, $\mathcal{H}_{weak}$. If however, the effective weak interaction itself arises as a consequence of the coupling of baryons and leptons to an intermediate heavy boson ($\langle X \rangle$), these decays are essentially 1st order in $\mathcal{H}_{weak}$ and are predicted to go so fast as to apparently contradict experimental data, at least in the case of photo decay. Estimates of the rates of the catalytic and photo decays are given both on the direct coupling and on the $\langle X \rangle$ theories, and a comparison with the available empirical limits on these rates is made. (Contractor's abstract)

2182

Washington U. [Dept. of Physics] St. Louis.

POLARIZATION OF PROTONS IN $C^{12}(d,p)C^{13}$, by R. G. Allas and F. B. Shull. [1959] [3]p. incl. diagrs. tables, refs. (Technical rept. no. 30) (AFOSR-TN-59-678) (AF 18(603)108) AD 247257 Unclassified

Also published in Phys. Rev., v. 116: 996-998, Nov. 15, 1959.

The polarization of protons from the ground-state C^{12}(d,p)C^{13} reaction has been measured over an angular range $\theta_1 = 15°$ to $\theta_1 = 60°$ at a deuteron bombarding energy of 10 mev. The polarization was found to be positive at all angles studied, the axis of quantization being defined by $n = k_p \times k_d$. The observed polarizations were 18% at 15° (lab); 11% at 18°; 13.8% at 24°; 15.2% at 30°; 19.5% at 36°; 44.4% at 48°; 30% at 54°; 45.8% at 60°. The results are compared with existing polarization measurements on C^{12}(d,p)C^{13}. (Contractor's abstract)

2183

Washington U. Dept. of Physics, St. Louis, Mo.

NUCLEON-STRUCTURAL CORRECTIONS TO FIRST FORBIDDEN UNIQUE BETA TRANSITIONS, by J. F. Dreitlein. [1959] [6]p. incl. table, refs. (Technical rept. no. 31) (AFOSR-TN-59-695) (AF 18(603)108) AD 247257   Unclassified

Published in Phys. Rev., v. 116: 1604-1609, Dec. 15, 1959.

The coupling of leptons to a conserved isovector current is shown to result in a small change in the shape of the electron momentum spectrum in forbidden unique beta transitions. The experimental advantages and disadvantages of studying such nucleon-structural effects in forbidden unique transitions rather than in allowed transitions, as suggested by Gell-Mann, are discussed. To facilitate the computations, the beta-decay interaction Hamiltonian is written in a form in which the terms leading to the "nucleon-structural" corrections associated with the coupling of the leptons to a conserved isovector current and the terms leading to effects of comparable order of magnitude are simply identified. (Contractor's abstract)

2184

Washington U. Dept. of Physics, St. Louis, Mo.

THEORY OF MUON CAPTURE, by H. Primakoff. [1959] [21]p. incl. tables, refs. (Technical rept. no. 22) (AFOSR-TN-59-1062) (AF 18(603)108) AD 229973   Unclassified

Also published in Rev. Modern Phys., v. 31: 802-822 July 1959.

The present paper deals with various aspects of th theory of muon capture with emphasis on the relation between theory and experiment. The theory is based on an effective Hamiltonian, $H_{eff}(\mu)$, which descri s a muon

capture with subsequent neutrino emission by an aggregate of A dressed nucleons:

$$\mu^- + \begin{Bmatrix} Z \text{ protons} \\ A\text{-}Z \text{ neutrons} \end{Bmatrix} \rightarrow \nu + \begin{Bmatrix} Z\text{-}1 \text{ protons} \\ A\text{-}Z\text{+}1 \text{ neutrons} \end{Bmatrix}$$

(Contractor's abstract, modified)

2185

Washington U. Dept. of Physics, St. Louis, Mo.

A MEASUREMENT OF THE LONGITUDINAL POLARIZATION OF Pr^{144} BETA-PARTICLES, by W. A. Mehlhop. Feb. 22, 1960, 106p. incl. diagrs. tables. (Technical rept. no. 26) (AFOSR-TN-59-1323) (AF 18-(603)108) AD 234106; PB 147144   Unclassified

A precision determination of the longitudinal polarization of the β- particles from radioactive Pr^{144} is reported. The β-transition in Pr^{144} ing of the kind $O^- \rightarrow O^+$, a potential presence of the pseudoscalar interaction type in β-decay would make itself felt in the predominant order of forbiddenness, a well known theoretical result. According the "post-parity" formulation of the theory of β-decay, the presence of the P-interaction would, in particular, result in a decrease of the degree of longitudinal polarization of the emitted betas. Thus a precise measurement of the electron polarization allows one to draw conclusions upon the absence or presence of the P-interaction. (Contractor's abstract)

2186

Washington U. [Dept. of Physics] St. Louis, Mo.

LONGITUDINAL POLARIZATION OF ELECTRONS FROM HOLMIUM-166 (Abstract), by T. A. Pond, W. A. Mehlhop, and E. D. Lambe. [1959] [1]p. [AF 18(603)-108]   Unclassified

Presented at meeting of the Amer. Phys. Soc., Gatlinburg, Tenn., Oct. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 77, Jan. 28, 1959.

A comparison of the longitudinal polarization of the beta-particles from P-32 and 27 hr Ho-166 has been undertaken. Earlier work has shown that the polarization in P-32 is $-(\nu/c \pm 6\%)$. Ho-166 decays in 2 branches of about equal intensity with endpoints that differ from P-32's by less than 10%. One branch is first forbidden, unique, and may be assumed to show polarization-ν/c. The other is first forbidden, A or P. The comparison is made by Møller scattering with a geometry similar to Frauenfelder's. The scatterer is 3.6 mgm/cm^2 Supermendur magnetized to saturation (about 14,500 gauss) and mounted at 30° to the incident beam. Pairs

of scattered and struck electrons with energies greater than 330 kev emerging from the foil at $(31 \pm 6)°$ to the direction of the incident beam are detected by 2 plastic scintillation spectrometers with fast-slow coincidence electronics. The change in counting rate when the magnetic field is reversed, after subtraction of the experimentally determined background, is $(8.41 \pm 0.38)\%$ for P-32, and $(8.14 \pm 0.73)\%$ for Ho-166. The electron helicity is negative in both cases.

2187

Washington U. [Dept. of Physics] St. Louis, Mo.

LONGITUDINAL POLARIZATION OF POSITRONS FROM NEON-19 (Abstract), by E. D. Lambe, J. B. Reynolds and others. [1959] [1]p. [AF 18(603)108]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Gatlinburg, Tenn., Oct. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 77, Jan. 28, 1959.

About 1 mc of Ne-19 is maintained continuously in a 50 cm^3 chamber between the poles of an electromagnet. The chamber is viewed from either end through the pole tips (2-in. of saturated Armco) by 2 1-in. Dx $1\frac{1}{2}$-in. NaI scintillation spectrometers biased to record only γ-rays of greater than a certain energy, E_o. This bias is usually set above 0.51 mev so that only the γ-ray emitted into the hemisphere around the momentum of a positron annihilating in flight can be recorded. If the positron is longitudinally polarized, this γ-ray is circularly polarized: for positive positron helicity, LCP. Because of the electron spin dependence of the Compton scattering of such γ-rays in the poles, the 2 counting rates show an asymmetry which reverses when the direction of magnetization is reversed. This asymmetry is $(1.60 \pm 0.18)\%$ for $E_o = 1.3$ mev, $(1.25 \pm 0.19)\%$ for $E_o = 1.0$ mev, $(0.86 \pm 0.16)\%$ for $E_o = 0.75$ mev, $4(0.11 \pm 0.05)\%$ for $E_o = 0.35$ mev.

The asymmetries to be expected from full positron polarization, v/c, have been calculated from the differential cross sections for the production of RCP and LCP γ-rays from positrons which annihilate isotropically. The agreement with the observed asymmetries is excellent.

2188

Washington U. [Dept. of Physics] St. Louis, Mo.

POLARIZATION OF COSMIC-RAY MUONS AT SEA LEVEL (Abstract), by C. S. Johnson. [1959] [1]p.

(Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)108], Atomic Energy Commission, and Office of Naval Research)   Unclassified

Presented at meeting of the Amer. Phys. Soc., Cleveland, Ohio, Nov. 27-28, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 402, Nov. 27, 1959.

Cosmic-ray muons at sea level are known to be partially longitudinally polarized. The object of this experiment was to measure the muon polarization by stopping the muons in a copper absorber and observing the up:down asymmetry in the decay electrons. Measurements were also made with iron and sulfur as control absorbers to test the asymmetry of the apparatus. Since this experiment is performed in zero magnetic field it has been possible to verify that unmagnetized iron depolarizes muons by precessing their magnetic moments in the strong randomly oriented magnetic fields of the domains. The up:down ratio of decay electrons was 1.14 ± 0.02 for copper, 0.98 ± 0.02 for iron, and 1.02 ± 0.03 for sulfur. On the basis of the 2-component neutrino theory the muon polarization is found to be $> 21 \pm 3\%$, where the inequality is due to depolarization effects. There is evidence that, in the absence of external magnetic fields, copper depolarizes the stopped muons, as indicated by a decrease in the up:down ratio with time.

2189

Washington U. [Dept. of Physics] St. Louis, Mo.

HYPERFINE SPECTRA OF SOME DEUTERIUM SUBSTITUTED TRIPHENYLMETHYLS, by D. C. Reitz. [1959] [1]p. (Technical rept. no. 26) (AFOSR-TN-59-392) (AF 49(638)464) AD 243091   Unclassified

Also published in Jour. Chem. Phys., v. 30: 1364-1365, May 1959.

The proton hyperfine spectra of triphenylmethyl and phenyl-bis-(p-deuteriophenyl) methyl were compared. These results and those obtained with diphenyl-m-deuteriophenylmethyl indicate that the Brovetto and Ferroni splitting constants are preferred over the splitting constants assigned by Lupinski.

2190

Washington U. [Dept. of Physics] St. Louis, Mo.

POSSIBLE SYMPTOM OF THE JAHN-TELLER EFFECT IN THE NEGATIVE IONS OF CORONENE AND TRIPHENYLENE, by M. G. Townsend and S. I. Weissman. [1959] [1]p. incl. diagr. (Technical rept. no. 29) (AFOSR-TN-59-1258) (AF 49(638)464) AD 243091   Unclassified

Also published in Jour. Chem. Phys., v. 32: 309-310, Jan. 1960.

Anions of coronene, triphenylene, benzene, and anthracene were produced by reduction with Li, Na, or K. Electron-spin resonance absorption spectra were given. The unusually broad lines of the coronene and triphenylene ions may be associated with Jahn-Teller distortions.

2191

Washington U. [Dept. of Physics] St. Louis, Mo.

DETERMINATION OF RATES AND MECHANISMS BY ELECTRON SPIN RESONANCE, by S. I. Weissman. [1959] [4]p. (Technical rept. no. 30) (AFOSR-TN-59-1325) (AF 49(638)464) AD 243091   Unclassified

Also published in Zeitschr. Elektrochem., v. 64: 47-50, 1960.

The occurrence of events with characteristic times in the range 10^{-9} to 10^{14} seconds may produce observable effects on electron spin resonance spectra. In some cases detailed information concerning mechanisms, not accessible to standard kinetic methods, may be obtained. Several cases of the use of electron spin resonance for these purposes are described. (Contractor's abstract)

2192

Washington U. Dept. of Chemistry, Seattle.

METALLIC REFLECTION FROM MOLECULAR CRYSTALS, by B. C. Anex and W. T. Simpson. [1958] [11]p. incl. diagrs. [AF 18(600)375] AD 247855
Unclassified

Also published in Rev. Modern Phys., v. 32: 466-476, Apr. 1960.

The molecular crystals of predominantly 1,5-bis-(dimethylamino)pentamethinium perchlorate (BDP) and auramine perchlorate were studied. By use of a special spectrometer, a BDP crystal showed fluorescence at 500-550 mμ, with a maximum at 525 mμ. The density of BDP was 1.311 ± 0.001 g/cc. The single-molecular absorption at 409 mμ has an integrated intensity corresponding to a transition moment length of 2.04A. A one-dimensional oscillator strength of 3.31 is computed from this length. The transition moment lengths of f values for the weak absorptions at 255 and 225 mμ are 0.34 and 0.32 A; this corresponds to f values each of 0.15. The half-width of the single-molecular absorption at 409 mμ was 0.374×10^{15} (units of ω, the circular frequency). For face 1 of BDP, ω^2 is estimated to be 19.4×10^{30}. The corresponding dif-

ference in the ω values taken at the same points is 2.98×10^{15}. As for auramine perchlorate, a typical spectrum is given. Work done on it is published separately.

2193

Washington U. Dept. of Chemistry, Seattle.

HÜCKEL THEORY: AN EFFECTIVE HAMILTONIAN, by W. D. Jones. [1959] [3]p. (AF 18(600)375)
AD 259224   Unclassified

Published in Jour. Chem. Phys., v. 31: 1317-1319, Nov. 1959.

An effective one-electron Hamiltonian for molecules is presented that gives exactly the single-atom energies for its diagonal elements. An operator is used that selectively cancels the nuclear attraction for all nuclei except the one on which a particular AO is centered. (Contractor's abstract)

2194

Washington U. Dept. of Chemistry, Seattle.

EVALUATION OF ONE-CENTER ELECTRON REPULSIVE INTEGRALS BETWEEN CERTAIN s-TYPE ATOMIC ORBITALS, by W. D. Jones and F. L. Brooks, Jr. [1959] [3]p. (AF 18(600)375) AD 247854
Unclassified

Published in Jour. Chem. Phys., v. 32: 124-126, Jan. 1960.

A general formula is derived for one center s-type electron repulsion integrals for the set of basic atomic orbitals which involve the complete set of associated Laguerre functions of order (2ℓ + 1) and degree (n + ℓ + 1) with a single orbital exponent. (Contractor's abstract)

2195

Washington U. Dept. of Chemistry, Seattle.

RESEARCH IN HETEROGENEOUS CATALYSIS, by G. D. Halsey, Jr. [Final rept.] Sept. 15, 1953-Sept. 15, 1959, 8p. incl. refs. (AFOSR-TR-59-127) (AF 18(600)-987) AD 226963; PB 143909   Unclassified

A summary of the present status of this research is presented. The 1st paper (WAU.02:001, Vol. I) is a study of the relationship of the adsorption of hydrogen to the activity of the catalyst for the conversion of para-hydrogen. This system is an ideal 1 for the elucidation of the catalytic process, because the isotherms that hold during reaction are not affected by the reaction. The results of the study, however, fail to reveal

any outstanding simplifications that would serve to elucidate a mechanism. Two other papers (WAU.02: 002, Vol. I and WAU.02: 005, Vol. II) represent a detailed study of the adsorption of rare gases on well characterized and pure surfaces. The latter of these presents extensive data for the adsorption of a gas, krypton, on a wide variety of surfaces, especially on evaporated metal films. The outstanding observation is that metals behave like insulators with respect to their interaction with the rare gas. The former paper shows that at best, the BET surface area techniques, and allied estimates, are reliable to 10%, with possible absolute error of 25%. This paper and another (WAU. 02:007, Vol. II) are the 1st fruits of the work on the high precision adsorption studies, being carried out in what is essentially a gas thermometer filled with a solid whose surface interacts with the chosen gas. Two other papers (WAU.02: 003 and 008, Vol. II) are devoted to the study of the solid solution argon-krypton, one of the simplest binary systems known that deviates from ideality. The 1st of these is an attempt to study the critical region for phase separation of this system by conventional means. In the other, an entirely new and improved method of studying the solution is presented. The last paper reported on (WAU.02: 004, Vol. II) is a study of the simplest possible Henry's law region, the solution of helium in argon.

2196

Washington U. Dept. of Chemistry, Seattle.

AUTOMATIC SLIT DRIVE FOR INFRARED SPECTROMETERS, by D. F. Eggers, Jr. and M. T. Emerson. Mar. 8, 1960 [3]p. incl. diagrs. table. (Technical note no. 5) (AFOSR-TN-59-146) (AF 18(600)1522) AD 234127   Unclassified

Also published in Jour. Opt. Soc. Amer., v. 50: 11-13, Jan. 1960.

An automatic slit drive has been constructed for a single-beam infrared spectrometer, using two helical potentiometers in a servosystem. The output of generator potentiometer is heavily loaded causing its output voltage function to curve sharply with displacement. This reduces the number of taps per prism to 2. Evaluation of circuit parameters is described, and values are listed for prisms of calcium fluoride, sodium chloride, potassium bromide, and cesium bromide, used in double pass. A simple modification permits selection of several different energy levels. The resulting curves of spectrometer output vs frequency are constant. (Contractor's abstract)

2197

Washington U. Dept. of Chemistry, Seattle.

INFRARED INTENSITIES OF SULFUR DIOXIDE: A RE-DETERMINATION, by D. F. Eggers, Jr. and

E. D. Schmid. [1959] [2]p. incl. diagr. table. (Technical note no. 6) (AFOSR-TN-59-881) (AF 18(600)1522) AD 234579; PB 145679   Unclassified

Also published in Jour. Phys. Chem., v. 64: 279-280, Feb. 1960.

Infrared intensity measurements have been reported for the 3 fundamentals of sulfur dioxide in the gas phase by 3 independent groups. Since those of this laboratory were much lower than those of the other 2 groups, the intensities have been remeasured here; the new results are in agreement with those of the other 2 groups. Possible reasons for this discrepancy are discussed. (Contractor's abstract)

2198

Washington U. Dept. of Chemistry, Seattle.

KINETICS AND EQUILIBRIA IN THE ALKYLATION OF DIBORANE, I, by L. Van Alten, G. R. Seely and others. Preliminary rept. June 25, 1959 [14]p. incl. diagrs. table. (AFOSR-TN-59-311) (AF 18(600)1541) AD 213243; PB 142299   Unclassified

Presented at meeting of the Div. of Inorg. Chem. of the Amer. Chem. Soc., San Francisco, Calif., Apr. 13-18, 1958.

Abstract published in 133rd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 38-L.

Also published in Adv. in Chem. Ser., No. 32: 107-114, 1961.

Studies were made of the reaction between B_2H_6 and trimethylborane, and the decomposition of monomethyl diborane (B_2H_5Me). Gas partition fractometry was used for analysis. Aliquots were removed at intervals from the reaction vessel for analysis by expansion into a small adjacent volume from which they were swept directly into the fractometer. The quantities present were estimated by graphical integration of the fractometer patterns. The areas where curves overlapped was estimated by comparison with curves obtained for each substance alone. The areas were corrected by factors proportional to the relative thermal conductivities with $B_2H_6:B_2H_5Me:BMe_3:B_2H_4Me_2$ as 1:1.23:1.42:1.42. The average 2nd-order velocity constant, determined graphically, was 0.40 1/min mol with an average deviation of 0.02. After several days, the reaction mixture reached a steady state, apparently an unchanging composition of B_2H_6, B_2H_5Me, and 1,1-dimethyldiborane. With respect to the reaction, $B_2H_6 + \frac{1}{2} 1,1-B_2H_4Me_2 + \frac{1}{2} 1,2-B_2H_4Me_2 = 2B_2H_5Me$, equilibrium constant values of 0.35 and 0.65 at 0° were obtained from mixtures established from B_2H_6-BMe_3 and B_2H_6-$B_2H_4Me_2$,

respectively. The decomposition of B_2H_5Me was a 1st-order reaction. The equilibrium constant values for the reaction $B_2H_5Me \rightleftharpoons B_2H_6 + (BH_2Me)_2$, were calculated.

2199

Washington U. Dept. of Chemistry, Seattle.

GAS-LIQUID FRACTOMETRIC ANALYSIS OF MIX-TURES CONTAINING METHYLDIBORANES, by G. R. Seeley, J. R. Oliver, and D. M. Ritter. June 25, 1959 [6]p. incl. diagr. tables. (AFOSR-TN-59-398) (AF 18-(600)1541) AD 214518; PB 142300   Unclassified

Also published in Anal. Chem., v. 31: 1993-1995, Dec. 1959. (Title varies)

The specific retention volumes, V_g, have been determined as functions of temperature for diborane, trimethylborane and the methyldiboranes on columns packed with mineral oil on pulverized fire-brick. Column efficiency was not great, but sufficient to permit almost complete separation of the elution curves at $0°C$ and the quantitative determination of the substances to an accuracy of 1-2% of the amounts present in a mixture. Extensive investigation of the equilibria and kinetics of formation and interconversion of the methyldiboranes has become possible through application of the gas-liquid partition fractometer as a quantitative analytical device. The results of such measurements are to be published elsewhere; the purpose of this contribution is to describe the analytical method itself. The commonly known boron hydrides have been observed qualitatively in this manner by Koski and his coworkers, and the selection of a suitable fluid for separation of the methyldiboranes was based upon those results. (Contractor's abstract)

2200

Washington U. Dept. of Chemistry, Seattle.

CALCULATION OF DELOCALIZATION CONTRIBU-TION TO INFRARED INTENSITY, by W. D. Jones and W. T. Simpson. [1959] [10]p. incl. tables. (AFOSR-TN-59-1329) [AF 49(638)677] AD 247853
                                                Unclassified

Also published in Jour. Chem. Phys., v. 32: 1747-1756, June 1960.

Infrared intensity may be related to energies and intensities of electronic transitions by using the theory of the vibrational perturbation of electronic transitions and holding the electronic state quantum number fixed. This suggests in particular relating the infrared intensity of an appropriate normal mode to the strong ultraviolet absorption in dye-like molecules having conjugated π-electron systems. The perturbation theory is tested by applying it to a displaced hy-

drogen atom and the hydrogen molecule ion. The results suggest the need for modifying the theory to employ floating orbitals. A floating orbital theory of infrared intensity which still brings in ultraviolet transition energies and moments is then constructed. This theory is next applied to the model compounds H_3^+, H_5^+ and H_7^+ and there is predicted an extraordinarily high delocalization contribution to the intensity for the anti-symmetric stretch. Values for the dipole derivatives are calculated ranging up to 65 debyes/A. (Contractor's abstract)

2201

Washington U. Dept. of Chemistry, Seattle.

THE SOLUBILITY, ACTIVITY COEFFICIENT AND HEAT OF SOLUTION OF SOLID XENON IN LIQUID ARGON, by W. H. Yunker and G. D. Halsey, Jr. [1959] 3p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-59-1210) (AF 49(638)723) AD 242750
                                                Unclassified

Also published in Jour. Phys. Chem., v. 64: 484-486, Apr. 1960.

The liquid solutions of Xe in Ar and Kr in Ar and the solid solution of Ar in Xe have been studied in the temperature range 84.0 - 87.5°K., using vapor pressure measurements. The solubility of Xe in Ar was found to be 4.14 - 5.01 ± 0.03 mol % Xe and the partial molar heat of solution of Xe in the infinitely dilute solution was found to be 632 ± 70 cal. per mol. For

$$\mu_{Xe} - \mu°_{Xe} = RT \ln n_{Xe} + \alpha(1 - n_{Xe})^2, \alpha = 535 \pm 58 \text{ cal}$$

per mol. No saturation of Kr in Ar was reached in this region (up to 4.7%); $\alpha = 146 \pm 30$ cal/mol. Argon was found to be less than 0.5% soluble in solid xenon. (Contractor's abstract)

2202

Washington U. [Dept. of Physics] Seattle.

JUMPING RATE OF DEUTERONS BETWEEN THE HYDROGEN BONDS OF KD_2PO_4 (Abstract), by V. H. Schmidt and E. A. Uehling. [1959] [1]p. [AF 49(638)-92]   Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 462, Dec. 28, 1959.

There are 4 principal lines in the magnetic resonance spectrum of deuterons in KD_2PO_4. If 1 of these lines is saturated other lines are enhanced or saturated in a definite way. An effective exchange of deuterons between nonequivalent positions can cause the observed

phenomena, but spin exchange cannot. The effective time τ_c of spatial exchange was measured directly using pulse methods. A value of about 0.4 sec was found for τ_c at 25°C. It decreases rapidly with increase in temperature, reaching a value of 0.015 sec at 70°C. The relaxation time T_1 decreases simultaneously by a factor of less than 2. The dependence of τ_c on temperature suggests barrier penetration with an activation energy of about 0.6 ev. The value found for τ_c, and failure of T_1 to change proportionally to τ_c, are not in accord with a relaxation model suggested previously, based on deuteron jumps and the quadrupole interaction from which the smaller value of $r_c = 5 \times 10^{-3}$ sec was deduced.

2203

Wayne State U. [Dept. of Mathematics] Detroit, Mich.

GROUPS OF AUTOMORPHISMS OF KAEHLER MANIFOLDS, by S. I. Goldberg. July 1959, 7p. (AFOSR-TN-59-797) (AF 49(638)14) AD 227350; PB 143953
Unclassified

Also published in Bull. Amer. Math. Soc., v. 66: 54-58, Jan. 1960. (Title varies)

A. Lichnerowicz proved that the largest connected Lie group of conformal transformations of a compact Einstein-Kaehler space $M^{2k}(k > 1)$ leaves invariant the Kaehlerian structure. In this report the following much stronger result is obtained: The largest connected Lie group of conformal transformations of a 4k-dimensional compact Kaehler manifold coincides with the largest connected group of automorphisms. Theorems of a less general nature but with no restriction on the dimension of the manifold are also obtained. These results can be partially extended to the open Kaehlerian manifolds and hold also for those symplectic manifolds in which the fundamental exterior 2- form is harmonic. (Contractor's abstract)

2204

Wayne State U. Dept. of Mathematics, Detroit, Mich.

RELATION BETWEEN ABSTRACT HOMOTOPY AND GEOMETRIC HOMOTOPY, by S. Verma. Mar. 1959, 117p. incl. diagrs. (Technical note no. 3) (AFOSR-TN-59-126) (AF 49(638)179) AD 210614; PB 142239
Unclassified

An actual construction of an abstract homotopy theory for the category of Kan complexes and Kan maps is described. Both the relative and the absolute homotopy groups are considered. An axiomatization of the theory is given and its uniqueness is established. How ho-

motopy and singular (co-) homology groups of a topological space may be defined from those of cubical complexes by applying the cubical singular functor is shown. A complete semi-simplicial singular functor is described to define a homotopy notion on A (the category of topological spaces) in terms of the homotopy notion on K (the category of Kan complexes and Kan maps). The homotopy groups of topological spaces are shown to be isomorphic to those of the total singular complexes of these spaces.

2205

Wayne State U. Dept. of Mathematics, Detroit, Mich.

ON THE UNIQUENESS THEOREM OF LOCAL HOMOLOGY THEORY, by S.-T. Hu. Mar. 1959, 13p. incl. refs. (Technical note no. 4) (AFOSR-TN-59-204) (AF 49(638)179) AD 211609; PB 142237
Unclassified

Also published in Tsing hua Jour. Chinese Studies, Special no. 1 (Natural Sci.): 192-200, Dec. 1959.

In a recent paper of T. R. Brahana, (Duke Math. Jour., v. 25: 381-400, 1959) an axiomatic approach to the local homology theory is given and the uniqueness theorem is established for the category of the triangulable local pairs. His methods of proof are parallel to those used by Eilenberg and Steenrod (Foundations of Algebraic Topology, Princeton, 1952) in the global homology theory. If one applies the global uniqueness theorem of Eilenberg and Steenrod instead of paraphrasing their methods, the proof of the local uniqueness theorem would be much simpler. In the present technical note such a proof is produced. (Contractor's abstract)

2206

Wayne State U. Dept. of Mathematics, Detroit, Mich.

ISOTOPY INVARIANTS OF TOPOLOGICAL SPACES, by S.-T. Hu. Mar. 1959, 69p. incl. diagrs. (Technical note no. 5) (AFOSR-TN-59-236) (AF 49(638)179) AD 212006; PB 142025
Unclassified

Also published in Proc. Royal Soc. (London), v. 255A: 331-366, Apr. 19, 1960.

An attempt was made to introduce and study new algebraic isotopy invariants of spaces. A general method of constructing isotopy invariants is given by means of a certain class of functors as follows. A functor F from a category C of spaces and maps into another such category D is said to be an isotopy functor if F carries isotopies into isotopies. If F is an isotopy functor from C into D and if X is a space in C, then the homotopy invariants of the space F(X) are isotopy invariants of the given space X. Special isotopy functors are constructed, namely, the m-th residual functor R_m and the m-th enveloping functor E_m. The

homology groups obtained by using these special functors are proved to be finitely computable. Applications of these isotopy invariants to linear graphs are given. Results show that these invariants can distinguish various spaces belonging to the same homotopy type. (Contractor's abstract)

2207

Wayne State U. Dept. of Mathematics, Detroit, Mich.

HOMOTOPY AND ISOTOPY PROPERTIES OF TOPO-LOGICAL SPACES, by S.-T. Hu. Nov. 1959, 23p. (Technical note no. 6) (AFOSR-TN-59-1108) (AF 49(638)179) AD 231386; PB 145515 Unclassified

Also published in Canad. Jour. Math., v. 13: 167-176, 1961.

The general tests for homotopy and isotopy properties of topological spaces are established in terms of hereditary and weakly hereditary properties. A general method of constructing new boundary and isotopy invariants of topological spaces are described.

2208

Wayne State U. [Dept. of Physics] Detroit, Mich.

DIFFUSION OF HYDROGEN IN GERMANIUM (Abstract), by R. C. Frank and J. E. Thomas, Jr. [1959] [1]p. [AF 49(638)158] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cleveland, Ohio, Nov. 27-28, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 411, Nov. 27, 1959.

Single crystal germanium diffusion specimens were prepared by a technique similar to that previously used for silicon by Van Wieringen and Warmoltz. The hollow cylindrical specimens were sealed at 1 end and attached to a mass spectrometer at the other. By surrounding the thin cylinder with hydrogen gas and observing it diffuse through into the mass spectrometer, permeation rates and diffusion coefficients were measured in the temperature range of 800 to 910°C. The excellent agreement between diffusion coefficients measured by the "delay time" and decay curve methods indicates that trapping effects by lattice defects were small or non-existent. At 800°C the diffusion coefficient was 4.7×10^{-5} cm^2/sec and the solubility was 6.0×10^{13} atoms/cc. The activation energy for diffusion is 8.7 ± 0.8 kcal/g atom and the heat of solution is 52.8 ± 1.4 kcal/g atom. The permeation rate was found to vary as the square root of the gas pressure which indicates that the hydrogen exists in the germanium lattice as hydrogen atoms or ions.

2209

Weizmann Inst. of Science, Rehovot (Israel).

AN NMR STUDY OF THE PROTOLYSIS KINETICS IN METHANOL AND ETHANOL, by Z. Luz, D. Gill, and S. Meiboom. [1959] 23p. incl. diagrs. tables, refs. (AFOSR-TN-59-19) (AF 61(052)03) AD 208600 Unclassified

Also published in Jour. Chem. Phys., v. 30: 1540-1545, June 1959.

Measurements by the nuclear magnetic resonance [NMR] technique of the hydrogen exchange kinetics in methanol and ethanol are reported. The exchange reaction is both acid and base catalyzed. The observed kinetics can be interpreted as a simple proton transfer between a neutral alcohol molecule and an alcoxonium, or alcoxyde ion respectively. In methanol a third mechanism, not involving ions, was also observed. In ethanol this reaction is presumably too slow for detection by the NMR technique. The hydrogen exchange was also studied in alcohol-water mixtures. Possible exchange mechanisms are discussed and values for their respective rate constants are given. (Contractor's abstract)

2210

Weizmann Inst. of Science, Rehovot (Israel).

TABLES OF EXCHANGE BROADENED N-M-R MULTIPLETS. [1959] 56p. incl. tables. (Technical note no. 2) (AFOSR-TN-59-292) (AF 61(052)03) AD 213032; PB 140692 Unclassified

Tables are given for calculated absorption lineshapes of NMR multiplets as function of exchange rate of the interacting nuclei. The equations on which the tables are based have been derived on the following assumptions: (1) chemical shift large compared to spin-spin interaction; (2) nuclei with spin 1/2; (3) absence of saturation; and (4) the duration of the exchange reaction can be neglected compared to the mean lifetime.

2211

Weizmann Inst. of Science. Dept. of Applied Mathematics, Rehovot (Israel).

NATURE OF THE SINGULARITIES IN THE SPECTRUM OF A ONE-DIMENSIONAL IONIC LATTICE, by J. Gillis and G. Weiss. [1959] [2]p. [AF 61(514)899] Unclassified

Published in Phys. Rev., v. 115: 1520-1521, Sept. 15, 1959.

It is known, by a theorem of van Hove, that regular lattices have singularities in their frequency spectra, the type of singularity depending on the dimension.

Although several studies of the 1-dimensional lattice with Coulomb interactions have appeared, no one yet has succeeded in identifying the type of singularity that appears in addition to the inverse square root singularity, in the frequency spectrum. In this note we establish that for a 1-dimensional crystal the singularity is of the form $g(\omega) \sim \{(\omega - \omega_1) \times \ln[1/(\omega - \omega_i)]\}^{\frac{1}{2}}$ where A is a constant and ω_1 is the position of the singularity. (Contractor's abstract)

2212

Western Reserve U. [Dept. of Physics] Cleveland, Ohio.

LOW-INTENSITY CONVERSION LINES IN TWO WEAKLY DEFORMED NUCLEI, by W. T. Achor, W. E. Philips and others. May 12, 1959 [29]p. incl. diagrs. tables, refs. (AFOSR-TN-59-433) (In cooperation with Vanderbilt U.) (Sponsored jointly by Air For e Of ice of Scientific Research under AF 18(603)61 and Atomic Energy Commission under AT(40-1)268 and AT(40-1)-1322) AD 214795; PB 143070   Unclassified

Also published in Phys. Rev., v. 114: 137-142, Apr. 1, 1959. (Title varies)

The electron spectrum of Sm^{151} has been measured with a lens spectrometer and its gamma-ray spectrum with a scintillation spectrometer. The L-conversion coefficient of the 21.7 ± 0.3 kev de-excitation of the first excited state of Eu^{151} is 20 ± 4, with α_L/α_{M+N} = 2.2 ± 0.4 and α_M/α_N = 2.2 ± 0.2 indicating M1 multi-polarity. The low intensity of the conversion electrons relative to the continuous beta spectrum of end point 75.9 ± 0.6 kev implies the existence of a weak beta transition whose end point is 54.2 ± 0.7 kev. The beta branching ratio 54.2-kev beta transitions/75.9 kev beta transitions is 1.7/100. Log_{10}ft values for the two beta decays are 7.6 ± 0.2 for the 75.9-kev decay and 8.8 ± 0.2 for the 54.2 kev decay. A partial analysis of the decay in terms of the Nilsson-Gottfried scheme has been made, but no definitive assignment for the 21.7-kev state appears to be possible. Measurements of the electron spectrum of Sn^{113} with the lens spectrometer reveal the existence of a weak conversion line corresponding to a transition of 253 kev. The intensity of this conversion line is $(2.8 \pm 1.0) \times 10^{-3}$ of the intensity of the conversion line from the 392-kev transition. This relative conversion electron intensity indicates that the 253-kev transition leads to the 392-kev state of In^{113}, implying the existence of an excited state at 645 kev. The existing uncertainty in the relative gamma-ray intensities for the 2 transitions makes it impossible to assign spin and parity to the 645-kev state; the decay scheme presented is therefore incomplete. (Contractor's abstract)

2213

Western Reserve U. Dept. of Physics, Cleveland, Ohio.

FITTING OF TABULATED DATA TO AN ANALYTIC FORM, by V. F. Walters and G. E. Tauber. July 31, 1959 [7]p. incl. tables. (AFOSR-TN-59-736) (AF 18-(603)61) AD 220083; PB 142991   Unclassified

A study is presented for finding an analytic function to fit a given set of tabulated values for K and L_I wave functions. It was desirable to find a minimum number of parameters which determine an analytic form that has approximately the same behavior as the original set of values. A method which produces good results with satisfactory accuracy depends on integrating the function over all points. Such integrations lead to a system of exact equations for the parameters. The method is simple and straightforward and should lend itself equally well to similar problems. The method of least squares was also used, and satisfactory results were obtained for some functions (Contractor's abstract)

2214

Western Reserve U. [Dept. of Physics] Cleveland, Ohio.

ON THE HALF-LIFE OF Tl^{204}, by R. W. Fink and B. L. Robinson. [1959] [6]p. incl. tables, refs. (In co-operation with Arkansas U.) [AF 18(603)61]
                    Unclassified

Published in Nuclear Phys., v. 10: 82-89, Feb. 1959.

Samples of Tl^{204} produced in different irradiations and of varying ages were counted in an end-window methane-flow beta-proportional counter for a period of 1.4 yr. The decay curves for these samples are identical, and the average value of the half-life is 3.78 ± 0.04 yr. Intercomparison of the ratio of K x-rays to beta-bremsstrahlung and of L x-rays to beta-bremsstrahlung between young (few mo) and aged (6 yr) reactor-produced, high specific activity solutions of Tl^{204} exhibited no differences which might arise from the presence of a long-lived isomeric state in thallium. Previous results are summarized. (Contractor's abstract)

2215

Western Reserve U. [Dept. of Physics] Cleveland, Ohio.

NUCLEAR STRUCTURE EFFECTS IN INTERNAL CONVERSION COEFFICIENTS BY CONFIGURATION MIXING, by L. S. Kisslinger. [1959] [13]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)61] and Oak Ridge Inst. of Nuclear Studies)   Unclassified

Published in Phys. Rev., v. 114: 292-304, Apr. 1, 1959.

The nuclear matrix elements which are needed to determine the internal conversion coefficients when a finite nucleus is employed are derived for nuclei for which the shell model wave functions are a good zero-order approximation for low-energy processes. Using configuration mixing, general expressions are derived for these matrix elements. It is shown that the nuclear structure alteration can be 10 to 20% or more for 1-forbidden transitions. Numerical results are given for the M1 and E2 279-kev transitions in Tl^{203}. (Contractor's abstract)

2216

Western Reserve U. School of Library Science, Cleveland, Ohio.

THE STORAGE AND RETRIEVAL OF NONNUMERICAL DATA IN LARGE AND COMPLEX DOCUMENTATION SYSTEMS, by A. Kent and J. W. Perry. Feb. 24, 1959, 25p. incl. diagr. (Technical note no. 6) (AFOSR-TN-59-82) (AF 49(638)357) AD 210142; PB 151639
Unclassified

Presented at meeting of the Amer. Soc. Mech. Engineers, Cleveland, Ohio, Mar. 30, 1959.

The introduction of automatic routines for the precise selection of pertinent information from large document collections covering broad areas of subject matter requires a careful analysis of the input and output phases of the documentation system used. A simplified model has been hypothesized to provide a universe of information with which to study various information retrieval systems, and to provide a basis for characterizing and later identifying information which involves no uncertainty. Some of the problems involved when uncertainty is introduced are discussed in qualitative terms. (Contractor's abstract)

2217

Western Reserve U. School of Library Science, Cleveland, Ohio.

THE PROCESSES OF DOCUMENTATION, by R. E. Booth and H. M. Wadsworth. Feb. 18, 1959, 29p. incl. diagrs. tables, refs. (Technical note no. 7) (AFOSR-TN-59-222) (AF 49(638)357) AD 211804; PB 142296
Unclassified

A documentation system is defined as a complex pattern of interacting and interdependent processes which facilitates the use of recorded specialized knowledge through its presentation, reproduction, publication, dissemination, acquisition, characterization, storage, and retrieval. These processes are divided into 2 categories: (1) processes over which the documentalist normally exercises little or no control; and (2)

processes over which the documentalist exercises a high degree of control. The latter group is the main subject of this paper. The processes are described verbally, then symbolized for statistical formulation. Statistical models are developed. A confidence interval for estimating the number of items available on a given subject is presented as part of the analysis of the acquisition process. Characterization, storage, and retrieval are examined from the point of view of sets and transformations which, in turn, are described in terms of Boolean algebra. (Contractor's abstract)

2218

Western Reserve U. School of Library Science, Cleveland, Ohio.

THE APPLICATION OF STATISTICAL DECISION THEORY TO PROBLEMS OF DOCUMENTATION, by H. M. Wadsworth and R. E. Booth. Mar. 9, 1959, 24p. incl. diagrs. tables. (Technical note no. 8) (AFOSR-TN-59-418) [AF 49(638)357] AD 215225; PB 142340
Unclassified

The application of statistical decision theory to documentation processes is considered. Choices of action in information retrieval situations are described and discussed quantitatively. Game theory is used to solve an illustrative problem involving documentalist's decision to stop or to continue searching. The players in this theoretical game are Nature and the documentalist. The documentalist used Bayes' solution to evaluate alternative strategies with Nature's strategies restricted. Concept of loss function based on utility theory is introduced. (Contractor's abstract)

2219

Western Reserve U. School of Library Science, Cleveland, Ohio.

MINIMUM CRITERIA FOR A COORDINATED INFORMATION SERVICE, by A. Kent. Oct. 16, 1959, 10p. incl. table. (Technical note no. 10) (AFOSR-TN-59-1140) (AF 49(638)357) AD 229882   Unclassified

Also published in Amer. Doc., v. 11: 84-87, 1960.

A set of minimum criteria for a coordinated information service was prepared in connection with various programs on the machine searching and correlation of metallurgical literature conducted by the Center for Documentation and Communication Research. Suggested criteria are listed and factors relating to these criteria which apply to the American Society for Metals pilot machine searching operation are indicated. (Contractor's abstract)

2220

Western Reserve U. School of Library Science,
Cleveland, Ohio.

MACHINE LITERATURE SEARCHING AND TRANSLA-
TION. AN ANALYTICAL REVIEW, by A. Kent. [1959]
[224]p. incl. diagrs. tables. (Technical note no. 11)
(AFOSR-TN-59-1141) (AF 49(638)357) Unclassified

Also published in Advances in Doc. and Library Sci.,
v. 3 (Pt. 1): 13-236, 1960.

New methods and devices for the analysis and retrieval
of recorded information attempt to provide a multidi-
mensional approach to these problems. The various de-
vices may be grouped in 6 broad classifications: (a)
Hand-sorted punched cards (document system); (b)
Hand-manipulated aspect cards (aspect system); (c)
Machine-sorted punched cards (document or aspect
systems); (d) Machine-manipulated aspect cards (as-
pect system); (e) Tape-reading devices (document or
aspect systems); and (f) Photographic film devices
(document system). Their similar or differing charac-
teristics are described. The many approaches to prob-
lems of mechanical translation of languages are dis-
cussed, according to their various goals and differing
research tactics, and common procedures and methods
are outlined. The world's literature of machine search-
ing and machine translation is reviewed.

2221

Westinghouse Electric Corp. Air Arm Div., Baltimore,
Md.

TRAJECTORY PROBLEMS IN CISLUNAR SPACE. Dec.
31, 1959, 42p. incl. diagrs. (AFOSR-TN-59-1284)
(AF 49(638)490) AD 230878; PB 145477
Unclassified

A numerical investigation was conducted of the earth-
moon-vehicle system as a planar, restricted 3-body
problem. Analytical methods were used to determine
the effects of variations in lunar orbit injection condi-
tions upon significant orbital parameters. From these
data, guidance and vernier propulsion requirements and
trade-offs may be determined for specific missions in
cislunar space. The significant parameter of velocity
relative to the moon is also investigated. The result
obtained is that the effects of a midcourse velocity cor-
rection on lunar miss distance and passing velocity are
of opposite sense; that is, if one is increased the other
is decreased. A velocity impulse in certain directions
has no effect on either miss distance or passing veloc-
ity and that, in general, at least 2 midcourse impulses
may be required to correct both of these factors. The
sensitivity of terminal miss and velocity conditions to
midcourse corrections in the most effective direction
is quite high, varying in the case of miss distance from
about 75 mi at the moon per mph correction to 20 mi
per mph and in the case of passing velocity, from about
17 to 5 mph at the moon per mph correction.

2222

Westinghouse Electric Corp. Air Arm Div., Baltimore,
Md.

TECHNIQUES FOR GUIDANCE, NAVIGATION, AND
COMMUNICATION IN CISLUNAR SPACE FLIGHT
(Unclassified title), by G. Shapiro and J. M. Edminston.
Technical rept. Dec. 30, 1959, 54p. incl. illus. diagrs.
(AFOSR-TR-59-211) (AF 49(638)490) AD 314895
Secret

2223

[Westinghouse Electric Corp.] Westinghouse Research
Labs., Pittsburgh, Pa.

IONIC PUMPING MECHANISM OF HELIUM IN AN
IONIZATION GAUGE, by L. J. Varnerin, Jr. and J.
H. Carmichael. [1955] [2]p. incl. diagr. [AF 18-
(600)1049] Unclassified

Published in Jour. Appl. Phys., v. 26: 782-783, June
1955.

This report gives an explanation on the pumping of
helium. The experiment utilized a Bayard-Alpert
gauge which had no previous outgassing. It is shown
that ions driven into a metal film cannot diffuse as
freely as in glass and can be trapped. For very thin
films the amount of gas depends upon the thickness of
the film.

2224

[Westinghouse Electric Corp.] Westinghouse Research
Labs., Pittsburgh, Pa.

ROLE OF RE-EMISSION IN IONIC PUMPING (Ab-
stract), by L. J. Varnerin, Jr. and J. H. Carmichael.
[1955] [1]p. [AF 18(600)1049] Unclassified

Published in Phys. Rev., v. 99: 1662, Sept. 1, 1955.

The ionic pumping mechanism of helium in a Bayard-
Alpert ionization gauge has been investigated. The
reduction in pumping speed resulting in a nonexpo-
nential pressure reduction in a closed system is
shown to result from the re-emission of helium pre-
viously pumped. The rate of re-emission was deter-
mined as a function of time from 0.5 min to 5000 min
after pumping a small amount of gas for 0.5 min (pres-
sure reduction Δp mm). The re-emission rate was
found to be approximately $C(mm/min) = 0.04\Delta p (mm)/$
$t^{1.1}$ (min) in this time interval. It is not possible in
any simple way to account for this on the basis of gas
diffusing to a surface into which the ions had been
driven. This phenomenological equation for the re-
emission of helium is used to derive an integro-dif-
ferential equation applicable to the pumping process.
Within the experimental accuracy of the data, the

equation is shown to account quantitatively for observed pumping experiments in which pressure is reduced from 8×10^{-5} mm to 3×10^{-8} mm and the effective pumping speed reduces by a factor of 400. (Contractor's abstract)

2225

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

ELECTRICAL CLEANUP OF GASES, by J. H. Carmichael. Final progress rept. Mar. 1954-Mar. 1959. May 1, 1959, 3p. (Research rept. no. 71F191-R2C) (AFOSR-TR-59-80) (AF 18(600)1049) AD 219190   Unclassified

A study of the mechanism for trapping [..ses as ions on metal surfaces was made. In order to separate ionic pumping from chemical absorption, only rare gases were used. In these studies it was found that the re-emission of these gases from the surface was playing an important role. A study of the ionic pumping and spontaneous re-emission of these gases has contributed considerably in an understanding of the pumping characteristics of ion pumps and ionization gauges. (Contractor's abstract)

2226

Wisconsin U. Dept. of Chemistry, Madison.

FREE RADICAL AND IONIC ADDITION REACTIONS TO CARBON-CARBON DOUBLE BOND, by H. L. Goering. Final rept. May 7, 1959 [3]p. incl. refs. (AFOSR-TR-59-38) (AF 18(600)1037) AD 213886   Unclassified

A summary of nine manuscripts published in the Jour. Amer. Chem. Soc. is presented. Included in the research project are the stereospecificity of the radical addition of HBr and sulhydryl compounds. Ionic additions are also studied and the chemistry of the more interesting adducts was investigated. Also bound in the report is part IV, The Radical Addition of Hydrogen Bromide and Deuterium Bromide to cis- and trans-2-Bromo-2-butene, of the project, Stereochemistry of Radical Additions.

2227

Wisconsin U. Dept. of Chemistry, Madison.

THE STEREOCHEMISTRY OF RADICAL ADDITIONS. IV. THE RADICAL ADDITION OF HYDROGEN BROMIDE AND DEUTERIUM BROMIDE TO CIS AND TRANS 2-BROMO-2-BUTENE, by H. L. Goering and D. W. Larsen. [1959] 25p. incl. diagrs. tables, refs. (Bound with its AFOSR-TR-59-38; AD 213866) (AF 18(600)1037)   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 5937-5942, Nov. 20, 1959.

The radical-chain additions of HBr and DBr to the isomeric 2-bromo-2-butenes at -80° in excess liquid HBr or DBr are completely stereospecific. Under these conditions the trans-addition products are obtained. As the reaction temperature is increased, i.e., as the amount of addendum in the liquid phase decreases, the stereospecificity diminishes to the point where addition is nearly random at room temperature. Under all conditions the degree of stereospecificity appears to be about the same for HBr and DBr. The intermediate 2,3-dibromobut-2-yl radical reacts about 2,4 times faster with HBr than with DBr. Radical addition gives only 2,3-dibromobutane and ionic addition results in the exclusive formation of 2,2-dibromobutane. (Contractor's abstract)

2228

Wisconsin U. Dept. of Chemistry, Madison.

PYRIDINIUM COMPLEXES. III. CHARGE-TRANSFER BAND OF POLYALKYLPYRIDINIUM IODIDES, by E. M. Kosower and J. A. Skorcz. Sept. 29, 1959 [39]p. incl. diagrs. tables, refs. (AFOSR-TN-59-811) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)282 and National Institutes of Health) AD 226713; PB 143599   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 2195-2203, May 5, 1960.

A study of the first (long wavelength) charge-transfer band of 20 different alkylpyridinium iodides under carefully standardized conditions has established that (1) increasing the number of methyl groups raises the transition energy (2) changing a methyl group from the 3- to the 2- to the 4-position increases the transition energy (3) varying the nature of the alkyl group from methyl to t-butyl on the 4-position has virtually no effect upon the transition energy and (4) the solvent sensitivity of 1-methylpyridinium iodide is appreciably greater than that of 1-ethyl-4-carbomethoxypyridinium iodide, as might have been expected on the basis of a previously proposed model. The maxima observed varies from 3738A for 1-methylpyridinium iodide to 3253A for 1,2,3,4,5,6-hexamethylpyridinium iodide. Surprisingly, replacement of the 1-methyl by hydrogen moves the charge-transfer band to 3463A. Two points favor the interpretation of the effect of alkyl groups as being due to the bond dipole generated by the combination of an sp^3 bonding orbital with an sp^2 orbital: (1) the effect of the 3-methyl group can be accounted for on the basis of electrostatic stabilization of the ground state and (2) a change in the nature of the alkyl group on the 4-position does not elicit electron-supply dependent on the number of α-hydrogens, as would have been expected for hyperconjugation. It is known that the absorption bands of alkylpyridinium iodides are a transition charge-transfer from the iodide ion to the alkylpyridinium ion on the basis of solvent effects, difference in

transition energy values, conductivity measurements, and a few substituent effects. In order to define the substituent effects on these absorption bands in a more precise manner, a series of different alkylpyridinium iodides were investigated. It was hoped that the relationships found would also cast some light upon the means by which alkyl groups supply electronic charge to electron-deficient systems. By rigid control of the many variables which affect the environment-sensitive pyridinium iodide transition, it is possible to obtain data applicable to both of these purposes.

2229

Wisconsin U. Dept. of Chemistry, Madison.

THE STUDY OF PYRIDINIUM IODIDE CHARGE-TRANSFER BANDS, by E. M. Kosower and J. A. Skorcz. Sept. 29, 1959 [9]p. incl. diagr. table, refs. (AFOSR-TN-59-812) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)282 and National Institutes of Health) AD 226711; PB 143641
Unclassified

Presented at Fourth Internat'l. meeting on Molec. Spectros., Bologna (Italy), Sept.7-12, 1959.

Also published in Advances in Molec. Spectros., v. 1: 413-417, 1962.

The general nature of pyridinium iodide light absorption is discussed. It is pointed out that the high sensitivity of this electronic transition to internal and external influences makes detailed study very rewarding with respect to information on electrical, steric, and solvent effects.

2230

Wisconsin U. Dept. of Chemistry, Madison.

PYRIDINIUM COMPLEXES. I. THE SIGNIFICANCE OF THE SECOND CHARGE-TRANSFER BAND OF PYRIDINIUM IODIDES, by E. M. Kosower, J. A. Skorcz and others. Sept. 29, 1959 [10]p. incl. diagrs. tables, refs. (AFOSR-TN-59-813) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)282 and National Institutes of Health)
AD 226712; PB 143599   ... ssified

Also published in Jour. Amer. Chem. Soc., v. 82: 2188-2191, May 5, 1960.

Research was undertaken to show how the existence of the second charge-transfer absorption band is in accord with the current model (WIS.05:001, Vol. II) for pyridinium iodide charge-transfer transitions. The close correspondence of the ΔTE value, the difference between the transition energies for the 2 bands, for 1-methylpyridinium iodide in chloroform to the ΔTE value

expected for production of an iodine atom is evidence for the charge (electron)-transfer nature of the excitation in the pyridinium iodide.

2231

Wisconsin U. Dept. of Chemistry, Madison.

HYDROGEN BONDING STUDIES. II. THE ACIDITY AND BASICITY OF SILANOLS COMPARED TO ALCO-HOLS, by R. West. May 28, 1959, 15p. incl. diagrs. table, refs. (AFOSR-TN-59-473) (AF 49(638)285) AD 215716; PB 142157   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 6145-6148, Dec. 5, 1959.

The hydrogen bonding acidity and basicity of some silanols and carbinols has been determined by the measurement of O-H stretching infrared band shifts upon admixture with the bases ether and mesitylene, and the acid phenol, respectively. The silanols studied are much more strongly acidic, but only slightly less basic, than the carbinols with analogous structure. The results for the silanols are discussed in terms of a model with strong π-bonding from oxygen to silicon involving only 1 of the 2 unshared electron pairs on the silanol oxygen. Intermolecular association of silanols was also studied by infrared spectroscopy. Trimethyl- and triethylsilanol are somewhat more highly associated than the corresponding carbinols, and the hydrogen bonds formed between silanol molecules appear to be decidedly stronger than those involving alcohols.

2232

Wisconsin U. Dept. of Chemistry, Madison.

NATURE OF PI-BONDING FROM OXYGEN TO SILICON IN ORGANOSILICON COMPOUNDS, by R. H. Baney, K. J. Lake and others. Dec. 8, 1959 [1]p. incl. table, refs. (AFOSR-TN-59-741) (AF 49(638)285) AD 229578
Unclassified

Also published in Chem. and Indus. (London), No. 36: 1129-1130, Sept. 5, 1959.

It is thought that the π bonding in silanols involves only 1 of the 2 unshared electron pair on the oxygen: $R_3Si-\overset{..}{O}-H \leftrightarrow R_3Si = \overset{..}{O}-H$. Basicity measurements are conducted on alkoxysilanes, siloxanes, and ethers with analogous structures. The following interpretations are presented: (1) $d\pi$-$p\pi$ bonding takes place in all of the silicon-oxygen compounds; (2) in alkoxysilanes and silanols the π-bonding is of the type described above, involving only 1 unshared pair on oxygen; and (3) in siloxanes, where 2 silicon atoms are bonded to each oxygen, both pairs of electrons on oxygen are involved in partial π-bonding: $R_3Si-\overset{..}{O}-SiR_3 \leftrightarrow R_3Si = O = SiR_3$.

2233

Wisconsin U. Dept. of Chemistry, Madison.

HYDROGEN BONDING STUDIES. IV. ACIDITY AND
BASICITY OF TRIPHENYLHYDROXY COMPOUNDS OF
GROUP IV$_B$ ELEMENTS AND THE QUESTIONS OF PI-
BONDING FROM OXYGEN TO METALS, by R. West
and R. H. Baney. Dec. 8, 1959 [16]p. incl. diagr. table,
refs. (AFOSR-TN-59-1207) (AF 49(638)285)
AD 229577; PB 144865   Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82:
6269-6272, Dec. 21, 1960.

The acidity and basicity as hydrogen bond donors and
acceptors was measured for the compounds Ph_3MOH,

where M = C, Si, Ge, Sn and Pb. The trends in acidity
and basicity in these compounds indicate that dative
pi-bonding from oxygen to M is strong in Ph_3SiOH,

weaker in Ph_3GeOH, and negligible in the other 3 com-

pounds. A linear relationship was found between ν OH
and the electronegativity of M, for these and related
hydroxyl compounds. (Contractor's abstract)

2234

Wisconsin U. Dept. of Physics, Madison.

ON THE MECHANISM OF THE SMALL ANGLE X-RAY
SCATTERING FROM COLD WORKED METALS, by
R. H. Neynaber, W. G. Brammer, and W. W. Beeman.
[1959] [6]p. incl. diagrs. (AF 18(600)698)
                                        Unclassified

Presented at meeting of the Small Angle X-Ray Conf.,
Kansas City, Mo., Sept. 23-25, 1958.

Published in Jour. Appl. Phys., v. 30: 656-661, May
1958.

The characteristic small angle x-ray scattering from
cold worked polycrystalline foils of Cu, Al, and Ni is
found to appear immediately when the foil is stretched
in the x-ray beam at liquid air temperature. The scat-
tering at a fixed angle is a reversible function of foil
temperature as long as recrystallization temperatures
are not exceeded. The temperature dependence is about
twice that expected from the Debye temperature factor
of an average Bragg reflection. It is postulated that the
small angle scattering is the result of 2 successive
Bragg reflections from 2 slightly misoriented subgrains
of the same grain. The small angle scattering is found
to be polarized. This can be understood only on the dou-
ble Bragg scattering model. The double Bragg model
was suggested by our observation of occasional isolated
small angle peaks from annealed foils. These have unu-
sual characteristics which quickly eliminate any possi-
ble single scattering source. They are double scatter-
ing from 2 large annealed grains which sometimes acci-
dentally satisfy all the orientation requirements. (Con-
tractor's abstract)

2235

Wisconsin U. [Dept. of Physics] Madison.

DOUBLE BRAGG SCATTERING IN COLD-WORKED
METALS, by M. B. Webb and W. W. Beeman. [1959]
[7]p. incl. diagrs. tables, refs. (AF 18(600)698)
                                        Unclassified

Published in Acta Metall., v. 7: 203-209, Mar. 1959.

The small-angle x-ray scattering from cold-worked
metals is examined in terms of a double Bragg scatter-
ing mechanism. The intensity and angular distribution
of the scattering expected from this mechanism are
calculated and found to be in accord with experiment.
It is shown that this mechanism should give a strongly
polarized scattered flux at small angles and that the
strong electric vector should be radial in the detecting
plane. The polarization of the scattered flux was meas-
ured and found in agreement with these predictions.
It is concluded that the double Bragg process and not densi-
ty fluctuation scattering is responsible for most of the ob-
served small-angle scattering. (Contractor's abstract)

2236

Yale U., New Haven, Conn.

PROCEEDINGS OF THE FIRST NATIONAL BIOPHYS-
ICS CONFERENCE, Columbus, Ohio (U.S.A.) (Mar. 4-
6, 1957), ed. by H. Quastler and H. J. Morowitz.
New Haven, Yale University Press, 1959, 756p. incl.
illus. diagrs. tables, refs. (AFOSR-5146) (AF 49(638)-
7)   Unclassified

This is a partial record of the First National (U.S.A.)
Conference on Biophysics and is intended to acquaint a
wide public with the present state of biophysical research
in this country. The volume consists of 214 articles of
papers submitted by invitation of the Program Commit-
tee or editors, papers submitted by authors and select-
ed by the editors, and all abstracts which were submit-
ted for presentation at the conference. It represents a
composite view of the frontiers of biophysics. The top-
ics are mainly in the fields of biology and medicine
pertaining to application of physicists' methods and in-
struments to biologists' problems. After an introduc-
tion of 3 papers, the remaining papers and abstracts
are arranged by topics under Part I (physical biology)
and Part II (medicine). Subject and author indices are
provided.

2237

Yale U. [Dept. of Mathematics] New Haven, Conn.

ON THE MAXIMALITY OF VANISHING ALGEBRAS,
by A. B. Simon. [1959] [4]p. (AF 18(600)1127)
                                              Unclassified

Published in Amer. Jour. Math., v. 81: 613-616,
July 1959.

Let G be a locally compact abelian group, μ the Haar
measure of G, L^1 the usual convolution algebra, S a
subset of G, and L_s the set of all functions the supports
of which lie in S. If G is the real line and S = $(0, \infty)$,
then as was proven by J. Wermer, L_s is the maximal.
The following theorem is proven. Let S be a measura-
ble subsemigroup of G. If L_s is a maximal proper
closed subalgebra of L^1, then G is (continuously iso-
morphic with) either a discrete subgroup of the reals
or the real line itself (with S mapping onto the non-neg-
ative part). The proof is based on a theorem concern-
ing Hölder groups which is due to F. B. Wright (Duke
Math. Jour., v. 24: 567-571, 1957) and on the following
remarks. Let H be a measurable semigroup contained
in G such that L_H is a maximal proper closed subalge-
bra of L^1. Then (1) H $\cap$ (-H) = $\{0\}$; (2) there is a maxi-
mal subsemigroup F_0 of the group G such that $L_F = L_H$
and $F_0 \cap (-F_0) = \{0\}$.

2238

Yale U. [Dept. of Mathematics] New Haven, Conn.

COMPOSITION ALGEBRAS AND THEIR AUTOMOR-
PHISMS, by N. Jacobson. [1959] 26p. incl. refs.
(AFOSR-TN-59-1117) (AF 49(638)110) AD 230513
                                              Unclassified

Also published in Rend. Circ. Matem. Palermo, Series
II, v. 7: 55-60, Jan.-Apr. 1958.

Automorphisms and groups of automorphisms of com-
position algebras are studied. Composition algebras are
the algebras arising from quadratic forms which per-
mit composition. These algebras are mainly quaternion
algebras and Cayley algebras. The problem of deter-
mining the quadratic forms which permit composition
(Hurvitz's problem) is solved for the case of character-
istic not 2. The analysis of the composition algebras is
essential for the study of their automorphisms. The
structure of the group of automorphisms of an arbitrary
Cayley algebra of characteristic not 2 is studied. Sim-
ple generators are obtained and the subgroups deter-
mined, giving fixed elements of a quaternion subalgebra
or a quadratic subalgebra. An analogue is proved for
Cayley algebras of the theorem that the automorphisms
of a central simple associative algebra are all inner.
(ASTIA abstract)

2239

[Yale U. Dept. of Mathematics] New Haven, Conn.

SOME GROUPS OF TRANSFORMATIONS DEFINED BY
JORDAN ALGEBRAS. I, by N. Jacobson. [1959] [18]p.
incl. refs. (AFOSR-TN-59-1118) (AF 49(638)110)
                                              Unclassified

Also published in Jour. Reine Angew. Math., v. 201: 178-
195, 1959.

The definition of the groups and Lie algebras in the gen-
eral case and their determination for special Jordan al-
gebras with some restrictions on the base field are pre-
sented. The theory of generic minimum polynomials for
arbitrary strictly power associative algebras is used as
a starting point and from it are obtained the main prop-
erties needed in the sequel. The case of central simple
Jordan algebras is discussed in the 2nd part. The ge-
neric minimum polynomials for these are derived and
some further essential properties established. In the
last section the results are utilized to obtain similar
ones for Lie algebras and to obtain the known structure
of orthogonal groups in 4 dimensional spaces relative to
quadratic forms with square discriminants.

2240

Yale U. [Dept. of Mathematics] New Haven, Conn.

[FUNCTIONAL AND CLASSICAL ANALYSIS]

by E. Hllle. Flnal rept. [1959] 2p. (AFOSR-TR-
59-158) (A F 49(638)153)   Unclassified

This contract served as the economic backbone of the
Special Program In Analysis at Yale during the academic
years 1957-1959. The present paper reports briefly the
visltors and students contributing to the research and a
list of 6 publications resulting from the work of two of
the visiting students.

2241

Yale U. [Dept. of Mathematics] New Haven, Conn.

SPECTRAL REPRESENTATION OF CERTAIN SEMI-
GROUPS OF OPERATORS, by C. Ionescu Tulcea. [1959]
[15]p. lncl. refs. (AF 49(638)153)   Unclasslfied

Published in Jour. Math. and Mech., v. 8: 95-109, Jan.
1959.

Let G be a locally compact group, S a locally compact
semi-group in G for which every non-vold open set in S
has posltive Haar measure. A character on S is a con-
tinuous complex valued function $\chi (\neq 0)$ which satisfies
$\chi(s)\chi(t) = \chi(st)$ for every s, t ϵ S. Let E be the collection
of characters endowed with the topology of unlform con-
vergence on compact sets. For any locally bounded
function $r(s) \geq 0$, defined on S, let E(r) be the subset of
E for which $|\chi(s)| \leq r(s)$. It is shown that E(r) is locally
compact and also gives sufficlent conditions under whlch
E is locally compact. The prlncipal result of the paper
concerns the integral representation of semi-groups of
normal operators (not necessarily bounded) whlch act
on a Hllbert space X. Let $\{U_s; s \epsilon S\}$ be a set of nor-
mal operators on X whlch satisfy the conditions: (1)
$U_{st} \subseteq U_s U_t$; (2) U_s and U_t commute; (3) $(U_s x | y)$ is con-
tinuous for every x $\epsilon \cap D(U_s)$ and y ϵ X. (In the case
where the U_s are not bounded operators, more condi-
tions are required on S.) Then there exists a unique
Hermitian spectral famlly $\{\mu_{x,y}; x,y \epsilon X\}$ on E such
that $(U_s x|y) = \int E\chi(s) d\mu_{x,y}(\chi)$. In case the operators
are all bounded, integration over E may be replaced by
integration over an E(r). Math. Rev. abstract)

2242

Yale U. [Dept. of Mathematics] New Haven, Conn.

SOME REMARKS ON COMMUTATIVE ALGEBRAS OF
OPERATORS ON BANACH SPACES, by D. A. Edwards
and C. T. Ionescu Tulcea. [195..] [11]p. (AF 49(638)-
153)   Unclassified

Published in Trans. Amer. Math. Soc., v. 93: 541-551,
Dec. 1959.

A serles of propositions are given in 4 parts concerning
commutative algebras of operators on a Banach space

and more especially commutative algebras of scalar
operators. (1) As an introduction, various results on
spectral families of measures are described. (2) Let A
be a nonempty bounded subset of X and suppose that
$T \in \Omega(X,X)$ is an operator such that: (i) $TU_f x = U_f Tx$ for
all f $\in$ C(Z) and x $\in$ A; (ii) $(Tx)_{x \epsilon A} \in \Omega(\beta,A)$. Then
there is a function g $\in L^1(Z,A)$ such that: (j) $\|g\| =$
$M(\beta)\|T\|$; (jj) $U_g x = Tx$ for every x belonging to the closed
linear space $\mathfrak{M}$ spanned by $U_{x \epsilon A}\Omega(\beta, \{x\})$. This ls a
generalization of a theorem due to W. G. Bade. (3) It ls
shown that under certain conditions, an algebra of scaler
operators can be ldentified wlth a von Neumann algebra.
Thus it ls possible to reduce many results concerning
algebras of scalar operators or σ-complete boolean al-
gebras of projections, in Banach spaces, to correspond-
ing results ln Hilbert spaces. (4) Varlous remarks on
spectral famllies of measures are made.

2243

Yale U. [Dept. of Mathematics] New Haven, Conn.

SOME THEOREMS ON FOURIER COEFFICIENTS, by
W. Rudin. [1959] [5]p. (F 49(638)153)   Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 855-859,
Dec. 1959.

The trigonometrlc polynomials with coefficients ± 1 ls
considered. Theorem I: There exists a sequence $\{\epsilon_n\}$
(n = 1, 2, 3, ...), wlth $\epsilon_n = \pm 1$, such that
$$\sum_{n=1}^{N} \epsilon_n e^{in\theta} < 5N^{1/2}, \ (0 \leq \theta < 2\pi; N = 1, 2, 3, ...).$$
Shapiro's proof for this theorem is given. Consider p
and q will always denote conjugate exponents. For
$1 \leq p < \infty$, L^p denotes the usual Lebesgue space of com-
plex functions on the unit circle. L^∞ ls the space of all
essentially bounded measurable functions on the circle.
The Fourier coefflclents of any f ϵL^1 wlll be denoted
by $\hat{f}(n) = \frac{1}{2\pi} \int_{-\pi}^{\pi} f(e^{i\theta})e^{-in\theta} d\theta$, (n = 0, ± 1, ± 2, ...). Theo-
rem II: Suppose $1 < p \leq 2$, and suppose there ls a con-
stant A such that $|F(z)| \leq A|z|^{q/2}$ near the orlgin. Then
F maps L^p into L^2. Theorem iII. Suppose $1 \leq p \leq 2$.
If $|F(z)| = A|z|^{2/p}$ near the origin, then F maps L^q lnto
L^q. When it is restricted to even functions F, Theorem
I can be used to show that Theorem III states a condi-
tion which is necessary as well as sufficient. Thus the
following Theorem IV holds: Suppose $1 \leq p < \infty$, F is an
even function, and $|z|^{-2/p}|F(z)|$ is not bounded near
the origin. Then there ls a contlnuous function f on the
circle to whlch corresponds no gϵL^q wlth $\hat{g} = F(\hat{f})$.

2244

Yale U. [Dept. of Mathematics] New Haven, Conn.

A CLASS OF SINGULAR INTEGRALS, by D. A. Edwards. [1959] [16]p. (AF 49(638)153) Unclassified

Published in Proc. London Math. Soc., v. 9: 161-176, 1959.

Let x denote a mapping of finite or infinite real linear interval I into a Banach space X over the real or complex field. For each compact interval $[a,b] \subseteq I$, let $E(a,b;x)$ be defined as the set of all finite sums of the form $\sum_{j=1}^{p} x(t_{2j}) - x(t_{2j-1})$, in which $a \leq t_1 < t_2 < ... < t_{2p} \leq b$. Let $E(I;x)$ denote the union of $E(a,b;x)$ for all $[a,b] \subseteq I$. The class of mappings x for which $E(I;x)$ is bounded is denoted by $\mathfrak{D}(I)$, and that for which $E(I;x)$ is conditionally weakly compact by $\mathfrak{Q}(I)$. The space of scalar-valued functions of bounded variation on I, with the usual norm, is denoted by $BV(I)$. The author shows first that if V denotes the mapping from X^* into the space of scalar-valued functions on I whose value at $x^* \in X^*$ is $x^* x(\cdot)$, then $x \in \mathfrak{D}(I)$ if and only if $VX^* \subseteq BV(I)$ and $x \in \mathfrak{Q}(I)$ if and only if V is a weakly compact operator from X^* into $BV(I)$. The singular integral theorem is then as follows. Let $I = [c,d]$ be a closed integral of $\overline{R}$ and $\{\varphi_n\}$ a sequence of scalar-valued functions defined on I^2 with $\varphi_n(t,\cdot)$ Lebesgue integrable over I for $n = 1,2,3,..., t \in I$. Let $x \in \mathfrak{Q}(I)$, let $J_n(x;t)$ denote the Bochner integral $\int c^d \varphi_n(t,u) x(u) du$, and let $\Phi(t,v) \equiv$ sign $(v - t) \int_t^v \varphi_n(t,u) du$ for $v, t \in I$. The following 3 conditions on the sequence $\{\varphi_n\}$ are then shown to be equivalent: (i) $J_n(\xi,t) \rightarrow \frac{1}{2}(\xi(t-0) + \xi(t+0))$ $(c < t < d)$ as $n \rightarrow \infty$ for each $\xi \in BV(I)$; (ii) $J_n(x, t) \rightarrow \frac{1}{2}(x(t-0) + x(t+0))$ $(c < t < d)$ strongly as $n \rightarrow \infty$ for each $x \in \mathfrak{Q}(I)$; (iii) for each fixed interior point t of I, $\Phi_n(t,v) \rightarrow \frac{1}{2}$ boundedly for $t < v \leq d$ and also boundedly for $c \leq v < t$ as $n \rightarrow \infty$. When these conditions hold the convergence in (i) takes place uniformly (for each fixed $t \in (c,d)$) over every conditionally weakly compact subset K of $BV(I)$. As an application, the real-valued functions ξ on I^2 of bounded Fréchet variation and bounded variation in each variable separately are characterized as those for which $x \in \mathfrak{D}(I)$ with $x(t) = \xi(t,\cdot), t \in I$.

2245

Yale U. [Dept. of Mathematics] New Haven, Conn.

ON A CLASS OF OPERATORS OCCURRING IN THE THEORY OF CHAINS OF INFINITE ORDER, by C. Ionescu Tulcea. [1959] [10]p. incl. refs. (AF 49(638)-153) Unclassified

Published in Canad. Jour. Math., v. 11: 112-121, 1959.

Let T and E be measurable spaces. If x is in E let u_x be a mapping of T into T. If t is in T and if A is a measurable subset of E, suppose that $p(t, A)$ defines a probability measure for fixed t, and define Uf, for f bounded and measurable on T, by $(Uf)(t) = \int_E p(t,dx) f[u_x(t)]$. Under supplementary hypotheses, ergodic properties of the sequence of powers of U are proved which contain various previous results proved in studies of chains of infinite order by Onicescu and Mihoc (Bull. Sci. Math., v. 59: 174-192, 1935), and later writers. Under suitable restrictions, with T the class of non-positive integers, it is shown that p is the transition function of a stationary mixing stochastic process, for which a form of the central limit theorem is stated. (Math. Rev. abstract)

2246

Yale U. Dept. of Mathematics, New Haven, Conn.

ON THE INVERSE FUNCTION THEOREM IN BANACH ALGEBRAS, by E. Hille. Apr. 1959, 9p. (AFOSR-TN-59-330) (AF 49(638)224) AD 213651; PB 146450 Unclassified

Also published in Bull. Calcutta Math. Soc., (Golden Jubilee Commemoration): 65-69, 1958-1959.

A proof is given of the inverse function theorem formulated for Frechet analytic functions with domain and range in a Banach algebra. A complex parameter α is introduced in the function, and the inverse function is obtained as a power series in α. The procedure makes it possible to use Cauchy's method of Calcul des limites for the convergence proof.

2247

Yale U. Dept. of Mathematics, New Haven, Conn.

AN APPLICATION OF PRÜFER'S METHOD TO A SINGULAR BOUNDARY VALUE PROBLEM, by E. Hille. [1959] [12]p. incl. table. (AF 49(638)224) Unclassified

Published in Math. Zeitschr., v. 72: 95-106, 1959.

It is known that under certain conditions the operator $b(x) d^2/dx^2$ subject to the boundary condition $y(0) = 0$ has pure point spectrum $0 < \lambda_0 < \lambda_1 < \lambda_2 ..., \lambda_n \rightarrow \infty$ on $C[0,\infty]$. A modification of the polar coordinate is used here to prove 2 theorems on the order of growth of λ_n as a function of n. [1] If $b(x) = (x + 1)^2 \omega(x)$, where (i) $\omega(x) > 0$, (ii) $\omega(x)$ is continuously differentiable and $\omega'(x) > 0$ for large x, and (iii) $J = \int_0^\infty |b(x)|^{-\frac{1}{2}} dx < \infty$; then $\lambda_n = (\pi n/J)^2 [1 + o(1)]$ as $n \rightarrow \infty$. [2] Suppose that (i) and (ii) hold, but that instead of (iii) it is required that (iv) for every $\epsilon < 0$ and $C > 1$ there is an $x(\epsilon,C)$ such

that $\omega(x) < \omega(y) < (1 + \epsilon)\omega(x)$ when $x(\epsilon,C) \leq x < y < Cx$,
(v) $\int_0^\infty x[b(x)]^{-1}dx < \infty$, and (vi) there is an integer
$p \geq 1$ such that $\lim \sup [\inf][\omega(x)]^{\frac{1}{2}}[L_p(x)]^{-1}\int_0^x (1 +$
$s)^{-1}[\alpha(s)]^{-\frac{1}{2}} ds = \mu_p[\beta_p]$, where $L_p(x) =$
$\log x \log_2 x \ldots \log_p x$, $\log_p x$ is the p times integrated
logarithm, and $1 \leq \beta_p \leq \mu_p < \infty$ except for $p = 1$ when
$1 < \beta_1$ is required. Then $\lambda_n = \rho_n^2 \omega[L_p^{-1} (\sigma_n n)]$ where
$\rho_n > \frac{1}{2}$ and tends to $\frac{1}{2}$ as $n \to \infty$, and
L_p^{-1} is the inverse function of L_p. The limits of inde-
terminacy of σ_n are $2\pi\mu_p^{-1} \leq \lim \inf \sigma_n = \lim \sup \sigma_n =$
$2\pi\beta_p^{-1}$ for $p > 1$. For $p = 1$, μ_p^{-1} is replaced by
$(\mu_1 + 1)^{-1}$ and β_p^{-1} by $(\beta_1 - 1)^{-1}$.

2248

Yale U. [Dept. of Physics] New Haven, Conn.

[BROADENING OF SPECTRAL LINES PRODUCED BY
THE IONS OF A PLASMA] Elargissement des raies
spectrales produites par des ions dans un plasma, by
M. B. Lewis and H. Margenau. [1959] [10]p. incl.
diagrs. tables. [AF 18(603)15]   Unclassified

Also published in Internat'l. Colloquium on the Optical
and Acoustical Properties of Compressed Fluids and
Molecular Interactions, Bellevue (France) (July 1-6,
1957), CNRS, Paris, 1959, p. 283-292.

For abstract see item no. YAL.08:005, Vol. II.

2249

Yale U. [Dept. of Physics] New Haven, Conn.

[THEORETICAL INTERPRETATION OF BAND SATEL-
LITES INDUCED BY PRESSURE] Essais d'interpréta-
tion théorique des bandes satellites induites par la
pression, by H. Margenau and L. Klein. [1959] [12]p.
incl. diagrs. refs. [AF 18(603)15]   Unclassified

Published in Internat'l. Colloquium on the Optical and
Acoustical Properties of Compressed Fluids and Mo-
lecular Interactions, Bellevue (France) (July 1-6, 1957)
CNRS, Paris, 1959, p. 283-292.

A quantum mechanical interpretation of pressure-
induced band satellites in terms of interaction energy
of oriented van der Waai molecules was made. Calcu-
lated splitting between E_0 and E_{+1} states is based on
earlier results. The $\Delta E_{0\pm1}$ is given for Ar perturba-
tion. The discussion is extended in terms of potential
curves and possible transitions in emission and absorp-
tion.

2250

Yale U. [Dept. of Physics] New Haven, Conn.

CLUSTER APPROACH TO THE STATISTICAL THEO-
RY OF LINE BROADENING BY IONS (Abstract), by
H. K. Wimmel and M. B. Lewis. [1959] [1]p. [AF 18-
(630)15]   Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Milwaukee, Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
318, June 18, 1959.

A general expression in terms of cluster integrals is
derived for the field distribution function in a dilute
gas, arbitrary particle fields and short-range interac-
tions between these particles being assumed. The for-
mula obtained reduces to Holtsmark's function for an
idealized plasma containing ions whose interaction is
neglected. By introducing a hard-sphere repulsion in
this model and taking into account 1- and 2-particle
cluster integrals only, the peak of the field distribution
shifts toward a field strength that is smaller by a factor
$\lambda = [1 - \{4\pi(\sqrt{2} - 1) D^3 n/3\}]^{2/3}$, where D = radius of
the hard-sphere potential, and n = particle density. For
a certain range of variables (small fields, low ion den-
sities) the new function is approximately a shifted
Holtsmark distribution.

2251

Yale U. [Dept. of Physics] New Haven, Conn.

HYPERFINE STRUCTURE OF THE METASTABLE
TRIPLET STATE OF HELIUM THREE, by J. A. White,
L. Y. Chow and others. [1959] [2]p. (Sponsored jointly
by Air Force Office of Scientific Research under [AF 18-
(603)15], National Science Foundation, and Office of Na-
val Research) AD 241029   Unclassified

Published in Phys. Rev. Ltrs., v. 3: 428-429, Nov. 1,
1959.

The frequency difference at zero magnetic field between
the levels $(3/2, -1/2)$ and $(1/2, -1/2)$ of the state $(1s2s,$
$^3S_1)$ was measured by the atomic beam magnetic reso-
nance method, which gave $\Delta\nu = (6739.7013 \pm 0.0004)$
mc/sec. Comparison between theory and experiment for
the ratio of this value to that for the $^2S_{1/2}$ state of the
He^{3+} ion (see item no. COU.19:009, Vol. II) gave a
larger discrepancy than expected. This is attributed to
inaccuracy in the computation of the relativistic correc-
tion for the atom.

2252

Yale U. [Hammond Metallurgical Lab.] New Haven, Conn.

LATTICE IMPERFECTIONS IN METALLIC AND IONIC
CRYSTALS [PART I] AND THE OPTICAL ABSORPTION
EDGE OF INSULATING CRYSTALS AT LOW TEM-
PERATURES [PART II], by A. S. Nowick and R. G.
Wheeler. Final rept. July 1, 1953-Feb. 28, 1959. Sept.
10, 1959, 12p. (AFOSR-TR-59-142) (AF 18(600)850)
AD 226965; PB 143955   Unclassified

Part I: The interactions between point defects and dis-
locations were investigated. The observations of Gyulai
and Hartly (Zeitschr. Phys. v. 51: 378, 1928), which
showed an enhancement of the conductivity of rock salt
by deformation, were confirmed and extended. The op-
tical properties of alkali halides were studied. Meas-
urements were made of the height of the F-band in
NaCl crystals under x-irradiation as a function of ir-
radiation dose and depth into the crystal. The results
showed that coloration by x-rays occurs in 2 stages.
The internal friction and elastic modulus of irradiated
alkali halide crystals were investigated. An irradiation
dose far below that required to produce an appreciable
F-center concentration greatly increased the modulus
and decreased the internal friction of a freshly de-
formed crystal; no change occurred in an annealed
crystal. Pure gold was selected for a study of quench
hardening phenomenon. The study led to the conclu-
sion that the annealing probably occurs by means of
self diffusion along dislocation lines. Part II: The
electronic band structure of CdS was studied. The
absorption lines were determined as a function of
crystal thickness. Edge luminescence in CdS is being
investigated.

2253

Yale U. [Sloane Physics Lab.] New Haven, Conn.

EFFECTS OF ATOMIC ELECTRONS ON p-p AND
n-p SCATTERING II, by G. Breit. Apr. 3, 1959, 3p.
(AFOSR-TN-59-369) (AF 18(600)771) AD 213861
                                   Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 401-402,
May 1, 1959.

The possibility that a screening effect, hitherto as-
sumed to be small, may prove to be nonnegligible at
low energies ($<$ 10 mev) was theoretically discussed.
Coulomb excitation of the molecular electrons and ac-
celeration of the target atom are considered. These
effects interfere with the employment of low energy
data for p-wave anomaly detection and increase the
relative importance of higher energy work.

2254

Yale U. [Sloane Physics Lab.] New Haven, Conn.

COMPENSATIONS IN ELECTRON EXCITATION

EFFECTS IN p-p AND p-n SCATTERING, by M. de Wit,
C. R. Fischer, and W. Zickendraht. May 5, 1959 [12]p.
(AFOSR-TN-59-486) (AF 18(600)771) AD 215779;
PB 142158   Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 1047-
1052, July 1959.

An account is given of calculations for monopole, dipole
and quadrupole Coulomb excitation. For each of the 3
multipoles the effects of the different channels were
combined, and finally the incoherent contributions were
added to the effects of the cross product terms on the
coherent scattering. Employing the asymptotic expres-
sion $kr - \eta \ln 2kr - (L\pi/2) + \arg (L+1+i\eta)$ for the phase of
the regular Coulomb function and 1 for its amplitude,
the result was found to be zero. This indicates that the
compensation of elastic and inelastic scattering effects
present in the classical mechanics treatment carries
over to some extent into the quantum mechanical prob-
lem. Separate action functions S_g, S_n are introduced for
treating nucleon motion in the ground and n^{th} excited
states as has previously been done for tracing corre-
spondence principle connections in nucleon Coulomb ex-
citation.

2255

Yale U. [Sloane Physics Lab.] New Haven, Conn.

VACUUM POLARIZATION AND SCREENING EFFECTS
IN SCATTERING FROM HEAVY NUCLEI (Abstract), by
G. Breit and S. Ohnuma. [1959] [1]p. (Sponsored jointly
by Air Force Office of Scientific Research under AF 18-
(600)771 and Atomic Energy Commission under AT(30-
1)1807)   Unclassified

Presented at Ninety-sixth annual meeting of the National
Academy of Sciences, Washington, D. C., Apr. 27-29,
1959.

Published in Science, v. 129: 1282, May 1, 1959.

In order to facilitate geometry calibrations of p-p scat-
tering experiments by scattering of protons by nuclei
and as a matter of general interest, effects of the vac-
uum polarization (vp) have been calculated and compared
with screening (sc) by electrons. In Uehling's approxi-
mation the vp appears as a superposition of Yukawa
terms for which the scattering amplitude is expressible
by means of the hypergeometric function suitable for
computation and can be rearranged in series with Bessel
functions of imaginary argument $K_n(x)$ in coefficients of
incident momentum. This expansion is related to the
classical orbit view shown to furnish a fair approxima-
tion. Classically the quantity x is the eccentricity of
the orbit times half the minimum distance of closest ap-
proach times the reciprocal range constant of the poten-
tial. The vp scattering is obtained by superposing am-
plitudes for Yukawa potentials. The results can be rep-
resented approximately by a universal curve relating
$Z_1 Z_2 / [E_{lab} \sin(\theta/2)]$, in usual notation, to the fractional

change in the differential cross section. For $\theta = 10°$ and energies 3 and 1.5 mev proton-argon scattering effects of ~ 272% and 0.166%, respectively, and for alpha-lead scattering at $\theta = 5°$ and 21.95 mev, a 0.080% vp effect are found. In latter case sc effect is -0.6%. For p-Xe, 9 mev, 10° the sc effect is -0.28%, comparable with the vp effect. Precision tests of vp action for fundamental theory are complicated by presence of sc potential.

2256

Yale U. [Sloane Physics Lab.] New Haven, Conn.

CALCULATIONS ON THE PHOTO-DISINTEGRATION OF THE DEUTERON, by G. Breit. 1959 [12]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)771 and Office of Ordnance Research)   Unclassified

Published in Proc. Internat'l. Conf. on Nuclear Forces and the Few-Nucleon Problem, University Coll., London (Gt. Brit.), July 8-11, 1959, New York, Pergamon Press, 1960, p. 311-322.

Preliminary measurements and calculations were made on the photo-disintegration of deuterons to test the views of nucleon-nucleon forces and electromagnetic properties of nucleons. An arrangement of the calculation is presented by means of which the inclusion of higher multipoles and changes in assumptions regarding potentials may be quickly taken into account. The arrangement is being programmed for an IBM 704. An amplitude method similar to that used in the nucleon-nucleon phase-shift analysis was used. Comparison with experiment showed the presence of systematic deviations at lower energies.

2257

Yale U. [Sloane Physics Lab.] New Haven, Conn.

METASTABILITY OF 2s STATES OF HYDROGENIC ATOMS (Addendum), by J. Shapiro and G. Breit. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)771] and Office of Ordnance Research)   Unclassified

After the publication of an earlier paper (item no. YAL.04:023, Vol. II) attention has been called to related work by Spitzer and Greenstein (Astrophys. Jour., v. 114: 407, 1951), in which the probability of double photon emission to 2s states of hydrogenic atoms has been calculated for the case $Z = 1$. There is excellent agreement in the values obtained for the transition probability in the 2 papers, the value of Spitzer and Greenstein being 8.277 sec^{-1} and that in the earlier paper, $8.226 \pm 0.001 \text{ sec}^{-1}$. The latter publication goes somewhat beyond the earlier one in this connec-

tion in the consideration of the Z dependence, of the accuracy of the results, and the discussion of the distinction between the double emission and cascade processes especially in connection with the Lamb shift.

2258

Yale U. [Sloane Physics Lab.] New Haven, Conn.

FORMATION OF MUONIUM (Abstract), by V. W. Hughes, A. Lurio and others. [1958] [3]p. incl. table. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1565], Atomic Energy Commission and Office of Naval Research)   Unclassified

Presented at Conf. on Physics of Electronics and Atomic Collisions, New York U., N. Y., Jan. 27-28, 1958.

Plans to form and study muonium by slowing down μ^+ mesons in a gas are outlined. Muonium will be formed by the capture of an electron from a gas atom by a μ^+ meson. The capture cross section will be of order πa_0^2 ($\sim 9 \times 10^{-17} \text{cm}^2$) at muon velocities comparable to electron velocities in the atom, but muonium formed by such an energetic muon has sufficient energy to be ionized in a collision with a gas atom. At muon velocities sufficiently low so that muonium atoms formed will be stable against ionizing collisions, the capture process can be treated by the method of perturbed stationary states and the capture cross section may be several orders of magnitude less than πa_0^2.

2259

Yale U. [Sloane Physics Lab.] New Haven, Conn.

MAGNETIC MOMENT OF HELIUM IN ITS $^3S_1$ META-STABLE STATE, by C. W. Drake, V. W. Hughes and others. [1959] [11]p. incl. diagrs. table, refs. (AFOSR-TN-59-16) [AF 18(600)1565] AD 208597   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 7, Jan. 29, 1958.

Also published in Phys. Rev., v. 112: 1627-1637, Dec. 1, 1958.

The ratio of the electronic g_J value of He in its 1s2s, $^3S_1$ metastable state to the g_J of H in its ground state has been redetermined by the atomic beam magnetic resonance method using separated oscillating fields. At magnetic fields of about 540 and 575 gauss the transitions $\Delta m = \pm 1$, ± 2 in He and $(F,m)=(1,0) \cdot (1, -1)$ in H are

observed at frequencies of approximately 1570 mc/sec and 1140 mc/sec, respectively. The natural line shapes for the separated oscillating fields method are obtained with spacings between the oscillating fields of both 4.2 cm and 2.2 cm. The experimental result is $g_J(He, {}^3S_1)/g_J(H, {}^2S_{1/2})|_{exp} = 1 - (23.3 \pm 0.8) \times 10^{-6}$, which agrees with an earlier measurement having an accuracy of 16 ppm, and also with the theoretical value $g_J(He, {}^3S_1)/g_J(H, {}^2S_{1/2})|_{theor} = 1 - (23.3 \pm 1.0) \times 10^{-6}$ obtained by Perl and Hughes, which was computed from the Breit equation for He with the addition of a term to represent the interaction of the anomalous spin magnetic moment of each electron with the external magnetic field. (Contractor's abstract)

2260

Yale U. [Sloane Physics Lab.] New Haven, Conn.

HYPERFINE STRUCTURE IN THE METASTABLE TRIPLET STATE OF He^3 (Abstract), by J. A. White, C. W. Drake, and V. W. Hughes. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1565], National Science Foundation, and Office of Naval Research)   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 10, Jan. 28, 1959.

The hyperfine structure of the $2\ {}^3S_1$ state of the He^3 atom has been determined by the atomic beam magnetic resonance method. Earlier measurements had indicated that the frequency corresponding to the $\Delta m_F = 0$ transition between the $(F, m_F) = (3/2, -1/2)$ and the $(F, m_F) = (1/2, -1/2)$ levels should be a minimum, and hence only quadratically field dependent, at a magnetic field of about 800 gauss. This minimum frequency was located and accurately measured. The hyperfine splitting, which according to the Breit-Rabi formula is exactly $3/(2\sqrt{2})$ times the minimum frequency, is 6739.7022 mc/sec with an estimated uncertainty of 1 part in 10^7. The present value is in agreement with the earlier value which had an uncertainty of 7 parts in 10^6.

2261

Yale U. [Sloane Physics Lab.] New Haven, Conn.

HYPERFINE STRUCTURE OF $He^4 - \mu^- e$ (Abstract), by V. W. Hughes and S. Penman. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1565], Atomic Energy Commission, and Office of Naval Research)   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 80, Jan. 28, 1959.

The availability of polarized muons and of a method for their detection may make possible a measurement of the hyperfine structure of the ground state of the system consisting of a He^4 nucleus, a negative muon, and an electron; hence it is useful to consider the theoretical value of this hfs splitting. The μ^- meson will be bound closely to the He^4 nucleus as in a mu-mesic atom, and the electronic wavefunction will be approximately hydrogenic. Hence in the lowest approximation the hfs splitting, ΔW, (which is inverted) is given by the Fermi formula and has the same value as for muonium. The principal corrections to this approximation arise from the finite size of the $He^4 - \mu^-$ atom, the reduced mass correction, and the anomalous magnetic moments of electron and muon. The expression $\Delta W = (\Delta W)_F (1 - 3\ m_e/2\ m_\mu)(1 + m_e/m_{He})^{-3}(1 + \alpha/2\pi)^2 = (4492 \pm 4)$ mc/sec gives these correction factors in the order listed. Higher order corrections arising from radiative processes, a more accurate treatment of muon and electron wavefunctions, the finite size of the He^4 nucleus, and recoil are omitted to the accuracy quoted.

2262

Yale U. [Sloane Physics Lab.] New Haven, Conn.

SEARCH FOR LOW-FREQUENCY ZEEMAN TRANSITIONS IN MUONIUM (Abstract), by D. McColm and V. W. Hughes. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1565], Atomic Energy Commission, and Office of Naval Research)   Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 82, Jan. 28, 1959.

Several experiments on the depolarization of muons in gases have suggested the possibility that $(\mu^+ - e^-$ bound state) is formed when positive muons are stopped in nitrous oxide gas. An experiment is in progress to observe a low-frequency Zeeman transition in muonium and hence to provide a more specific test of muonium formation. A maximum change in events counting rate of 40% between the rf-on and rf-off conditions is predicted. One run has been made and no effect due to the rf was observed either in N_2O ($\sim 3\%$ statistics) or in A ($\sim 5\%$ statistics). Since muonium will act chemically much like a hydrogen atom, there is considerable question as to whether it will remain free in the gas during its lifetime since it will make many collisions with gas

molecules. In particular an O_2 impurity could result in the formation of muonium oxide (a $^2\pi$ ground state) and an NO impurity could lead to a change in the hfs state due to an exchange collision.

2263

Yale U. [Sloane Physics Lab.] New Haven, Conn.

ELECTRON MAGNETIC MOMENT AND ATOMIC MAG-NETISM, by V. W. Hughes. [1959] [28]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1565], Office of Naval Research, and National Science Foundation)
Unclassified

Published in Recent Research in Molecular Beams, New York, Academic Press, 1959, p. 65-92.

Theoretical and experimental values of electron spin magnetic moment and the atomic electronic magnetic moments (g_J values) were compiled for various iso-topes. Diagrams for various apparatuses used in ex-perimental measurements are given.

2264

Yale U. Sloane Physics Lab., New Haven, Conn.

MULTIPLET STRUCTURE OF EXCITONS IN CdS, by R. G. Wheeler. May 1959 [8]p. incl. diagrs. refs. (AFOSR-TN-59-526) (AF 49(638)503) AD 216260; PB 142266   Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 463-465, June 1, 1959.

A description is given of the line absorption spectra near the absorption edge of single crystals at 4.2°K. The spectra are interpreted assuming an S-like con-duction band and a p-like valence band, and deriving optical selection rules from the symmetry proper-ties associated with these bands.

2265

Yale U. Sloane Physics Lab., New Haven, Conn.

ZEEMAN SPLITTING OF EXCITON LINES IN CdS, by R. G. Wheeler and J. O. Dimmock. Oct. 1959 [11]p. incl. diagrs. table, refs. (AFOSR-TN-59-764) (AF 49-(638)503) AD 226822; PB 143957   Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 372-374, Oct. 15, 1959.

The 2-fold splitting of 3 absorption lines in CdS in the wavelength region greater than 4840A is reported. All other lines observed do not split in fields up to 19 kgauss. The g values of the lines are dependent upon the orientation of the magnetic field with respect to the c axis of the crystal. Also observed was a small shift in the mean position of the split lines which is approx quadratic with magnetic field strength.

2266

Yeshiva U. Graduate School of Mathematical Sciences, New York.

NOTE ON THE PAIR DENSITY NEAR A WALL, by J. L. Lebowitz. [1959] 12p. incl. refs. (AFOSR-TN-59-953) (AF 49(638)753)   Unclassified

The asymptotic value is calculated of the conditional probability density ρ_2 $(\underline{r}_2, \underline{r}_1)$ for finding a fluid parti-cle at a point $\underline{r}_2$ for in the interior of a fluid when it is known that there is a particle at $\underline{r}_1$ in contact with the walls (rigid) of the container. This value is different from the well known expression for the asymptotic value of $\rho_2(\underline{r}_2, \underline{r}_1)$ when both $\underline{r}_2$ and $\underline{r}_1$ are in the inte-rior of the fluid. The derivation presented is based on the virial theorem for total momentum fluctuations in an equilibrium system and makes use of the assump-tion that there are no long range correlations in a fluid. Application is made of the result to rederive simply the expression for the 2nd virial coefficient and the exact equation of state of a hard sphere gas in 1 di-mension.

2267

Zator Co., Cambridge, Mass.

A NEW METHOD FOR DISCOVERING THE GRAM-
MARS OF PHRASE STRUCTURE LANGUAGES, by R. J.
Solomonoff. Apr. 1959, 13p. incl. diagrs. tables.
(Rept. no. ZTB-124) (AFOSR-TN-59-110) (AF 49-
(638)376) AD 210390; PB 140705   Unclassified

A new method was devised for the discovery of the
grammars of phrase structure languages. The method
has applications in information retrieval, linguistics
pattern discovery and a kind of mechanical transla-
tion. A technique is used that is similar to one de-
scribed by Chomsky and Miller for discovering the
grammars of finite state languages. In finite state
languages, a phrase that forms a cycle may be succes-
sively repeated an arbitrary number of times in an ac-
ceptable sentence, because the insertion of that phrase
does not change the state that exists at the point of in-
sertion. In phrase structure languages, the correspond-
ing entity that forms a cycle is an ordered pair of
phrases. If the first phrase of such a pair be inserted
before, and the second phrase be inserted after a suita-
ble type of single phrase in an acceptable sentence, then
the sentence will remain acceptable. The insertions
may be repeated an arbitrary number of times, be-
cause the process does not change the phrase type of
the single phrase. The set of all such cycles and
higher order cycles that exist in a phrase structure
language along with the insertion rules, constitute a
complete grammatical description of the language.
These cycles are discovered by a systematic process
of deletion and reinsertion of phrases and pairs of
phrases. A teacher on equivalent, is used to determine
if the sentences resulting from the deletions and rein-
sertions are acceptable sentences. (Contractor's
abstract)

2268

Zator Co., Cambridge, Mass.

THE NEXT TWENTY YEARS IN INFORMATION
RETRIEVAL. SOME GOALS AND PREDICTIONS, by
C. N. Mooers. Mar. 1959, 18p. incl. refs. (Rept. no.
ZTB-121) (AFOSR-TN-59-245) (AF 49(638)376)
AD 212225; PB 140835   Unclassified

Presented at Western Joint Computer Conf. on New
Horizons with Computer Tech., San Francisco, Calif.,
Mar. 3-5, 1959.

Also published in Amer. Doc., v. 11: 229-236, July
1960.

Some of the history of retrieval machine development
during the past 20 yr is sketched as background. At
present, there are still no completely satisfactory
machines for retrieval on large collections. Solution
of the language problem in retrieval is currently some-
what ahead of machine development. Future develop-

ments are sketched. Work is already underway on the
use of machines for the assignment of descriptors to
the text, which is a crude kind of mechanical transla-
tion. Retrieval machines will soon be called upon to
assist the customer in using a retrieval system by
helping him to formulate his search requests. This
assistance amounts to education of the customer. The
notion of education by machine is extended to machine
assistance in helping the customer to read the docu-
ments uncovered. It is shown how this process, when
combined with work on mechanical translation, will lead
to machines which can provide essays on any given sub-
ject upon request. Machines will become archival de-
vices to store facts, not texts. Human-to-machine and
machine-to-human communication will become very
important. Information machines can be expected to
become as numerous as computers now are. (Contrac-
tor's abstract)

2269

Zator Co., Cambridge, Mass.

THE MECHANIZATION OF LINGUISTIC LEARNING,
by R. J. Solomonoff. Apr. 1959, 16p. (Rept. no.
ZTB-125) (AFOSR-TN-59-246) (AF 49(638)376)
AD 212226   Unclassified

Also published in Proc. Second Internat'l. Cong. on
Cybernetics, Namur (Belgium) (Sept. 3-10, 1958),
Namur, Association Internationale de Cybernétique,
1960, p. 180-193.

Some methods were obtained for the mechanization of
linguistic learning, which is of interest in information
retrieval, mechanical translation and linguistic analysis.
Routines were devised for discovering the grammatical
rules of certain elementary language types in a suitable
training situation. One of the routines is for the dis-
covery of the grammars of phrase structure languages,
a problem that has not yet been satisfactorily dealt
with. This method is an extension of techniques for the
mechanization of inductive inference previously de-
veloped for solving problems in arithmetic learning.
In as much as most of the English language appears to
be describable as a phrase structure language (though
it is not at all economical to express English grammar
rules in this form), the above method may be of some
importance in analysis of ethnic languages. In some
idealized cases the problem of learning to translate
languages is considered as a problem in discovering
the grammar rules of a new type of generalized lan-
guage. An example is shown in which learning to trans-
late between 2 phrase structure languages is identical
with discovering the grammar rules of a new kind of
phrase structure language. (Contractor's abstract)

2270

Zator Co., Cambridge, Mass.

RESEARCH IN INDUCTIVE INFERENCE, by R. J.

Solomonoff. Progress rept. for the year ending Mar. 31, 1959. May 1959, 12p. (Rept. no. ZTB-130) (AFOSR-TN-59-519) (AF 49(638)376) AD 216240; PB 142292 Unclassified

The concept of language was generalized to include patterns of many extremely diverse types. This will make it possible to apply inductive inference methods that were originally devised for simple phrase structure languages to more complex pattern types, such as arithmetic problems, transformational languages, and translation between pairs of phrase structure languages and transformational languages. Work was done on devising machines that will improve their own methods of operation. Work completed includes new methods for discovering the grammars of finite state languages and phrase structure languages, and methods for determining all possible phrase structures of an arbitrary sentence of a phrase structure language of known grammar. Important work was done on methods of discovering approximation languages. Routines of this type are not accurate all of the time but are useful for getting quick, approximate results. Just about all the basic theoretical work was done so that a machine to discover the grammars of phrase structure languages could be programmed. With what seems at present to be only a little more work, a machine could be made to discover translation rules between certain simple language pairs, and learn to work several kinds of arithmetic problems. However, such a machine would be very slow in learning, would ask a very large number of questions, and would often be unable to learn a pattern if a single error were made in giving examples to it. Work is now progressing on a unified method of overcoming these difficulties. (Contractor's abstract)

2271

Zator Co., Cambridge, Mass.

ON MACHINES TO LEARN TO TRANSLATE LANGUAGES AND RETRIEVE INFORMATION, by R. J. Solomonoff. Progress rept. Oct. 1959, 17p. (Rept. no. ZTB-134) (AFOSR-TN-59-646) (AF 49(638)376) AD 228203; PB 161263 Unclassified

Presented at Internat'l. Conf. for Standards on a Common Language for Machine Searching and Transl., Cleveland. Ohio, Sept. 6-12, 1959.

Also published in Advances in Doc. and Library Sci., v. 3(Pt. 2): 941-953, 1961.

This paper discusses theoretical work which makes it possible for a machine to be programmed to learn to translate between 2 simple, synthetic languages, after it has been given a large set of correct examples in a suitable training situation. The limitations of the methods are discussed. A system is described in which a machine would learn to assign descriptors or other search indices to documents, after having been given a large set of documents and the search indices that have been assigned to them by humans. Some of the problems that must be solved before such a system can be realized are discussed. A unified method is proposed for resolving the difficulties of both the information retrieval and the mechanical translation routines. (Contractor's abstract)

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