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USSR AND EASTERN EUROPE SCIENTIFIC ABSTRACTS

PHYSICS AND MATHEMATICS

No. 29

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Acoustics

VEL'MIN, V. A. and DUBROVSKIY, N. A., Acoustics Institute, Academy of Sciences USSR

CRITICAL RANGE OF ACTIVE HEARING IN DOLPHINS

[Abstract of a paper delivered at the Scientific Session of the Joint Science Council of the Soviet Academy of Sciences on the Complex Problem of Physical and Technical Acoustics, the Science Council of the Soviet Academy of Sciences on the Problem of Acoustics, the Science Council of the Soviet Academy of Sciences on the Problem of Ultrasound and the Science Council of the Acoustics Institute of the Soviet Academy of Sciences Dedicated to the Ninety-Fifth Birthday of Hero of Socialist Labor N. N. Andreyev, 17 December 1975, Moscow]

[Abstract] An investigation is made of the critical range in that part of the dolphin's hearing apparatus that is used in analysis of echolocation signals. The results show a critical time range of 200-300 µs within which the characteristics of active hearing differ sharply from those outside this range. For instance the dolphin is able to distinguish intervals between pulse pairs only if these intervals are within the critical range; short

pulses of artificial reverberation exceeding the echo level by 50 dB affect the detection of an echo from a target if the interval between the reverb pulse and the echo pulse does not exceed the critical range, and so forth. Assuming that the critical range is a fundamental characteristic of active hearing, experiments were done to determine this range more precisely. It was found that the critical interval for the bottlenosed dolphin is 260 ± 25 µs. Experiments with long intervals showed that the dolphin is incapable of distinguishing intervals longer than the critical range. The confidence coefficient for the 260 µs result is 90%. References 3 Russian.

USSR   UDC: 534.2

SCIENTIFIC SESSION OF THE JOINT SCIENCE COUNCIL OF THE SOVIET ACADEMY OF
SCIENCES ON THE COMPLEX PROBLEM OF PHYSICAL AND TECHNICAL ACOUSTICS, THE
SCIENCE COUNCIL OF THE SOVIET ACADEMY OF SCIENCES ON THE PROBLEM OF ACOUSTICS,
THE SCIENCE COUNCIL OF THE SOVIET ACADEMY OF SCIENCES ON THE PROBLEM OF ULTRA-
SOUND AND THE SCIENCE COUNCIL OF THE ACOUSTICS INSTITUTE OF THE SOVIET ACADEMY
OF SCIENCES DEDICATED TO THE NINETY-FIFTH BIRTHDAY OF HERO OF SOCIALIST LABOR
ACADEMICIAN N. N. ANDREYEV

[Abstract] The scientific session of Joint Science Council of the Soviet
Academy of Sciences on the Complex Problem of Physical and Technical Acous-
tics, the Science Council of the Soviet Academy of Sciences on the Problem
of Acoustics, the Science Council of the Soviet Academy of Sciences on the
Problem of Ultrasound and the Science Council of the Acoustics Institute of
the Soviet Academy of Sciences Dedicated to the Ninety-Fifth Birthday of Hero
of Socialist Labor Academician N. N. Andreyev was held 17 December 1975 in
the conference hall of the Acoustics Institute. The opening talk was given
by Professor L. M. Lyamshev, chairman of the Joint Science Council of the
Soviet Academy of Sciences on the Complex Problem of Physical and Technical
Acoustics. He spoke of N. N. Andreyev's leading role in establishment and

development of acoustics in the Soviet Union. The following papers were
delivered at the session: "Critical Range of Active Hearing in Dolphins"
by V. A. Vel'min and N. A. Dubrovskiy; "Magnetostriction Materials Under the
Action of Compression" by I. P. Golyamina and V. K. Chulkova; "On the Gener-
ation of Sound by Thermal Sources" by L. M. Lyamshev and K. A. Naugol'nykh;
"Nonlinear Phenomena in Magnetoelastic Media" by A. L. Polyakov; "Acoustics
and Hydrodynamics of Some Marine Animals" by Ye. V. Romanenko. Recollec-
tions on N. N. Andreyev were presented by Professor V. S. Grigor'yev, Pro-
fessor A. V. Rimskiy-Korsakov, Professor L. A. Chernov, S. G. Gershman and
B. D. Tartakovskiy. Abstracts of the papers are given.

USSR UDC: 534.2

GOLYAMINA, V. P. and CHULKOVA, V. K., Acoustics Institute, Academy of Sciences USSR

MAGNETOSTRICTION MATERIALS UNDER THE ACTION OF COMPRESSION

[Abstract of a paper delivered at the Scientific Session of the Joint Science Council of the Soviet Academy of Sciences on the Complex Problem of Physical and Technical Acoustics, the Science Council of the Soviet Academy of Sciences on the Problem of Acoustics, the Science Council of the Soviet Academy of Sciences on the Problem of Ultrasound and the Science Council of the Acoustics Institute of the Soviet Academy of Sciences Dedicated to the Ninety-Fifth Birthday of Hero of Socialist Labor N. N. Andreyev, 17 December 1975, Moscow]

[Abstract] The paper gives the results of an experimental study of the influence that compressive stresses have on the characteristics of magnetostriction materials that are of importance for acoustic emitters -- the magnetostriction constant a (ratio of the amplitude of the first harmonic of mechanical stress to the amplitude of the stimulating induction), the mechanical Q-factor and Young's modulus. The study specimens were Soviet
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GOLYAMINA, V. P. and CHULKOVA, V. K., AKUSTICHESKIY ZHURNAL, Vol 22, No 4, Jul/Aug 76 pp 624-625

magnetostriction materials NP-2T nickel, 50KF Permendur and ferrites 21-SPA, F-42 and F-38. The range of compressive stress was 0-800 kg/cm^2 in magnetic fields from zero to 1.5-3 times the field corresponding to the maximum coefficient of electromechanical coupling. The results showed that the Q-factor increases with compression for all materials with negative striction. In Permendur, which has positive striction, the Q-factor drops with compression in fields of practical interest, and increases only with very weak or very strong magnetization. The Young's modulus increases with compression for all materials, the effect being most pronounced in relatively weak fields in materials with a high coupling coefficient -- ferrite F-42 and Permendur. The influence of compressive stress on both the Young's modulus and the Q-factor decreases with increasing magnetic field intensity. At the same time, compression reduces the ΔE-effect of the material. It is concluded that the resonant frequency of acoustic emitters under working conditions is not appreciably changed by the influence of compression on the Young's modulus. References 8: 7 Russian, 1 Western.

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LYAMSHEV, L. M. and NAUGOL'NYKH, K. A., Acoustics Institute, Academy of Sciences USSR

ON THE GENERATION OF SOUND BY THERMAL SOURCES

[Abstract of a paper delivered at the Scientific Session of the Joint Science Council of the Soviet Academy of Sciences on the Complex Problem of Physical and Technical Acoustics, the Science Council of the Soviet Academy of Sciences on the Problem of Acoustics, the Science Council of the Soviet Academy of Sciences on the Problem of Ultrasound and the Science Council of the Acoustics Institute of the Soviet Academy of Sciences Dedicated to the Ninety-Fifth Birthday of Hero of Socialist Labor N. N. Andreyev, 17 December 1975, Moscow]

[Abstract] A simplified model is proposed for explaining the principal features of sound emission into the ambient medium when energy is rapidly released into a limited region of matter, as frequently occurs when intense optical emission interacts with matter. Curves are given showing the profile of the spherical sound wave generated by such a thermal source for the limiting cases $R_0 \gg c\tau$ and $R_0 \ll c\tau$ (R_0 is the bounded spherical region where the

given energy release occurs in time τ, and c is the speed of sound). An expression is found for the pressure in the vapor bubble formed when the energy density is sufficient to transform liquid to vapor. An approximate analysis is made of the hydrodynamic characteristics of the process of sound emission by thermal sources. References 3: 2 Russian, 1 Western.

NONLINEAR PHENOMENA IN MAGNETOELASTIC MEDIA

[Abstract of a paper delivered at the Scientific Session of the Joint Science
Council of the Soviet Academy of Sciences on the Complex Problem of Physical
and Technical Acoustics, the Science Council of the Soviet Academy of Sciences
on the Problem of Acoustics, the Science Council of the Soviet Academy of
Sciences on the Problem of Ultrasound and the Science Council of the Acoustics
Institute of the Soviet Academy of Sciences Dedicated to the Ninety Fifth
Birthday of Hero of Socialist Labor N. N. Andreyev, 17 December 1975, Moscow]

[Abstract] An examination is made of nonlinear phenomena described by the
higher terms of the expansion for magnetoelastic energy with respect to
magnetization and mechanical stress. An investigation is made of magneto-
striction stresses in a material with magnetization $M = M_0 + M_1 \sin \omega t$. The
magnitudes of the first three stress harmonics are found as a function of
the quantities M_0 and M_1, which are taken as arbitrary. Conditions are found
that maximize the first harmonic. A method is proposed for determining the

magnetoelastic constants from experimental data. Values of the maximum
amplitude of the first harmonic of magnetostriction stress are calculated
for a number of materials used in sound emitters -- nickel, Permendur,
ferrites and so forth. The method of successive approximations is applied
to analysis of propagation of longitudinal and transverse waves in a medium
having both the magnetoelastic nonlinearity considered above and ordinary
nonlinearity of elastic properties. It is shown that a second harmonic
arises in the longitudinal wave that increases with distance, the nonlinear
parameter being a function of the constant of magnetization M_0 applied in
the direction of sound propagation. This parameter is $\Gamma \approx \Gamma_{ac} + AM_0^2$, where
Γ_{ac} is the nonlinear parameter with consideration of elastic nonlinearity
alone, and A is the combination of elastic and magnetoelastic constants.
Estimates show that for practically realizable values of M_0 the nonlinear
parameter Γ may be made an order of magnitude greater than Γ_{ac}. References
2 Russian.

USSR   UDC: 534.2

ROMANENKO, YE. V., Institute of Evolutionary Morphology and Ecology of Animals
imeni A. N. Severtsov, Academy of Sciences USSR

ACOUSTICS AND HYDRODYNAMICS OF SOME MARINE ANIMALS

[Abstract of a paper delivered at the Scientific Session of the Joint Science
Council of the Soviet Academy of Sciences on the Complex Problem of Physical
and Technical Acoustics, the Science Council of the Soviet Academy of
Sciences on the Problem of Acoustics, the Science Council of the Soviet
Academy of Sciences on the Problem of Ultrasound and the Science Council of
the Acoustics Institute of the Soviet Academy of Sciences Dedicated to the
Ninety-Fifth Birthday of Hero of Socialist Labor N. N. Andreyev, 17 December
1975, Moscow]

[Abstract] A survey of research on acoustics and hydrodynamics of marine
mammals, primarily dolphins. Emphasis is placed on the use of self-contained
miniaturized pickups and receivers, tape recorders, noise generators, bio-
logical monitors and so forth that are attached directly to the animals,
allowing them freedom of movement throughout an experiment. Among the new
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facts acquired in this way: dolphins emit high-frequency echolocation pulses
by a nonresonant mechanism; previously undetected low-frequency pulses with
a fundamental tone of 300-400 Hz are emitted by dolphins with a weakly
resonant mechanism; the duration of echolocation pulses emitted by dolphins
differs for different directions -- pulses emitted in the forward direction
are twice as long as those emitted to the sides; dolphins have a built-in
shield to attenuate their own perception of the signals they emit so that
these high-intensity sounds do not interfere with their acute hearing; the
boundary layer surrounding the dolphin is partly laminarized, enabling the
animal to swim with less effort; the fur covering of seals modifies the
boundary layer, reducing drag. References 8: 4 Russian, 4 Western.

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KALININ, V. L., Murmansk Marine Higher Engineering Academy

ON A METHOD OF DETERMINING THE DEPTH OF SUBMERSION OF UNDERWATER OBJECTS
UNDER CONDITIONS OF A REFRACTING MEDIUM

[Abstract] It is shown that the error due to refraction in determining the
coordinates of an underwater object can be reduced by appropriate processing
of depth-finder readings without using detailed hydrophysical information.
It is assumed that the geometric theory of sound propagation is applicable,
that the underwater object does not change its depth during observation,
that there is no horizontal gradient in the speed of sound in the region of
observation, and that the function of the vertical gradient of the speed of
sound is time-independent. On the basis of Snell's law the author derives
expressions for the length of an acoustic beam reflected from the underwater
object, and for the horizontal distance to the object. A numerical example
is given. References 4 Russian.

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POLYANSKAYA, V. A., Acoustics Institute, Academy of Sciences USSR

CALCULATION OF THE FIELD AMPLITUDE WHEN RAYS ARE REFLECTED FROM A CURVED
BOUNDARY IN A MEDIUM

[Abstract] It is shown that when calculating fields by ray tracing in a
three-dimensional medium with arbitrary variation of parameters, the presence
of totally or partially reflecting interfaces with nonzero first derivatives
of nearby parameters makes it necessary to introduce additional boundary
conditions to account for these interfaces. Formulas are derived for the
general case of reflection of sonic beams from an arbitrary fairly smooth
curvilinear boundary. It is noted that disregarding the correction to the
boundary conditions results in considerable loss of accuracy, particularly
in the case of multiple reflections, as when calculating repeated reflection
of sound waves from the ocean surface and bottom. References 4: 2 Russian,
2 Western.

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YESIPOV, I. B., ZVEREV, V. A., KALACHEV, A. I. and NAUGOL'NYKH, K. A.,
Acoustics Institute, Academy of Sciences USSR, Radio Physics Scientific
Research Institute, Gor'kiy

ON LOW-FREQUENCY PARAMETRIC EMISSION OF SOUND

[Abstract] During emission of an intense amplitude-modulated sound wave,
nonlinear parametric interaction of the signal components in the medium
causes generation and independent propagation of a wave with the modulation
frequency. The effect of parametric emission has been studied previously on
comparatively high frequencies; in this paper the authors give the results
of an experimental study of low-frequency parametric emission. The carrier
wave on 105 and 123 kHz was generated by a piezoelectric disk transducer.
The modulation frequency varied over a range of 1-5 kHz. The transducer was
92.5 cm in diameter, and was placed at a depth of 6 m below the surface of
the sea in a position such that the main lobe of the radiation pattern
touched neither the bottom nor the surface. Sound reception was by a
spherical pickup 5 cm in diameter located 80 m from the emitter. Curves are
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given showing the signal level in dB as a function of angle. It was found
that the curve becomes sharper with increasing modulation frequency. It
was also found that the amplitude of the received signal increases as the
square of the voltage across the emitter, whereas the pumping level changes
linearly. The amplitude of the received signal is also a linear function
of the percentage modulation. The results of this study confirm the feasi-
bility of directional parametric emission on 1-5 kHz using an emitter that
has comparable or smaller dimensions than the wavelength of the low-frequency
signal. References 4: 3 Russian, 1 Western.

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DIFFRACTION OF SOUND OVER A WIDE BARRIER

[Russian abstract provided by the source]

[Text] An examination is made of the problem of diffraction of a plane
sound wave by a wide trapezoidal barrier having different flat faces, both
ideal and with acoustic impedance. The solution is found by considering the
sequential diffraction of sound by the edges of the barrier. Formulas are
derived for the acoustic pressure in the "deep" shadow zone. The theoretical
results are compared with experimental data. References 8: 5 Russian, 3
Western.

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USSR

UDC: 534.232-8

L'VOVSKAYA, G. F., Acoustics Institute, Academy of Sciences USSR

ON A METHOD OF INCREASING THE AMPLIFICATION FACTOR OF A DISK-AND-ROD ULTRA-SONIC TOOL WITH CONVERSION OF THE DIRECTION OF VIBRATIONS

[Abstract] The author calculates the normal modes and coefficients of ampli-
fication of a disk-and-rod ultrasonic tool in which the thickness decreases
by a power law from the periphery toward the center of the disk. The re-
sults are comparable with the case of a disk of constant thickness. Curves
are given showing the resonant frequencies and amplification factors plotted
against the dimensional characteristic $H - h_0$, where H is half the overall
length of the working rod, and h_0 is half the thickness of the disk at the
center. The results show that a disk of variable thickness gives higher
amplification factors than one of constant thickness. References 4: 3 Rus-
sian, 1 Western.

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PAVLOV, V. I., Physics Department, Moscow State University imeni M. V. Lomo-
nosov

ON ABSORPTION OF SOUND IN A MEDIUM WITH NOISE

[Abstract] An analysis is made in perturbation theory of the nonlinear
interaction of a monochromatic sound wave with noise during propagation in
a fluid. The case of interaction between a high-frequency signal and low-
frequency noise is emphasized. It is shown that in certain cases the signal
energy is transferred to the noise, resulting in anomalously high signal
attenuation. The proposed mechanism is confirmed by comparison with experi-
mental data. References 7: 5 Russian, 2 Western.

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BALAKSHIY, V. I., PARYGIN, V. N. and FILIPPOV, B. P., Physics Department,
Moscow State University imeni M. V. Lomonosov

ANGULAR DISPLACEMENT OF AN ACOUSTIC BEAM EXCITED BY A WEDGE-SHAPED PIEZO-
ELECTRIC TRANSDUCER

[Abstract] An analysis is made of the problem of excitation of sound waves
by a wedge-shaped piezoelectric transducer. It is shown that the wave front
rotates with a change in frequency, the angle of turn being directly pro-
portional to the taper angle of the wedge. As the frequency f of the sonic
beam changes, the angular displacement of the beam conforms to the relation
$df/d\gamma$, where $\gamma = 2\pi f h/v_0$, h is the thickness of an equivalent plane-parallel
plate, and v_0 is the speed of sound in the piezoelectric. This effect of
angular displacement of a sonic beam can be used to adjust the angle of
incidence of the light in acousto-optical deflectors. Experiments with
lithium niobate transducers confirmed the effect. References 5: 2 Russian,
3 Western.
1/1

UDC: 534.232

KONEVSKIY, I. N. and SURIKOV, B. S., State Scientific Research and Design
Institute of the Rare Metals Industry

INVESTIGATION OF TWO-LAYERED SONIC LENSES

[Abstract] A theoretical and experimental study is made of the field in the
focal plane of lenses with the Lüneberg property of focusing a plane acoustic
wave on a surface lying opposite, and having an index of refraction that
varies from the center to the edge in accordance with the law $n(r) = \sqrt{2 - r^2}$
(where r is the instantaneous normalized radius). In practice, such lenses
are multilayered structures in which the constant indices of refraction of
the layers give a stepwise approximation to the given law $n(r)$. To distin-
guish them from Lüneberg lenses they are called spheroidal or cylindroidal
lenses. The authors consider two-layered spheroidal and cylindroidal lenses
with concentric or coaxial layers having different indices of refraction.
Curves are given for the distribution of sonic pressure in the focal plane
of the lenses. The results show that two-layered lenses of the type con-
sidered may have sharp radiation patterns with width of the order of a few
degrees. References 6 Russian.
1/1

UDC: 534.222.2

BAKHVALOV, N. S., ZHILEYKIN, YA. M., ZABOLOTSKAYA, YE. A. and KHOKHLOV, R. V.,
Moscow State University imeni M. V. Lomonosov, Department of Computational
Mathematics and Cybernetics

NONLINEAR PROPAGATION OF A SOUND BEAM IN A NONDISSIPATIVE MEDIUM

[Russian abstract provided by the source]

[Text] A nonlinear acoustics equation is numerically integrated for finite
beams with time-periodic boundary condition and signal amplitude diminishing
from the center of the beam toward the edges. Figures are given that show
the shape of the density perturbation for different values of the parameter
that defines the relative contribution of nonlinear and diffraction effects
at different distances from the boundary of the nonlinear medium and at
different points of the beam cross section. It is shown that there is an
appreciable difference between the nonlinear distortions in the sonic beam
and distortions of a plane wave. The region of shock wave formation in the
beam is constructed for a given amplitude distribution.
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L'VOVSKAYA, G. F., Acoustics Institute, Academy of Sciences USSR

THEORETICAL STUDY OF THE CHARACTERISTICS OF A DISK-AND-ROD ULTRASONIC TOOL

[Abstract] A theoretical study is done on the disk-and-rod ultrasonic tool
shown in the diagram. The analysis is based on a tool with the following
parameters: $R = 52$ mm, $R_2 = 41.5$ mm, $R_3 = 33.5$ mm, $r_0 = 6$ mm, $h = 4.5$ mm, and
H varies over a wide range with step of 1 mm (minimum $H = 30$ mm) $c_1 = 5400$ m/s,
$c_2 = 5790$ m/s, $\rho_1 = 4.5$ g/cc, $\rho_2 = 5.2$ g/cc, $\nu_1 = \nu_2 = 0.29$, $l(R_m) = 303$ N/m·A,
$\mu^\varepsilon(R_m) = 10$, $\alpha_1 = 10^{-3}$ and 10^{-4}, $\alpha_2 = 10^{-2}$, where c_i, ρ_i, ν_i are the velocity
of longitudinal Young waves, density and Poisson's ratio respectively of the
active ($i = 2$) and passive ($i = 1$) materials, $l(R_m)$ is the magnetostriction
constant of the annular ferrite transducer on the middle radius of the ring,
$\mu^\varepsilon(R_m)$ is the permeability of the "constricted" ferrite reduced to the perme-
ability of a vacuum on the middle radius of the ring, and α_1 and α_2 are the
coefficients of mechanical losses in the passive and active materials respec-
tively. Calculations are done both for an unloaded tool, and for a loaded
tool where the ratio of the specific mechanical resistance of the load to
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the wave impedance of the passive material is $\zeta = 10^{-3}$. The results can be
used in optimizing the design of ultrasonic tools of this type. References
3 Russian.
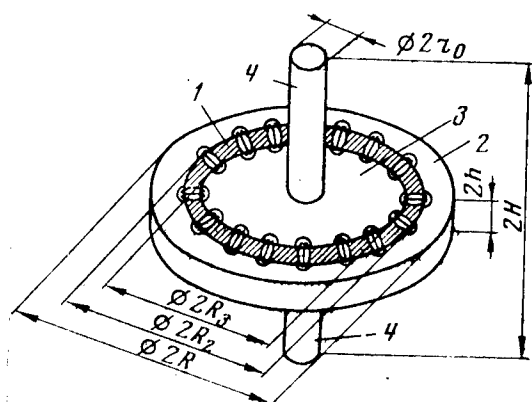
1--annular magnetostriction transducer;
2--outer passive part of the disk;
3--inner passive part of the disk;
4--working rod.

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OSTROVSKIY, D. V.

STATISTICAL PARAMETERS OF A FLAT DISCRETE ANTENNA WITH CONSIDERATION OF THE
INTERACTION BETWEEN ELEMENTS

[Abstract] An examination is made of the statistical properties of discrete
acoustic radiators with consideration of the interaction between elements.
Exact formulas are derived for generalized Rayleigh distribution parameters
of the modulus of directional gain as a function of amplitude-phase errors
and element failures. Approximate formulas are found, assuming that random
errors and failures do not cause additional redistribution of the vibra-
tional velocities of the elements. It is shown that the resultant simplifi-
cation has no effect on the way that the distribution parameters depend on
errors, and that these parameters coincide for identical levels of directional
gain. A numerical example is considered, and a comparison of curves for the
standard deviation of the modulus of directional gain calculated from the
proposed formulas shows that consideration of phase errors increases the
standard deviation by 20-25%. Thus the variance in parameters of the elements
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causes a certain redistribution of vibrational velocities with respect to the
antenna aperture. The simplified formulas are applicable for engineering
estimates with a correction factor. References 11: 9 Russian, 2 Western.

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ANDEBURA, V. A.

ON THE ACOUSTICAL-MECHANICAL CHARACTERISTICS OF SPHEROIDAL EMITTERS AND SCATTERERS

[Abstract] Expressions are derived for the acoustic characteristics of oscillating spheroidal emitters and scatterers of arbitrary configuration with small wave dimensions, i. e. in the long-wave approximation. The asymptotic behavior of radial spheroidal functions is examined for the case of small values of the wave parameter. The force acting on a rigid spheroid in a sonic field is found, and an expression is given for this force in the limiting low-frequency case. It is shown that the axial force acting on a rigid sphere for low-frequency incident waves is $3\pi/4$ times greater than for a disk of the same diameter assuming identical incident wave pressure. The axial force is proportional to the ratio of diameter to wavelength practically up to 0.5 within wide limits of change in configuration for an oblate spheroid. References 8: 6 Russian, 2 Western.

1/1

FOMIN, I. A., Institute of Theoretical Physics imeni L. D. Landau, Academy of Sciences USSR

TRANSVERSE ACOUSTIC IMPEDANCE OF A NORMAL FERMI LIQUID

[Abstract] The paper gives results of calculation of transverse acoustic impedance of helium-3 in the high-frequency region, i. e. where the frequency of oscillations ω and the time τ between collisions of quasi-particles satisfy the strong inequality $\omega\tau \gg 1$, with consideration of Fermi-liquid effects, assuming that the function $F(\theta)$ that describes the interaction of quasi-particles in Landau theory can be approximated by two spherical harmonics: $F(\theta) = F_0 + F_1 \cos\theta$. A table is given summarizing important data for the real and imaginary parts of the transverse impedance for different values of F_1 in the case of purely diffuse reflection. It is shown that impedance measurement can be used as an argument for the existence of transverse null sound only when quantitative agreement is observed between theory and experimental data. References 7: 4 Russian, 3 Western.

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ZASTAVNYY, A. V., KOROL', V. M. and LYSENKO, P. L., Scientific Research
Institute of Physics, Rostov-na-Donu State University

INFLUENCE THAT BOMBARDMENT WITH 5.5 MeV PARTICLES HAS ON THE CHARACTERISTICS
OF p-Si ION-DOPED SEMICONDUCTOR DETECTORS

[Russian abstract provided by the source]

[Text] The paper compares the characteristics of ion-doped p-Si detectors
and n-Si surface-barrier detectors after exposure to α-particles with
energy of 5.5 MeV. It is shown that the spectrometric characteristics of
the ion-doped detectors are more stable. Doses several times higher than
for the surface-barrier detectors were required to reduce the energy reso-
lution of the ion-doped detectors by a factor of two. References 7: 6
Russian, 1 Western.

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TAKIBAYEV, ZH. S., GRISHCHENKO, V. F., GERACIMENKO, N. N., and
GORELKINSKIY, YU. V.

CURRENT-VOLTAGE CHARACTERISTICS OF SILICON p-n JUNCTIONS BOMBARDED WITH SMALL
DOSES of ^{235}U FISSION FRAGMENTS

[Abstract] Current-voltage characteristics of silicon junctions bombarded
with ^{235}U fission fragments were studied. The fragments were generated by a
thin layer of ^{235}U bombarded with neutrons. An analysis is made of the
recombination parameter m that characterizes the processes taking place on
the junction surface. The results show that individual fission fragments
(heavy nuclei) can result in significant changes in the current-voltage char-
acteristics of p-n junctions. Depending on the angle of incidence of an
individual fragment, damage occurs either in the space charge region or on the
surface, which leads to changes in the forward or reverse branches of the
current-voltage characteristic. There are also cases of simultaneous damage
to the surface and the space charge region. References 7: 2 Russian,
5 Western.

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KARDO-SYSOYEV, A. F., PANYUTIN, YE. A., and CHASHNIKOV, I. G., Technical
Physics Institute imeni A. F. Ioffe Academy of Sciences USSR, Leningrad

S-SHAPED SWITCHING IN SEMICONDUCTOR STRUCTURES AT HIGH CURRENT DENSITIES

[Russian abstract provided by the source]

[Text] At high current densities in a semiconductor with impact ionization,
the space charge responsible for the S shape of the current-voltage character-
istic is restructured. Theoretical analysis of the current-voltage characteris-
tics considering this mechanism has been performed on models assuming homoge-
neous distribution of current density in the structures with plane-parallel
junctions. Agreement between theoretical and experimental current-voltage
characteristics was observed only up to the cutoff currents on sections with
negative differential resistance. The discrepancy between theory and experi-
ment was attributed to formation of filamentary currents, but the distribution
of current density was not experimentally studied. This paper deals with
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analysis of such experiments on planar n-i-n and p-i-p structures. The
experiments were performed by recording the recombination radiation from
structures using a pulse image converter. It was found that the distribution
of current density is heterogeneous and similar to the pattern of geometric
current spread from a "point" region, the current density increasing in the
direction from the emitter to the noninjecting contact. The experiments
performed do not confirm the hypothetical filamentary currents a few μm in
diameter mentioned in the literature. It is shown that consideration of
spreading of current lines weakens the rigid requirement for ratio of hole
and electron current at the boundary of the impact ionization region.
References 8: 2 Russian, 6 Western.

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VINETSKIY, V. L. SHEYNKMAN, M. K. and YASKOVETS, I. I., Institute of Physics, Academy of Sciences UkSSR; Institute of Semiconductors, Academy of Sciences UkSSR, Kiev

THE NATURE OF THE ANOMALOUS TEMPERATURE DEPENDENCE OF DARK CONDUCTIVITY OF SEMICONDUCTORS

[Russian abstract provided by the source]

[Text] A theoretical study is presented of the nature of the "negative" temperature dependence of equilibrium concentration of current carriers $(dn/dT < 0)$ in a narrow, low-resistance surface area in a high-resistance semiconductor. It is shown that in a semiconductor with one row of compensating acceptor levels it is very difficult to realize a negative temperature dependence. However, when a heterojunction is present between the low-resistance surface and the high-resistance volume of the semiconductor, a negative dependence may obtain; the equilibrium conductivity is decreased by 1/2

several orders of magnitude as the temperature increases by about 100 K, which agrees with the available experimental data on the conductivity of CdS and CdSe films. References 6: 3 Russian, 3 Western.

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USSR

MANENKOV, A. A., MILYAYEV, V. A., MIKHAYLOVA, G. N., and SEFEROV, A. S.,
Institute of Physics imeni P. N. Lebedev Academy of Sciences USSR

DETECTION OF LARGE ELECTRON-HOLE BUBBLES IN GERMANIUM AND DETERMINATION OF
THEIR PARAMETERS FROM SHF CONDUCTIVITY MEASUREMENTS

[Abstract] The basic parameters of large electron-hole bubbles in nonuniformly
compressed germanium were determined by the shf conductivity and breakdown
method, which had also been used earlier for small bubbles. The germanium
specimens for this study were disks 4.0 mm in diameter and 2.0 mm thick, free
of dislocations and with a residual impurity concentration less than $2.6 \cdot 10^{11}$
cm^{-3}, under a pressure of 950 kgf/cm^2. The shf conductivity and its kinetics
were measured at 10 GHz under laser excitation at the 1.06 μm wavelength, at
temperatures from 4.2 to 1.3 K. The amplitude of the quasisteady signal was
found to decrease rapidly with decreasing temperature,approaching zero at 2.8 K,
while the quasisteady period became longer. Below 2.8 K the signal was found
to decrease exponentially with a time constant 750 μs, with a polarity
reversal and shorter time constant at 1.3 K. Evaporation from a bubble was
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found to become negligible only at or below 2.8 K, with Auger emission becoming
the dominant process. A "hot" shf breakdown was found to occur in the presence
of a large bubble, the characteristics of the exciton breakdown being here
radically different than in undeformed germanium. The absence here of a peak
and a valley indicates that one large bubble, with a surface much smaller than
that of a cloud of small bubbles, does not influence the buildup of an electron
avalanche. The results of these measurements confirm the existence of a large
electron-hole bubble in deformed germanium 1.0 mm in diameter, with a particle
concentration $n_0 = 2.5 \cdot 10^{16}$ cm^{-3}, a bond energy $E_0 = 4.6$ meV, and a lifetime
$\tau_0 = 500$ μs. Figures 2; references 14: 6 Russian, 8 Western.

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USSR

VVEDENSKIY, V. L., Institute of Problems in Physics, Academy of Sciences USSR

CRYSTALLIZATION OF STRATIFIED He^3-He^4 SOLUTIONS

[Abstract] A study was made concerning the crystallization of stratified He^3-He^4 solutions, with a lower He^3 concentration and a higher He^3 concentration. On the basis of nuclear-magnetic-resonance measurements, phase diagrams have been plotted in temperature-pressure coordinates within the 0.25-0.38 K and 25-28 atm range as well as in temperature-concentration (He^3,%) coordinates. The experiment has produced new evidence about the phase constitution and the critical points. The three-phase $He^3(liq)_{l.c}$-bcc-$He^3(liq)_{h.c}$ equilibrium line was found to split at 0.38 K into an $He^3(liq)_{l.c}$-$bcc_{l.c}$-$bcc_{h.c}$-$He^3(liq)_{h.c}$ line and an $He^3(liq)_{l.c}$-$bcc_{h.c}$-$He^3(liq)_{h.c}$ line (l.c = lower concentration, h.c = higher concentration). Only crystals with the same approximately 52% He^3

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concentration were found to grow above 0.38 K. The experiment has also confirmed the bcc structure of crystals with a higher than about 4% He^3 concentration down to that splitting equilibrium line and the transition here to hcp crystals at approximately 0.3 K. Figures 3; references 8: 4 Russian, 4 Western.

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DUBCHAK, A. P., LYSENKO, V. S., NAZAROV, A. N., ATAMANENKO, V. T., LOKSHIN,M.P.,
and POLISHCHUK, YU. YA., Institute of Semiconductors, Academy of Sciences
UkrSSR, Kiev

STUDYING THE DIELECTRIC-SEMICONDUCTOR INTERFACE BY THE METHOD OF THERMALLY
STIMULATED DISCHARGE AFTER B^+ ION IMPLANTATION

[Abstract] The method of thermally stimulated discharge is useful for studying
the changes in the electrophysical characteristics of MOS structures after
ion implantation, inasmuch as neither current-voltage curves nor capacitance-
voltage curves yield sufficient information about the radiation defects and
about the energy distribution of traps. Such a study was made on $Me-SiO_2-Si$
and $Me-Al_2O_3-SiO_2-Si$ structures with an oxide layer 1000-2000 $\overset{o}{A}$ thick. The
specimens were doped with B^+ ions of sufficient energy to reach the dielectric
(oxide)-semiconductor interface and in amounts varying from 0.1 to $10\,\mu\,C/cm^2$.

DUBCHAK, A. P., LYSENKO, V. S., NAZAROV, A. N.,ATAMANENKO, V. T.,
LOKSHIN, M. P., and POLISHCHUK, YU. YA., UKRAINSKIY FIZICHESKIY ZHURNAL
Vol 21, No 7, Jul 76 pp 1197-1201

The temperature spectra of the discharge current were measured, and two peaks
were recorded: at 84 and 216 K for $Si-SiO_2$ at 133 and 250 K for $Al_2O_3-SiO_2-Si$,
their widths and heights depending on the implantation dose. The results,
combined with theoretical calculations, indicate that implantation of boron
ions has established a system of energy levels in two-layer as well as in
three-layer structures within the upper half of the forbidden band. Some of
these levels seem to be analogous to those caused by radiation defects, but
their true nature is not known yet. Figures 3; references 24: 8 Russian,
16 Western.

KARPLYUK, K. S., Kiev State University imeni T. G. Shevchenko

EXCITATION OF SURFACE WAVES DURING DIFFRACTION OF A PLANE WAVE AT A HALF-PLANE
PLASMA-DIELECTRIC BOUNDARY

[Abstract] A nonhomogeneous plasma-dielectric interface may, unlike a homo-
geneous one, serve as a receiver antenna for surface waves excited by a plane
wave impinging on it and diffracted at an inhomogeneity. This situation is
analyzed here for the case of a plane electromagnetic wave which, coming from
the dielectric side, impinges on and is diffracted at an ideally conducting
half-plane boundary with the plasma. The problem is solved on the basis of
Maxwell's fundamental field equations with appropriate boundary conditions.
In the simplest model one assumes the motion of ions and the thermal motion of
electrons to be negligible in the plasma, with the latter being regarded as
another dielectric. It is sufficient to calculate only the tangential component
of the electric field intensity, all other E and H components being expressible
in terms of the latter. An exact analytic solution is found which, with the
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given boundary conditions, leads to paired integral equations and these in
turn are solved by the factorization method. Generally it is necessary to use
numerical methods for evaluating the integrals. The method of steepest
descent may be used in some cases such as, for instance, the far-field zone
of the dielectric. Figures 3; references : 5 Western.

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Fluid Dynamics

TAMARIN, A. I., TEPLITSKIY, YU. S. and LIVSHITS, YU. YE., Institute of Heat
and Mass Exchange imeni A. V. Lykov, Academy of Sciences BSSR, Minsk

ON THE PRINCIPLES GOVERNING MOTION OF GAS BUBBLES IN A FLUIDIZED BED

[Abstract] An experimental study is done on the dimensions of gas bubbles
in a nonhomogeneous fluidized bed of sand (particle size $d = 0.23$ mm, velocity
at onset of fluidization $u_0 = 6$ cm/s) and silica gel ($d = 0.19$ mm, $u_0 = 2$ cm/s).
The experiments were done in a column 300 mm in diameter by a dynamometer
sensor method similar to that described by A. I. Tamarin, I. Z. Mats and
G. G. Tyukhay in the collection "Teplo- i massoperenos v dispersnykh
sistemakh" [Heat and Mass Exchange in Dispersed Systems], Minsk, 1968.
Experimental data in the literature on bubble sizes are generalized on the
basis of the proposed model of bubble expansion in a fluidized bed. The
formula derived for bubble size is

$$D_b = \frac{q}{\sqrt[3]{g}}[(u - u_0)h]^{3/2}$$

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where g is the acceleration of free fall, h is the height above the screen,
and q is a dimensionless coefficient that does not depend on h or $u - u_0$; u is
the gas filtration rate. The value of q can be taken as 1.3 for bubbles in
equipment with porous screens at distances of at least 200 mm from the gas
distributor. References 11: 2 Russian, 9 Western.

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USSR UDC: 532.528

TERENT'YEV, A. G., Cheboksary

ON A NONLINEAR THEORY OF CAVITATING FLOW AROUND OBSTACLES

[Abstract] Based on the example of steady-state cavitating flow of an infinite stream of ideal incompressible weightless fluid around a plate, the author shows the feasibility of single-valued construction of potential flow assuming only the physically justified conditions relative to the pressure in the cavity and liquid respectively

$$p = p_0 = \text{const}, \quad p \geqslant p_0,$$

and the condition

$$\oint_L dz = 0,$$

showing that a continuous closed curve L can be found that encloses the cavity and the barrier. It is theoretically shown that steady-state
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potential cavitating flow is parted, whereas in reality only one-sheeted flow is possible. This contradiction may be eliminated in unsteady flow. The unsteady process at the end of the cavity is very complicated, and as yet cannot be mathematically treated. However, the departure from the steady state is local, and has no appreciable influence on the average hydrodynamic and geometric characteristics of flow close to the plate. The theory implies that a certain amount of liquid is periodically entrained by the cavity and returned to the main flow, which is borne out by cavitating flow in actual liquids. References 5: 3 Russian, 2 Western.

2/2

USSR   UDC: 532.526

SHINKIN, G. P., Moscow

INTERACTION OF A LAMINAR MIXING ZONE WITH AN EXTERNAL FLOW

[Abstract] Pressure-induced interaction of a laminar mixing zone with an
external flow is considered in the hypersonic approximation. It is assumed
that homogeneous flows of perfect gases are mixed, and that they have high
Mach numbers ($M_\infty \gg 1$, $M_{-\infty} \gg 1$, the subscripts ∞ and $-\infty$ corresponding to the
undisturbed parameters of the upper and lower flows respectively). The
viscous mixing zone is treated separately from the inviscid shock layer.
The boundary streamline is found from the condition of equality of the
induced pressure on either side of the mixing zone. Analytical solutions
are found in the asymptotic regions of weak and strong interaction for
displacement thicknesses, boundary streamline and induced pressure in the
local-similarity approximation. References 4: 3 Russian, 1 Western.

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USSR   UDC: 532.556.4

FRANKFURT, M. O.

INVESTIGATION OF THE EFFECTIVENESS OF A 'JET FLAP' DIFFUSER

[Russian abstract provided by the source]

[Text] The paper gives the results of an experimental study of a diffuser
device formed by a thin turbulent jet blown out of a tapered plug nozzle at
the outlet of a cylindrical channel. The author defines the way that the
energy characteristics of such a device depend on the momentum of the jet
and the flow section of a nozzle with continuous and interrupted annulus
as the flow escapes from the channel into free space. Interpolation formulas
are proposed for approximate evaluation of the aerodynamic effectiveness of
the given device, which can be used in installations with high-temperature
flows or aggressive media. References 2: 1 Russian, 1 Western.

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LAMINAR BOUNDARY LAYER IN A SWIRLING FLOW

[Russian abstract provided by the source]

[Text] An investigation is made of a three-dimensional non-self-similar
laminar boundary layer of compressible gas in a swirling flow. The boundary
layer equations are written in variables that ensure constant coefficients
of the highest derivatives, and are solved by a numerical finite-difference
method. An examination is made of singularities of the boundary layer that
arise when there is a retrograde-circulation region in the channel. Refer-
ences 10: 7 Russian, 3 Western.

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LEVITSKIY, S. P. and LISTROV, A. T., Voronezh

ON THE INFLUENCE THAT VISCOELASTIC PROPERTIES OF A LIQUID HAVE ON THE
DYNAMICS OF SMALL OSCILLATIONS OF A GAS BUBBLE

[Abstract] A search of the literature reveals that many papers have been
devoted to questions of the dynamics of gas bubbles in viscoelastic liquids.
Several of them have made a numerical study of the radial oscillations of a
gas bubble in an incompressible viscoelastic Oldroyd liquid. Others are con-
cerned with an exact solution to the equation of small oscillations of a
cavity in an Oldroyd medium with periodic change of pressure at infinity.
Analysis of the oscillations of a bubble in a viscoelastic liquid is complicated
by singularities of passage to the limit in the rheological equation of the
medium which are of considerable interest for this problem. The authors discuss
these features and on the basis of a numerical analysis of the precise solution
they investigate the characteristics of small oscillations of a bubble in an
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Oldroyd medium. Linear analysis of the problem shows that oscillations of
bubbles in viscoelastic liquids close to resonant frequencies should develop
more intensively than in Newtonian liquids. Figures 7; references 11:
4 Russian, 7 Western.

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OREL, V. R., Moscow

ON THE OSCILLATIONS OF AN IDEAL LIQUID ACTED ON BY THE FORCES OF SURFACE
TENSION. THE CASE OF A DOUBLY CONNECTED FREE SURFACE

[Russian abstract provided by the source]

[Text] Any number of works have been devoted to problems of small oscillations
of an ideal liquid with regard to the forces of surface tension. Several of
these have examined the oscillations of a liquid with one free surface.
Others have investigated the oscillations of an arbitrary number of immiscable
liquids, which are separated by equilibrium surfaces, assuming that only zero
oscillations are possible on each interface. In this article the author
examines the problem of oscillations of an ideal liquid with two free surfaces,
on each of which perturbations of a non-zero amount are kinematically allowable.
The perturbations satisfy the condition of constancy of the total volume. A
method of solution is proposed. As an example a problem of axisymmetrical
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oscillations of a liquid osculating sphere of the circular opening under
conditions of weightlessness is considered. The first two normal frequencies
and modes of the oscillations are found. Figures 4; references : 11 Russian.

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SULTANOV, M. A., Tadzhik State University imeni V. I. Lenin

HYDRODYNAMIC PROCESSES IN THE CHANNEL OF A HIGH-POWER PULSE DISCHARGE

[Abstract] A study was made concerning the effect of anode-to-cathode streamers
on the structural and the spectroscopic characteristics of a high-power pulse
discharge, on its dynamics, and on the buildup of the plasma cloud. In the
experimental part were used two conical electrodes 10 mm in diameter and 10 mm
apart between tips, both of the same or each of a different material: copper,
aluminum, iron, or nickel. The capacitance of the discharge circuit was
1200 μF, the charging voltage was 3.0 kV. A high-speed camera, an oscillograph,
and a spectrograph were used for recording the space-time characteristics of
such a discharge. The propagation of shock waves, the expansion and collapse
of plasma filaments, the shifting of the shock-compressed plasma region, the
temperature profiles, and the electron concentration profiles are analyzed on
the basis of photographs and theory. Use is made of hydrodynamic and energy-
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heating relations in calculating the plasma parameters. The discharge process
is found to be periodic and attenuating within 3-4 half-periods. The struc-
ture of a discharge is found substantially different between two electrodes
of the same material and between two electrodes of different materials, with
the plasma found leaning toward the cathode in the latter case. Figures 6;
references 34: 31 Russian, 3 Western.

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BASHKIN, A. S., ORAYEVSKIY, A. N., TOMASHOV, V. N. and YURYSHEV, N. N.,
Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

A CHEMICAL CO-LASER ON A MIXTURE OF $CS_2 + O_3$ WITH PHOTOINITIATION

[Russian abstract provided by the source]

[Text] A study is done on the feasibility of using ozone as the oxidant in
a chemical CO-laser based on the reaction of oxidation of carbon disulfide.
It is found that SF_6 is a more effective diluent than He or Ar. An energy
density of 4.5 MJ/cc is achieved -- double the value attainable on a
$CS_2 + O_2$ mixture under optimum conditions. References 19: 3 Russian, 16
Western.

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IL'INSKIY, YU. A. and KHOKHLOV, R. V., Moscow State University

ON THE FEASIBILITY OF DEVELOPING A GAMMA LASER

[Abstract] A state-of-the-art survey on the feasibility of developing
lasers that emit on wavelengths of 1 Å and shorter. It is shown that limi-
tations due to the strong absorption of gamma radiation in matter can be
overcome by using the Borrman effect. However, for effects of forced emis-
sion to become appreciable the resonant gain β would have to be of the order
of 1 cm^{-1}. To achieve high gains with short-lived isomers would require an
excessive number of nuclei on the upper level, although neutron pumping may
be a possible approach to solution of this problem. The use of long-lived
isomers with separation by conventional methods requires suppression of
mechanisms leading to line broadening. These two approaches are examined in
some detail, and ways of overcoming the inherent difficulties are considered.
A third approach is discussed as a compromise in which isomers with inter-
mediate lifetimes of 0.01 s up to a few dozen seconds are used. References
24: 20 Russian, 4 Western.
1/1

USSR

BABIN, A. A., BELYAYEVA, N. N., BELYAYEV, YU. N. and FREYDMAN, G. I., Gor'kiy
Radiophysics Research Institute

ON PARAMETRIC GENERATION OF COHERENT EMISSION IN A SPATIALLY INCOHERENT
PUMPING FIELD

[Russian abstract provided by the source]

[Text] An experimental study is done on parametric emission in a spatially
incoherent pumping field (emission from a ruby laser in multimode operation).
It is shown that when the ratio l_r/l_n of the lengths of the correlation
between the resonant and nonresonant waves and the pumping wave is small,
the incoherence of the pumping wave has little influence on the spectral
and spatial characteristics of resonant wave emission. An investigation is
made of the way that the self-excitation threshold and the conversion factor
depend on the correlation length l_n and the transparency of the mirrors of
the parametric light generator. Conversion of spatially incoherent pumping
to frequency-tunable emission is achieved with a divergence close to the
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diffraction limit (which is approximately an order lower than the pumping
divergence), and with a conversion factor close to that for coherent pump-
ing (up to 20% with respect to the number of photons of the resonant wave,
and up to 40% with respect to the photon flux). References 24: 15 Russian,
9 Western.

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KULAGIN, YE. V., PIKHTELEV, A. I., TUTURKIN, YU. P., TIMOFEYEV, YU. V. and
FATEYEV, B. P.

INVESTIGATION OF OPTICAL PUMPING AND AMPLITUDE CHARACTERISTICS OF THE Rb^{87}
VAPOR LASER

[Russian abstract provided by the source]

[Text] An investigation is made of optical pumping in a rubidium vapor
laser. A technique for calculating rubidium laser characteristics is con-
sidered for general assumptions on the spectral makeup of the pumping light,
the structure of the microwave field in the cavity and the re-emitted light.
The results are in close agreement with experimental data. References 11:
10 Russian, 1 Western.

1/1

STROGANOV, V. I. and VERBOVSKIY, V. I., Institute of Physics of Semicon-
ductors, Siberian Department, Academy of Sciences USSR, Novosibirsk

A RUBY LASER WITH VARIABLE EMISSION LOSSES

[Abstract] The paper describes ruby laser designs with variable transmission
of the output mirror enabling extraction of part of the emission (variable
emission losses). The principle of operation is based on using a half-wave
quartz plate which is rotated in such a way that the resultant extraordinary
ray can be coupled out of the optical cavity before reflection. It is shown
how the output energy of the laser depends on the angle of rotation of the
polarization plane (double the angle of rotation of the half-wave plate).
The proposed design enables placement of MKP crystals inside the optical
cavities of these lasers, increasing the coefficient of conversion to the
second harmonic by a factor of 3-4 as compared with crystal placement outside
the resonator. References 3 Russian.

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KURINA, G. A., Voronezh Polytechnical Institute

ON THE SECOND APPROXIMATION OF THE AVERAGING METHOD IN ELECTRON MASER THEORY

[Russian abstract provided by the source]

[Text] Nonlinear differential equations with a single fast phase that
describe oscillations of electrons in masers are examined within the frame-
work of the second approximation of the averaging method. The necessity of
accounting for the nonresonance wave with any interaction length is demon-
strated on the basis of an example of a cyclotron resonance maser with a
Fabry-Perot resonator having its axis parallel to the static magnetic field.
The second approximation of the averaging method is used to account for this
wave. References 3 Russian.

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KURIN, A. F., KURINA, G. A. and NOVIKOV, V. V., Voronezh State University

NONLINEAR THEORY OF A CYCLOTRON RESONANCE MASER WITH FABRY-PEROT RESONATOR

[Russian abstract provided by the source]

[Text] A nonlinear analysis is made of the steady-state operation of a
cyclotron resonance maser with Fabry-Perot resonator, the axis of the reso-
nator coinciding with the direction of the static magnetic field. It is
shown that there are four amplification branches. Optimum values of
efficiency, cavity length and mismatch are calculated for a number of
longitudinal and transverse electron velocities. References 7 Russian.

1/1

ALESHKEVICH, V. A., AKHMANOV, S. A., ZHDANOV, B. V., KOVRIGIN, A. I., KUZ-
NETSOV, V. I. and SUKHORUKOV, A. P., Moscow State University imeni M. V.
Lomonosov

INVESTIGATION OF THE FREQUENCY CHARACTERISTICS OF OPTICAL BREAKDOWN OF SOLID
TRANSPARENT DIELECTRICS IN A NANOSECOND PULSE LASER FIELD

[Russian abstract provided by the source]

[Text] An investigation is made of the frequency dependence of true optical
breakdown of fused and crystalline quartz and NaCl in the wavelength range of
$\lambda = 0.26-1.06\mu m$. It is found that in the visible and infrared region, the
threshold of true optical breakdown in these materials is weakly dependent
on wavelength, evidencing the predominant role of avalanche ionization.
With a transition to the ultraviolet band, a breakdown threshold reduction
was observed in all investigated materials. In NaCl crystals this effect
is attributed to a sharp increase of absorption in the ultraviolet by non-
homogeneities. This is confirmed by analysis of the morphology of fractures.
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The reduction of the breakdown threshold in quartz can be attributed to the
contribution of many-photon ionization.
        The paper gives considerable attention to procedural problems involved
in the elimination of the influence of self-focusing and stimulated
Mandelstam-Brillouin scattering on the results of breakdown studies. It is
shown that strong prefocusing (lenses with $F = 1.5-2$ cm) is a reliable
deterrent to self-focusing in the investigated materials for nanosecond
pulses in the investigated wave band. It is pointed out that filamentary
fractures are not necessarily the result of self-focusing. References 11:
5 Russian, 6 Western.

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UDC: 621.375.823.541.1

BASHKIN, A. S., GORSHUNOV, N. M., KUNIN, YU. A., NESHCHIMENKO, YU. P.,
ORAYEVSKIY, A. N., TOMASHOV, V. N. and YURYSHEV, N. N., Moscow Engineering
Physics Institute

ACHIEVEMENT OF EMISSION IN A CS_2-O MIXTURE IN A SHOCK TUBE WITH HYPERSONIC
NOZZLE

[Abstract] The paper gives the first results of experiments on generation
of emission by CO molecules formed as a result of chemical reaction between
CS_2 and O in a shock tube installation. A three-section shock tube with
hypersonic nozzle was used. The optical cavity was formed by a spherical
opaque gold-sputtered mirror and a flat dielectric mirror with 2% trans-
mission. A mixture of oxygen and argon heated in the shock tube expanded
in the hypersonic nozzle and was mixed in the ejector with CS_2. With an
active cavity length of 7 cm, emission was achieved with 10 W of power in
a 1.8 ms pulse. Research is now in progress on optimizing the cavity,
mixture composition and shock tube regime. References 3 Western.

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UDC 537.523:621.378.8

BASHKIN, A. S., GRIGOR'YEV, P. G., ORAYEVSKIY, A. N., and SKVORTSOV, A. B.,
Physics Institute imeni P. N. Lebedev Academy of Sciences, USSR, Moscow

A POWERFUL SOURCE OF UV RADIATION ABOUT 1 μ s IN DURATION FOR PUMPING OF
GAS LASERS

[Abstract] The source of UV radiation suggested consists of a brass rod 1.8 cm
in diameter, covered with a thin polyethylene tube. The rod is return current
lead carrying a row of rings 0.4-0.6 cm wide with small projections on two
sides. A sliding discharge is initiated by feeding a short pulse of voltage
with an amplitude of up to 300 kV to one of the rings and the brass rod.
Total discharge length is 93 cm. The discharge circuit is made so as to
achieve the minimum inductance. With a stored energy of 50 kJ, a brightness
temperature of over 50,000 K is achieved in the 240-340 nm spectral range,
pulse duration about 1 μs. References 11: 8 Russian, 3 Western.

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VOLKOV, A. YU., DYEMIN, A. I., YEPIKHIN, V. N., and KUDRYAVTSEV, YE. M.,
Physics Institute imeni P. N. Lebedev Academy of Sciences USSR, Moscow

THE POSSIBILITY OF INCREASING THE EFFICIENCY OF GAS DYNAMIC LASERS: CARBON
DISULFIDE GAS DYNAMIC LASERS

[Abstract] The authors note that there is an as-yet unused method of increas-
ing the low efficiency of GDL: the use of working molecules and pumping
molecules with low levels. This allows the production of the same population
inversion as for molecules with high laser levels, but at low gas temperatures.
The drop in the stagnation temperature for the GDL suggested in comparison with
ordinary CO_2 GDL is of great significance for practice, since it reduces the
demands placed on materials of nozzles and high pressure chambers and
obviously simplifies the design of a closed cycle. Calculations for the CS_2
molecule show that inversion should occur for a number of transitions in the
11.4-117.0 μm range with CS_2 pumped by ordinary N_2 or CO molecules as well as

VOLKOV, A. YU., DYEMIN, A. I., YEPIKHIN, V. N., and KUDRYAVTSEV, YE. M.,
KVANTOVAYA ELEKTRONIKA Vol 3, No 8, 1976 pp 1833-1836

O_2 or CO_2. The maximum efficiency theoretically possible, considering
relaxation losses, is 10%. The calculations are confirmed by experimental
emission on the $00^o 1-10^o 0$ transition with wavelength of 11.4 μm.
References 12: 2 Russian, 10 Western.

KOLOMIYSKIY, YU. R., LETOKHOV, V. S., TUMANOV, O. A., Institute of Spectroscopy, Academy of Sciences USSR, Moscow

STUDY OF VIBRATIONAL EXCITATION OF THE COS MOLECULE AND STIMULATED EMISSION WITH PUMPING BY A CO_2 LASER PULSE

[Abstract] This work is dedicated to experimental investigation of processes of excitation, relaxation and stimulated emission on the example of one of the simplest molecules, the carbonyl sulfide molecule COS, when it is pumped by the radiation of a pulsed CO_2 laser. As a result of the studies performed on pumping of the harmonic of the COS molecule on the $P(22)$ wavelength, it was established that the frequency of pumping radiation about 0.01 cm^{-1} off center relative to the transition $v = 0, J = 5 \rightarrow v_2 = 2, J = 4$ of the deformation mode of the COS molecule. The time of the vibration-vibration exchange in this mode $\tau_{vv} p = (1.3 \pm 0.25) \cdot 10^{-6}$ s·mm Hg, while the time of

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KOLOMIYSKIY, YU. R., LETOKHOV, V. S., TUMANOV, O. A.,,KVANTOVAYA ELEKTRONIKA Vol 3, No 8, Aug 75 pp 1771-1781

rotational relaxation $\tau_r p = (2.9 \pm 0.6) \cdot 10^{-8}$ s·mm Hg. The powerful CO_2 laser pulse forms a population inversion between levels $v_2 = 2$ and $v_2 = 1$ of the deformation mode of oscillation, stimulating emission on this transition at a wavelength of $\lambda = 18.92$ μm. The absence of visible luminescence in the molecule at significant incident CO_2 laser energy densities indicates that the excitation mechanism of this rather simple molecule is different from the case of more complex molecules. References 16: 8 Russian, 8 Western.

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ANAN'YEV, YU. A., TRUSOV, V. P. and SHERSTOBITOV, V. YE.

SELECTING AN UNSTABLE OPTICAL CAVITY FOR A GAS DYNAMIC LASER

[Abstract] Energy calculations are done for an unstable gas dynamic laser
cavity comprised of two spherical mirrors with axis perpendicular to the gas
flow (fig. 1). The analysis is based on the geometric approximation for the
quasi-steady state, assuming that the mirrors are rectangular (the shape
corresponding to maximum energy coupled out). The distributions of gain and
field throughout the cavity are calculated by the method of iterations, and
numerical results are given for a laser using a CO_2-N_2-H_2O mixture. The
cavity is optimized by varying its magnification M and the lengths of the
left and right sections l_1 and l_2 (see fig. 1). For each design, the reso-
nator efficiency X is calculated, defined as the ratio of the number of
quanta leaving the cavity in the form of useful emission to the total number
of excited molecules entering the cavity in the same time period. It is found
that the efficiency of energy conversion can be maximized by taking the total
length of the cavity just short of the relaxation length of the medium, the

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length of the left section about an order of magnitude shorter, and cavity
losses such that the threshold value of the gain $(\log M - \log R)/L$ (where R is
reflectance) is about half the value at input to the cavity. Although
specific calculations show that the simplest unstable cavity with spherical
mirrors can provide satisfactory energy conversion efficiency, the uniformity
of field distribution over the mirrors is poorer than for the two-dimensional
case (with cylindrical mirrors). It is shown that high conversion efficiency
can be combined with uniform field distribution in prism cavities where the
influence of wave aberrations of odd order is appreciably attenuated as com-
pared with the ordinary telescopic cavity shown in fig. 1. A possible
arrangement is shown in fig. 2. The cylindrical mirror of variable curvature
1 varies the magnification of the cavity, and the ratio between the overall
length of the resonator and l_1 is varied by shifting plates 3 and 4 parallel
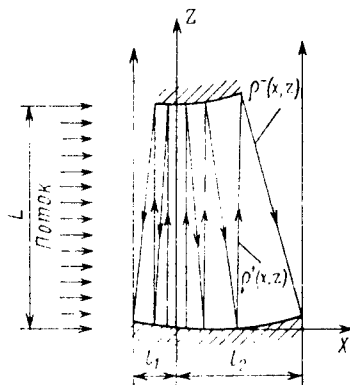to the gas flow, and by the inclination of the mirrors. References 6 Russian.

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Fig 1
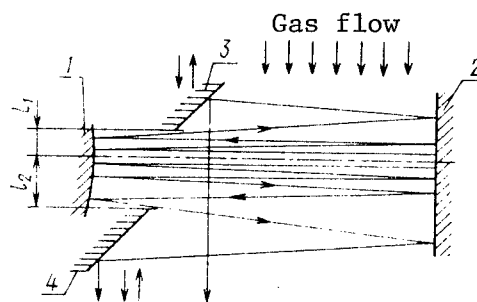

Fig 2

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ISAYEV, A. A., KAZARYAN, M. A., PETRASH, G. G., and CHEREZOV, V. M.,
Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

STUDY OF A MANGANESE VAPOR PULSED LASER

[Abstract] A study is made of the emission characteristics of a pulsed
manganese vapor laser. Discharge tubes were used with working portions of
alundum 60-70 cm in length, internal diameter 1.5-2.0 cm. Quartz windows
glued to the ends of the discharge tube at a slight angle to the axis and the
electrodes were located outside the heated zone. The discharge tube was
excited by the discharge of a capacitor through a TGI1-2500/50 hydrogen
thyratron. The pulse repetition frequency varied between 2 and 21 kHz. The
best emission parameters were achieved with helium as the buffer gas. The
average emission power was 2.1 W, peak power 24 kW, efficiency 0.2%. The
volumetric peak power was about 140 W/cm^3, volumetric emission pulse energy --
2.5 μJ/cm^3. References 7: 5 Russian, 2 Western.

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GRIDIN, V. A., KROTOV, V. A. and PETROVSKIY, A. N., Moscow Engineering
Physics Institute

DESTRUCTION OF MKP CRYSTALS BY ULTRASHORT LASER PULSES

[Russian abstract provided by the source]

[Text] An investigation was made of the action of ultrashort laser pulses
on nonlinear MKP crystals. It is shown that crystal destruction is discrete
and independent of crystal orientation or the focal length of the lenses.
The threshold energy of destruction increased with an increase in the focal
length of the lenses. With a transition from $\lambda_1 = 1.06$ µm to $\lambda_2 = 0.53$ µm
a reduction by a considerable factor was observed in the threshold energy
of destruction. It is shown by the method of two-frame pulse holography
that destruction increases in both directions away from the focal plane.
The rate of increase in destruction counter to the laser pulse was estimated
at $1.6 \cdot 10^{10}$ cm/s. Figures 5, references 7: 6 Russian, 1 Western.

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ANDREYEV, S. I., BELOUSOVA, I. M., DASHUK, P. N., ZAROSOLOV, D. YU., ZOBOV,
YE. A., KARLOV, N. V., KUZ'MIN, G. P., NIKIFOROV, S. M. and PROKHOROV, A. M.,
Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

A PLASMA-SHEET CO_2 LASER

[Russian abstract provided by the source]

[Text] An experiment is done on using a plasma sheet as the cathode for
cavity discharge in the working mixture of a CO_2 laser. The plasma sheet is
formed by sliding discharge channels in the incomplete stage on a Mylar film
surface. An energy input of about 1-2 J into the sliding discharge produced
a homogeneous plasma surface measuring 6 x 40 cm, ensuring formation of a
cavity discharge in a 3.5 cm gap with gas pressures from 0.5 to 1.5 atm in
a gas mixture with component ratio $CO_2:N_2:He = 1:2:3$. Emission energy of
20 $J \cdot l^{-1} \cdot atm^{-1}$ was achieved at half-height in pulses of standard shape with
energy input of 165 $J \cdot l^{-1} \cdot atm^{-1}$ to the cavity discharge. References 15:
12 Russian, 3 Western.
1/1

BYKOVSKIY, YU. A., MAKOVKIN, A. V., MOLOCHEV, V. I., SMIRNOV, V. L. and SHMAL'KO, A. V.

COUPLING THE RADIATION OF A SEMICONDUCTOR LASER INTO THIN-FILM AND FIBER-OPTICS WAVEGUIDES

[Abstract] The prospects of utilizing semiconductor lasers as small coherent light generators for integrated-optical circuits is causing research to be conducted for effective methods of coupling their radiation to thin-film waveguides. Possible ways of doing this by means of diffraction-lattice devices have been previously studied. The authors of this article suggest and demonstrate one new way to couple the radiation from a semiconductor laser to such waveguides on the basis of an optical tunneling effect.

A four-sided semiconductor laser in which all faces are mirrors of the optical cavity enables direct tunneling of the luminous energy from the active region of the laser into an optical waveguide, appreciably reducing the dimensions of the coupling device and simplifying manufacture. The emission of such a
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laser is a set of closed ring modes that undergo total internal reflection on all four faces of the active region. The emission energy of the laser placed a distance of the order of fractions of a wavelength above the surface of a film is optically tunneled into the waveguide, the laser itself serving as the input device. The paper gives the results of experiments on coupling laser emission into thin-film and fiber-optics waveguides. The authors state that it is necessary to ensure a high degree of optical quality of the surfaces between which the tunneling of light energy takes place in order to achieve maximal effectiveness. Figure 1; references 5: 4 Russian, 1 Western.

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ISAYEV, A. A., KAZARYAN, M. A., LEMMERMAN, G. YU., PETRASH, G. G. and
TROFIMOV, A. N., Physics Institute imeni P. N. Lebedev, Academy of Sciences,
Moscow

PULSED EMISSION ON TRANSITIONS OF THE COPPER ATOM IN A DISCHARGE IN COPPER
BROMIDE AND CHLORIDE VAPORS

[Abstract] The purpose of this work was to determine the peculiarities of
laser generation using vapors of copper by injection of these atoms into a
halide discharge. Studies with copper chloride were performed in an
installation with a TGI1-2000/35 thyratron in quartz tubes 11 and 18 mm in
diameter with a length of the heated portion of 40 and 90 cm. The copper
bromide discharge was studied with a TGI1-2500/50 thyratron in tubes 30 mm
in diameter and 50 cm in length. Emission was achieved with a pulse recur-
rence rate of up to 20 kHz. An investigation is made of the way that emis-
sion power depends on discharge conditions. The experiments indicated that

ISAYEV, A. A., KAZARYAN, M. A., LEMMERMAN, G. YU., PETRASH, G. G., and
TROFIMOV, A. N., KVANTOVAYA ELEKTRONIKA Vol 3, No 8, Aug 76 pp 1800-1802

the emission characteristics of the copper bromide and chloride lasers were
comparable to the characteristics achieved with copper vapor lasers.
References 13: 5 Russian, 8 Western.

VOTSISH, A. D., and KOLESNIKOV, YU. B., Institute of Physics, Academy of
Sciences Latvian SSR

ON MOMENTUM TRANSFER FROM PULSATION MOTION TO AVERAGED MOTION IN MHD SHEAR
FLOW

[Abstract] The paper gives the results of an experimental study of two-
dimensional turbulence resulting from interaction between a magnetic field
and a flow of electrically conductive fluid. It is shown that under certain
conditions in flow with shear the energy of pulsation motion may be tapped
off by the averaged flow. The experiments were done on a horizontal mercury
loop in a nonconductive channel of 50 x 60 mm rectangular cross section
placed in the gap of a DC electromagnet. Shear flow was produced by a flat
gap 3 x 50 mm at the inlet to the working section with the long side parallel
to the magnetic field. Measurements were taken at a fixed flowrate of
20 cm/s. It was found that the gradient of the averaged velocity and its
maximum value are increased by application of a magnetic field to the flux,
beginning at a distance of 360 mm from the initial section. This is
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attributed to the two-dimensional structure of turbulence beyond this
distance. This effect is accompanied by energy flux from small-scale to
large-scale perturbations, up to and including energy transfer to the
averaged flow. This is confirmed by turbulent stress measurements, which
show that in the absence of a magnetic field the pulsation motion takes
energy from the averaged motion, and when the magnetic field strength be-
comes sufficiently great the energy transfer of turbulent pulsations to
the averaged flow appreciably exceeds the generation of energy by the
averaged flow. References 11: 8 Russian, 3 Western.

2/2

DAUTOV, A. I., ISMAGILOV, R. KH., SHASHKOV, A. G. and SHAVALIYEV, KH. M.,
Kazan' Aviation Institute, Institute of Heat and Mass Exchange imeni A. V.
Lykov, Academy of Sciences BSSR, Minsk

INVESTIGATION OF THE CHARACTERISTICS OF A PLASMOTRON WITH A CHANNEL OF
VARIABLE RADIUS

[Abstract] An experimental study is done on the thermal and electrical
characteristics of a plasmotron with an arc chamber that becomes narrower
in the direction of the gas flow, and the peculiarities of these character-
istics are discussed. It is shown that heat flux, enthalpy, electric field
strength and efficiency are appreciably dependent on the law of variation
in the rate of flow of the plasma-forming gas lengthwise of the arc chamber,
and that the profile of the arc chamber and law of variation in gas flow-
rate can be optimized by improving the plasmotron characteristics. Refer-
ences 4 Russian.

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DUBASOV, A. M., Institute of High Temperatures, Academy of Sciences USSR

CALCULATION OF THERMAL STRESSES IN CERAMIC ELEMENTS OF THE HEAT-RESISTING
CHANNEL WALLS IN AN MHD GENERATOR

[Russian abstract provided by the source]

[Text] A technique is presented for calculating thermal stresses in a
ceramic plate and cylinder of limited length. The temperature field varies
only with respect to the thickness of the plate or the height of the cylinder.
Heat stresses in the plate are calculated with consideration of the way that
the elastic modulus depends on temperature and the stressed state. Thermal
stresses in the cylinder are calculated for the case of a fixed modulus in
the form of polynomials of r and z, where r is the radial coordinate and z
is the axial coordinate. The solution satisfies equations of compatibility
and equilibrium and the boundary conditions on one end exactly. Solutions
on the remainder of the surface are found by the method of point-by-point
satisfaction of boundary conditions. Examples are given of calculation for
a plate and for cubiform and elongated cylinders. References 6 Russian.
1/1

BITYURIN, V. A., IVANOV, P. P., KOVBASTYUK, V. I. and KORYAGINA, G. M.,
Institute of High Temperatures, Academy of Sciences USSR

CONCERNING THE INFLUENCE OF VARIOUS LOSSES ON THE CHARACTERISTICS OF
HIGH-POWER MHD GENERATORS

[Russian abstract provided by the source]

[Text] A discussion of the flow peculiarities of MHD generators for first
generation open-cycle MHD electric power plants: boundary layer development,
conduction nonhomogeneity in the channel cross section, Hall effect in a
flow with nonhomogeneous conduction, end effect, etc. It is shown that
nonhomogeneity of conduction appreciably increases the necessary channel
length without much effect on conversion efficiency. Inattention to this
circumstance in the simplified techniques for MHD generator calculations
used in the literature on technical and economic estimates of MHD electric
power plants may result in considerable inaccuracy in determination of the
competitiveness of MHD generators as compared with other kinds of power
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plants. It is concluded that the flow regime must be carefully optimized
in order to achieve acceptable characteristics of MHD electric power plants.
References 9 Russian.

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BOBKOV, A. A., KOVALEV, V. N. and LARIONOV, YU. A., Moscow Power Engineering
Institute

ON TESTING A HALL MHD GENERATOR

[Annotation of an article deposited in VINITI, 1 Jul 76 No 2486 Dep.]

[Text] The paper gives the results of an experimental study of the thermal
and electrical characteristics of a subsonic MHD Hall generator (distribution
of temperature, pressure, velocity and specific heat stresses through the
walls of the electrodes, and Hall potential lengthwise of the channel).
    The first test series on the annular Hall generator was done outside
the magnet with external applied voltage to evaluate the equivalent internal
resistance of the generator and the electrical resistance of the insulation,
and to work out the design of the channel.
    A second series of experiments was done in the magnetic field to deter-
mine the electrical characteristics of the Hall generator (effective Hall
parameter, current-voltage characteristics of the generator).
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    Conclusions are drawn from the experimental data on the workability of
the channel design, and on the influence that additive deposits on the cold
walls of the channel have on the stability of the electrical characteristics
of the Hall generator. The theoretical and experimental current-voltage
characteristics of the generator are compared for different values of the
potential drop near the electrodes.

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USSR   UDC: 621.387.143:621.793

GONCHAR, N. I., ZVYAGINTSEV, A. V., MITIN, R. V. and PRYADKIN, K. K., Physico-technical Institute, Academy of Sciences UkrSSR, Khar'kov

USING AN ELECTRODELESS CAPACITIVE RF PLASMOTRON TO APPLY REFRACTORY DIELECTRIC COATINGS

[Russian abstract provided by the source]   ♦

[Text] An investigation is made of the feasibility of using an rf plasmotron with capacitive discharge to apply refractory dielectric coatings to metallic and nonmetallic surfaces. A discharge chamber is designed for effective utilization of a filamentary capacitive discharge configuration. A qualitative analysis is made of commercial alumina coatings applied to metal backings. References 6: 5 Russian, 1 Western.

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Molecular Physics

GAVRIKOV, V. F., DRONOV, A. P., ORLOV, V. K. and PISKUNOV, A.K,

THE INTERACTION OF VIBRATIONALLY EXCITED DIATOMIC MOLECULES WITH TRIATOMIC MOLECULES

[Russian abstract provided by the source]

[Text] A study is made of the vibrational interaction of diatomic molecules with combination levels of triatomic molecules. The analysis considers V-V and V-T process as well as intramolecular exchange. Simple expressions are produced relating the vibrational temperature of the ν_3 mode of the triatomic molecule to the vibrational temperature of the diatomic molecule under quasi-equilibrium conditions. It is shown that under certain conditions, the ν_3 mode may be heated by energy stored in oscillations of the diatomic molecule. Estimates of this effect are produced for the systems $HF-CO_2$, $DF-CO_2$, D_2-CO_2 and $CO-CS_2$. Experimental measurements are presented of the gain in a supersonic D_2-CO_2 stream on the 00^o1-10^o0 transition. The measured gain confirms
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that in the system D_2-CO_2, heating of the ν_3 mode of CO_2 occurs due to the energy stored in the D_2 vibrations. References 29: 6 Russian, 23 Western.

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ARMBATSUMYAN, R. V.

SEPARATION OF ISOTOPES BY THE METHOD OF DISSOCIATION OF POLYATOMIC MOLECULES
IN A STRONG INFRARED FIELD

[Summary of a paper delivered at an expeditionary session of the Council of
the Soviet Academy of Sciences on the Problem of Coherent and Nonlinear
Optics held 15-17 January 1976 at Tsakhkadzor near Yerevan]

[Abstract] An investigation is made of processes of rapid dissociation of
SF_6 molecules in a strong infrared field. An analysis is made of the way
that dissociation rate and isotopic selectivity depend on initial gas
pressure and the IR frequency. It is shown that the dissociation rate is
determined by vibrational-vibrational exchange during the IR pulse. The
behavior of selectivity with pressure is also determined chiefly by this
mechanism. The upper limit of dissociation selectivity is fixed at 13 by
the imperfection of the chemical cycle of separation. The lower limit of
dissociation of SF_6 was found to be 23 MW/cm^2. The author has developed a
theory of overcoming anharmonicity of oscillations by an appropriately chosen

sequence of transitions: first the molecule goes through a P-transition
($v = 0 \rightarrow v = 1$), then a Q-transition ($v = 1 \rightarrow v = 2$) and an R-transition
($v = 2 \rightarrow v = 3$), and then goes up to the limit of dissociation through a quasi-
continuum of vibrational levels of molecules. It is suggested that the
mechanism responsible for selective processes is dissociation in a two-
frequency IR field -- v_1 in resonance with the vibrational transition is the
weaker component that excites the first few levels of the molecules, and v_2
off-resonance from the absorption frequency is responsible for dissociation
of the pre-excited molecules. The dispersion characteristic of the quasi-
continuum is plotted, and it is shown that the rate of dissociation in SF_6
with frequency detuning by 130 cm^{-1} from the v_3 band is 40 times below the
rate when detuning is only 20 cm^{-1}, where the dissociation rate is about
1.2-1.3 times lower than for high-Q single-frequency exposure. The author
feels that the results confirm the proposed theory of anharmonicity compen-
sation.

USSR   UDC: 535.341

BIRYUKOV, A. S., VOLKOV, A. YU., KUDRYAVTSEV, YE. M. and SERIKOV, R. I.,
Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

ANALYSIS OF DATA ON THE PROBABILITIES OF SPONTANEOUS EMISSION AND ON THE
CROSS SECTIONS OF COLLISIONAL BROADENING OF LINES OF THE 00^01-10^00 TRANSITION
OF THE CO_2 MOLECULE

[Russian abstract provided by the source]

[Text] A critical analysis is made of a number of experimental papers on
measurement of Einstein's coefficient A_{mn} and the cross sections of collisional
broadening of line $P(20)$ of the 00^01-10^00 transition in the CO_2 molecule. As
a result, a value of $A_{mn} = 0.187$ s^{-1} is recommended for the line $P(20)$, while
values of 7.58, 5.56 and 4.86 MHz/mm Hg are recommended as quantities defining
broadening of lines at 300 K due to collisions between CO_2 molecules and
CO_2, N_2 and He respectively. References 23: 8 Russian, 15 Western.

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HORA, H., New South Wales University, Kensington, Australia

INCREASED NUCLEAR ENERGY YIELDS FROM THE FAST IMPLOSION OF COLD SHELLS DRIVEN
BY NONLINEAR LASER PLASMA INTERACTIONS

[Russian translation by B. F. Polkovnikov of a paper delivered at the Seventh
All-Union Conference on Coherent and Nonlinear Optics, Tashkent, May, 1974;
English abstract provided by the source]

[Text] The nonlinear interaction force between laser fields and cold plasma
shells efficiently transforms radiant energy into mechanical energy of
implosion. This transfer of energy has been considered before in numerical
experiments and is treated here analytically in a didactic example starting
with the inhomogeneous Rayleigh density profile. Up to 50% of the laser
energy could be transferred into the energy of compression if a single,
untailored pulse of $2.5 \cdot 10^{16}$ W/cm^2 intensity and of only a few picoseconds
duration is used for spherical illumination of the shell. If the pulse is
short enough to reduce collisional thermalization, then the collapse and
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compression of the plasma can remain both at the threshold of Fermi degeneracy
and adiabatic. This results in nuclear reaction gains G, based on the
deposited energy E_0, and without α-particle reheating, of G = 400 for
E_0 = 2.25 kJ (DT), 900 kJ (DD), 13 MJ (HB). About 1000 times less laser
energy is necessary than in the case of gasdynamic ablation resulting in
the same nuclear reaction yields. References 21: 2 Russian, 19 Western.

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USSR
AFANAS'YEV, YU. V., BASOV, N. G., VOLOSEVICH, P. P., GAMALIY, YE. G., KRO-
KHIN, O. N., KURDYUMOV, S. P., LEVANOV, YE. I., ROZANOV, V. B., SAMARSKIY,
A. A. and TIKHONOV, A. N., Physics Institute imeni P. N. Lebedev, Academy
of Sciences USSR

EXTREME PHYSICAL CONDITIONS IN THE PROCESS OF LASER-INITIATED THERMONUCLEAR
COMBUSTION

[Abstract] The authors analyze the physical conditions that arise in the
plasma of thermonuclear targets in laser-driven fusion on the thermonuclear
combustion stage. Assuming laser emission energy of the order of 10^6 J and
a target with deuterium-tritium fuel content of 10^{-3} g, the following values
are estimated for the characteristic parameters of the thermonuclear plasma
in the combustion process: pressure 10^{14} atmospheres, combustion time
$2 \cdot 10^{-11}$ s, average ion temperature 0.6 MeV, and time of energy transfer from
α-particles and neutrons to ions 10^{-11} s. It is shown that there should be
a group of hot ions with temperature of the order of 1 MeV or more about
equal in number to the neutron production (14 MeV) of 10^{19}. The characteristic
1/2

neutron density is 10^{24} cm^{-3}, and the neutron flux is of the order of 10^{30} s^{-1}.
Thus neutron-neutron scattering is possible with the production of 28 MeV
neutrons. The parameters found in this numerical experiment would be useful
in a variety of experiments, and could be registered by analysis of ion,
neutron and x-ray spectra. References 2 Russian.

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LOKTIONOV, A. A., KHOMENKO, K. I.

USE OF MAPPING SYSTEMS TO REPRESENT AND STATISTICALLY ANALYZE MEASUREMENTS
FROM BUBBLE CHAMBER PHOTOGRAPHS

[Abstract] In the Laboratory of Mathematical Physics of the Institute
of High Energy Physics, Acad. Sci. KazSSR, in the analysis of bubble chamber
measurements a mapping system is used with processing of the data by the
method of least squares on a BESM-4 computer. The structure of the
system utilizes the standard BESM-4 hardware and specialized software. A
flow chart of the software is presented. The system has been used for
methodological work related to debugging of measurements and geometric
reconstruction utilizing the Mirabel' new generation bubble chamber. The
effects of a large number of various factors defining the motion of the
particle in the hydrogen bubble chamber results in a complex form of the
particle trajectory on stereo projections in the plane of the film. In
order to produce a high quality representation, the track is described on

the plane of the film by an m-power polynomial. As this curve approaches
the "true" trajectory, the mean-square deviation S of the polynomial from
the measurements decreases (approaching a certain limit). The statistical
analysis of the results of measurements gives an idea of the nature of
the trajectory of the particles in the stereo projection in the plane of
the film. References: 5 Russian.

ANASHIN, V. V., BUDKER, G. I., BULUSHEV, A. F., DIKANSKIY, N. S., KOROLEV,
YU. A. (deceased), KOT, I. KH., KUDELAYNEN, V. I., KUSHNIR, V. I., LIVSHITS,
A. A., MESHKOV, I. N., MIRONENKO, L. A., PARKHOMCHUK, V. V., SKRINSKIY, A. N.,
SMIRNOV, B. M., SUKHINA, B. N. and USOV, A. P., Institute of Nuclear Physics,
Siberian Department, Academy of Sciences USSR, Novosibirsk

THE NAP-M PROTON ACCUMULATOR. I. THE MAGNETIC AND VACUUM SYSTEM

[Russian abstract provided by the source]

[Text] The paper describes the magnetic and vacuum system of a proton ac-
cumulator designed for experiments on electron cooling [see G. I. Budker,
Atomnaya energiya, 1967, Vol 22, p 346; V. V. Anashin et al., Doklad na
IV Vsesoyuznom soveshchanii po uskoritelyam zaryazhennykh chastits (Report
to the Fourth All-Union Conference on Charged Particle Accelerators), 1975,
Vol 2, p 304, "Nauka"]. The arrangement of the accumulator -- magnets with
homogeneous field and edge focusing, and long straight intermediate gaps --
is determined by the specific nature of electron cooling. The vacuum chamber

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is exhausted by magnetic discharge and sorption pumps, and can be heated to
300°C. The working vacuum is $2 \cdot 10^{-10}$ mm Hg. References 5 Russian.

2/2

BAKLAKOV, B. A., BOROVIKOV, V. M., PEREMEYENKO, V. F., KARLINER, M. M. and PETROV, S. P., Institute of Nuclear Physics, Siberian Department, Academy of Sciences USSR, Novosibirsk

THE NAP-M PROTON ACCUMULATOR. II. CURRENT STABILIZATION IN THE SUPPLY CIRCUITS FOR THE MAGNETS OF THE CONTROLLING FIELD AND THE CORRECTING ELEMENTS

[Russian abstract provided by the source]

[Text] A description of the systems for stabilizing currents in the windings of the magnets for the controlling field and 24 correcting elements. Current instability in the windings of the magnets for the controlling field does not exceed $1 \cdot 10^{-4}$; the relative magnitude of pulsations is no greater than $2 \cdot 10^{-5}$ at currents up to 7.5 kA. The current instability of the correcting elements for each of the 24 channels is less than $1 \cdot 10^{-3}$ for correction currents up to 30 A. References 3 Russian.

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BATASHEV, A. P., RYBALOV, S. V., and SAPOZHNIKOV, G. I.

A RECUPERATOR WITH INTENSIVE ELECTRON-BEAM DECELERATION

[Abstract] A recuperator is proposed in which beam deceleration involves flattening of the cylindrical electron beam followed by deceleration in a hollow slotted collector. A quadrupole lens is used for transformation of beam shape. The authors investigate a consequent-pole lens of circular cross section in which the conductors are spaced around the periphery with density varying as $\cos 2\varphi$. It is shown that a lens current of 0.5 A flattens the beam to $h/l = 0.05$. Experiments show that beam transformation increases percentage recuperation to 99% as compared with 95% without the lens. References 6 Russian.

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PEREMEYENKO, V. F., DIKANSKIY, N. S., KALININ, A. S., KARLINER, M. M.,
LAZARENKO, B. A., LITVINOV, A. A., MEDVEDKO, A. S., OSTANIN, V. P.,
PARKHOMCHUK, V. V., SUKHINA, B. N. and CHEREPANOV, V. P., Institute of
Nuclear Physics, Siberian Department, Academy of Sciences USSR, Novosibirsk

THE NAP-M PROTON ACCUMULATOR.   III. THE ACCELERATING SYSTEM. MONITORING BEAM
PARAMETERS

[Russian abstract provided by the source]

[Text] The frequency in the NAP-M accelerating system is tuned with respect
to a Hall pickup signal proportional to the magnetic field. Precision
frequency tuning is done with respect to the radial and phase coordinates
of the beam. Monitoring of beam parameters consists in measurement of the
position of the equilibrium orbit and beam current. The beam current is
measured at particle injection, during acceleration, and also during an
experiment where beam bunching is absent. The systems use electrostatic
pickups, Rogowski loops and a magnetic-modulation current sensor. Refer-
ences 6 Russian.
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BOLVANOV, YU. A., KONONOV, V. I., KUPER, E. A., LEDENEV, A. V., NIFONTOV,
V. I., ORESHKOV, A. D., OSHCHEPKOV, YU. I., PESTRIKOV, D. V., PISKUNOV,
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THE NAP-M PROTON ACCUMULATOR. IV. ACCUMULATOR CONTROL SYSTEM

[Russian abstract provided by the source]

[Text] The basis of the NAP-M accumulator control system is the ODRA-1325
digital computer. The paper describes the equipment for data transmission,
the analog-code and code-analog conversion equipment, and the control program
that organizes interaction between the computer and external devices.
References 6 Russian.

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SHEKHTER, V. M., Leningrad Institute of Nuclear Physics imeni
B. P. Konstantinov, Academy of Sciences USSR

WEAK INTERACTION WITH NEUTRAL CURRENTS

[Abstract] Neutral currents were experimentally observed but recently--in
late 1973. Their discovery led to a redefinition of the weak interaction; in
particular, it has been found to be not universal: its constants differ for
different particles. Neutral currents are also important for an understanding
of astrophysical phenomena. The study of the weak interaction with neutral
currents is essentially just beginning. This review provides a systematic
presentation of experimental results up to mid 1975 and their theoretical
implications. The analysis is limited to processes involving neutrinos,
doubtless related to the weak interaction. Many experiments are also presented
allowing in principle detection of the effects of nonconservation of parity.
Results to date indicate clearly that when muon neutrinos interact with nucleons
and electrons, processes occur which do not involve emission of muons and
therefore result from the weak interaction with neutral currents. Neutrino

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and antineutrino spectra are presented from experiments at Argonne, the CERN
group, at Serpukhov, the HPW group and Caltech-Fermilab. Two versions of the
calibration theory of weak interaction are discussed which correspond to the
Weinberg-Salam model and the so-called vector model. Both versions agree
with experiment when free parameters of the Weinberg angle type are appropri-
ately selected. References 112: 14 Russian, 98 Western.

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KOLTOCHNIK, S. N., and KUCHIN, I. A.

CALCULATION OF THE CONTRIBUTION OF DOUBLE DIFFRACTION PRODUCTION AND
CHECKING OF FACTORIZATION OF CROSS SECTIONS OF DIFFRACTION PROCESSES OF
pp SCATTERING

[Russian abstract provided by the source]

[Text] A model of simultaneous exchange, parametrized with respect to data on
reactions of elastic scattering of protons and diffraction excitation of
nucleon isobars in pp collisions is used to calculate the cross section σ_{pp}^{DD}
of double diffraction production in the momentum range from 5 to 300 GeV/c.
The results of the calculations are compared with available experimental data.
It is shown that the assumption of factorization of cross sections of elastic
scattering and diffraction production is not confirmed by calculation: the
factorization relationship is some 2.5 times greater than the value of σ_{pp}^{DD}.
References 13: 5 Russian, 8 Western.
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KAZACHA, V. I. and KOZHUKHOV, I. V.

USE OF RADIAL LINES IN PULSE-TYPE ACCELERATORS

[Abstract] High-energy electron beams (10-15 MeV) can be generated in multigap
rather than in more costly and difficult to design single-gap accelerators. A
system of twin radial lines for a multigap accelerator had been proposed earlier.
Here the transient characteristic of such a line is calculated, for the ulti-
mate purpose of optimizing its design in terms of maximum pulse amplitude
with minimum pulse distortion over a period of several tens of nanoseconds.
The fundamental transmission-line equations are first solved for the general
case of simple electrodes in the form of parallel disks or coaxial cylinders.
Each twin line in the proposed radial system consists of one line shorted at
the center and one not. The transient characteristic here depends on the
degree of asymmetry. Calculations and E-wave measurements have shown that the
performance in this case may be improved by having the characteristic impedance
of the shorted line vary more appreciably with the radius than its unshorted
counterpart. Figures 5; references 8: 3 Russian, 5 Western.
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USSR UDC 539.123

PONTEKORVO, B. M., Joint Institute for Nuclear Research, Dubna

INSTALLATIONS FOR THE INVESTIGATION OF FREE NEUTRINOS

[Abstract] Several tables are presented which the author prepared for lectures on neutrinophysics in order to give an impression of the scale and achievements of this section of physics. The tables list existing installations for the investigation of free neutrinos. They include the overwhelming majority of installations for which funds have been allocated. The four tables list: 1) installations for the investigation of artificial "low" energy neutrinos; 2) installations for the investigation of artificial high energy neutrinos; 3) installations for the investigation of cosmic "low" energy neutrinos; and 4) installations for the investigation of cosmic high energy neutrinos. References 33: 1 Russian, 15 Hungarian, 17 Western.

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USSR

ALESHIN, V. I., BALYSH, A. YA., GALITSKIY, V. M., KOZLOV, YU. V., LEBEDEV, V. I., MARTEM'YANOV, V. P., MIKAELYAN, L. A., POMANSKIY, A. A. and TARASENKOV, V. G., Institute of Atomic Energy imeni I. V. Kurchatov

ON SPONTANEOUS TRANSITIONS OF NUCLEI TO THE SUPERDENSE STATE

[Abstract] A search was made for spontaneous transitions of nuclei to the superdense state. Two scintillation counters were used at a depth of 600 m in the neutrino station of the Soviet Academy of Sciences. One counter contained sodium iodide, and the other contained hexafluorobenzene. Tungsten shielding and an anticoincidence system were used to cut down the external background. Gamma quanta were registered in the 3-10 MeV range. No effects associated with transition to the superdense state were observed. An estimate is made of limitations on the parameters of the superdense state. References 3: 2 Russian, 1 Western.

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BELENOV, E. M., DANILEYKO, M. V., KOZUBOVSKIY, V. R., NEDAVNIY, A. P. and
SHPAK, M. T., Institute of Physics, Academy of Sciences UkrSSR

ULTRAHIGH-RESOLUTION SPECTROSCOPY BASED ON RING LASER WAVE COMPETITION

[Russian abstract provided by the source]

[Text] A new method is proposed for nonlinear laser spectroscopy without
direct use of Lamb shifts. The physical basis of the technique is in the
competition of effects of spectral and spatial burnouts of the gas line,
and the phase interaction between traveling waves in a ring laser. The
procedure was applied to investigation of the hyperfine structure of the
absorption line of excited neon on the transition $4p'[{}^3\!/\!_2]_2 \to 5s'[{}^1\!/\!_2]_1$ due
to the presence of isotopes in the absorbing medium. The ring laser is shown
to have the following advantages over a linear laser: it has much higher
sensitivity and simpler registration (up until now research of this kind has
not been done at all on a linear laser). A ring laser was used for precision
measurement of Zeeman splitting of the methane absorption line belonging to

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BELENOV, E. M., DANILEYKO, M. V., KOZUBOVSKIY, V. R., NEDAVNIY, A. P. and
SHPAK, M. T., ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI, Vol 71,
No 1(7), Jul 76 pp 78-87

the $F_1^{/2/}$ component of branch $P(7)$ of group ν_3 with resolution of $2 \cdot 10^{-6}$ cm^{-1}.
The authors demonstrate the feasibility of improving sensitivity and accuracy
of the nonlinear spectroscope based on a ring laser for studying the hyper-
fine structure of weakly absorbing gases by using self-oscillatory emission
modes. References 22: 13 Russian, 9 Western.

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USSR

KIRSANOV, V. P., TROSHKIN, S. V. and BYKOV, I. V.

INFLUENCE OF AN ILLUMINATOR HOUSING ON THE ELECTRICAL AND LOAD CHARACTERISTICS OF FLASH LAMPS

[[Abstract]] An investigation was made of the electrical and load characteristics of IFP-8000 flash lamps operating in free space and in three types of illuminators: a closed metal cylinder filled with magnesium oxide powder in a layer about 1 cm thick; a less restrictive quartz tube covered on the outside with a similar magnesium oxide layer; a four-lamp illuminator with ceramic reflector having part of the space filled with a neodymium glass plate 1.5 cm thick. It was found that lamps with a reflective coating on the envelope and those located in the center of the multiple-lamp illuminator have maximum energy reduced by about 1.5 times as compared with the open lamp; the corresponding energy reduction is about 20% when the diameter of the reflector is doubled. The electrical conductivity of the gas discharge plasma increases by 30% in illuminators, and the discharge temperature increases by 15%. A reduction in service life by a factor of about 30 can be expected if they are enclosed in illuminators. References 10: 8 Russ., 1 West.
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MENDE, F. F., UVAROV, I. I., TYSHLYAR, V. I. and TRUBITSYN, A. V., Physico-
technical Institute, Academy of Sciences UkrSSR, Khar'kov

ON CALCULATING THE SURFACE RESISTANCE OF SUPERCONDUCTORS

[Abstract] Expressions convenient for practical use are derived for calcu-
lating the surface resistance of superconductors of the first and second kind.
The analysis is based on certain implications of BCS theory. Calculations
are compared with exact results of the Mattis-Bardeen and Abrikosov-Gor'kov-
Khalatnikov microscopic theories. The comparison shows good agreement with
the microscopic theory for the proposed temperature and frequency dependences
of surface resistance. The proposed analytical formulas also show good
agreement with experimental data. References 12: 10 Russian, 2 Western.

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USSR

LIPATOV, L. N., Institute of Nuclear Physics imeni B. P. Konstantinov
Academy of Sciences USSR

CALCULATION OF THE GELL-MANN-LOW FUNCTION IN SCALAR THEORY WITH A STRONG
NONLINEARITY

[Abstract] The Gell-Mann-Low function is calculated for the class of scalar
models in the quantum field theory which are described by the Lagrangian

$$L = \int d^D x \left[\frac{(\partial_\mu \phi)^2}{2} - g \frac{\phi^n}{n!} \right]$$

In order to render the theory renormalizable, the dimension of the space is
assumed

$$D = \frac{2n}{n-2} \quad (n = 4, 6, 8, \ldots)$$

The invariant charge is first defined in terms of the propagator of a scalar
particle using the Feynman diagram method. The method is applicable to
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LIPATOV, L. N., PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI
Vol 24, No 3, Aug 76 pp 179-183

perturbation theory of every order, and is used here in the extreme case of a
very strongly nonlinear interaction ($n \to \infty$ and thus $D \to 2$). As the charge
increases, the GML function of the charge reverses sign and an ultraviolet
stability point appears. The number of such points increases as $\sqrt[4]{n}$. Most
interesting, from the physical standpoint, are the cases n = 4 and n = 6.
This method of calculation yields for these cases results which differ from
the true values by amounts of the order of 1/n. Figures 1; references 6:
3 Russian, 3 Western.

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USSR   UDC: 534.232.46.001.24

BUSHER, M. K.

FREE OSCILLATIONS OF AN ELASTIC RING OF PERIODIC STRUCTURE

[Russian abstract provided by the source]

[Text] Based on Reisner's variational principle a solution is found for the
problem of free oscillations of a thin elastic ring that has a periodic
structure. A ring is considered that is made of two materials with different
elastic moduli and densities. The spectrum of the first five natural fre-
quencies and vibrational modes of the ring is found. It is shown that in
a ring with nonhomogeneous structure the separation of oscillations into
two types -- flexural and longitudinal -- is fundamentally impossible.
References 3: 2 Russian, 1 Western.

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USSR   UDC: 532.529

KOROBKO, V. I., GREKOV, V. F., and SHASHMIN, V. K., Saratov State University
imeni N. G. Chernyshevskiy

DYNAMIC CHARACTERISTICS OF DISCRETE PARTICLES IN AN EFFERENT HELICAL FLOW OF
HEAT-TRANSFER AGENT

[Russian abstract provided by the source]

[Text] The authors determine the dynamic characteristics of a discrete
particle falling under the influence of gravitational force into an efferent
helical flow of heat-transfer agent and a uniform flow of heat-transfer
agent based on Chen's equation and the results of numerical calculation.
In the case where the particle falls into a uniform flow the calculations
are compared with experimental results. References 5 Russian.

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CASCADE PROCESSES IN PHENOMENA OF PARAMETRIC INTERACTION IN A PLASMA

[Abstract] A brief survey article on development of a nonlinear theory for
parametric plasma instabilities. Parametric absorption of emission close to
the critical density is considered in the elementary process of resonant
interaction between an electromagnetic waveform on frequency $\omega \approx \omega_p$ with
finite amplitude on the one hand, and a Langmuir-sonic wave of infinitesimal
amplitude on the other hand. A cascade model of energy transfer is examined
in an isothermal plasma, disregarding nonlinear interaction of "sonic"
density oscillations. Approximate equations are derived for the Langmuir
oscillations, and an expression is found for the effective frequency that
describes the rate of dissipation of the pumping wave:

$$\nu_{eff} \approx \frac{\pi}{4}\omega_p \frac{E_0^2}{8\pi n_0 T_e} .$$

Determination of this quantity is the purpose of the nonlinear theory of
parametric instability.
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    Models of parametric backscatter are discussed for an isothermal
plasma, and for a nonisothermal plasma with hot electrons. References 19:
10 Russian, 9 Western.

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GOREV, V. V., KINGSEP, A. S. and RUDAKOV, L. I.

STRONG LANGMUIR PLASMA TURBULENCE

[Abstract] An investigation is made of modulation instability as a mechanism
of dissipation in a heated plasma when the density of Langmuir noises W/nT
exceeds $(\Delta k r_{De})^2$ (where Δk is the spectral width) in a broad spectrum $\Delta k \sim k$.
The physical meaning of modulation instability is as follows. When there
is a rise in the local density of noise energy the averaged force $\nabla e^2 E^2 / 2m\omega^2$
acting on the electrons of the plasma pushes them out of the localization
region. The charge separation field extracts ions as well, so that a minimum
plasma density is formed where Langmuir noises are blocked. This is a
favorable process from the energy standpoint as the frequency of Langmuir
waves drops. It is shown that modulation instability leads to localization
of the energy of Langmuir oscillations in separate spatial regions.

CONTENTS

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ABSOLUTE PARAMETRIC INSTABILITY OF LOW-FREQUENCY WAVES IN A NONHOMOGENEOUS
ANISOTROPIC PLASMA

[Abstract] A method is outlined for reducing the problem of absolute para-
metric instability excited by a monochromatic pumping field of arbitrary
amplitude in a nonhomogeneous magnetoacoustic plasma to the problem of para-
metric excitation of volumetric oscillations in a homogeneous isotropic
plasma. Parametric stimulation of a low-frequency wave with dispersion
completely determined by the rf field is examined in a strong magnetic
field where the cyclotron frequency of ions appreciably exceeds the frequency
of the excited waveforms. Increments in the buildup of oscillations are
determined, and it is shown that spatial nonhomogeneity of the plasma has a
stabilizing effect on parametric instability. References 5: 2 Russian,
3 Western.

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