

UNCLASSIFIED

AD 408 375

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA



UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

408375

CATALOGED BY DDC

AS AD No.

THE UNIVERSITY OF ROCHESTER
THE INSTITUTE OF OPTICS

ROCHESTER, NEW YORK

408 375

INVESTIGATIONS OF THE OPTICAL
DETECTION OF HYPERFINE RESONANCES
IN ALKALI VAPORS

Report No. 6

Contract No. DA-36-039 SC-87273

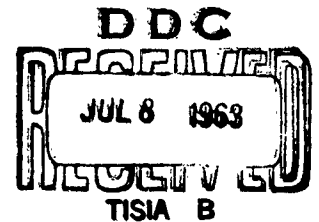
DA Project No. 3A99-15-001

with

U.S. Army Signal Research and
Development Laboratory
Fort Monmouth, New Jersey

6th Quarterly Progress Report
(15 August 1962 to 15 November 1962)

Prepared by
C. O. Alley, Principal Investigator



NO OTS

"ASTIA AVAILABILITY NOTICE: Qualified Requestors May
Obtain Copies of this Report from ASTIA. ASTIA Release
to OTS Not Authorized."

INVESTIGATIONS OF THE OPTICAL
DETECTION OF HYPERFINE RESONANCES
IN ALKALI VAPORS

Report No. 6

Contract No. DA-36-039 SC-87273

with

U.S. Army Signal Research and Development
Laboratory, Fort Monmouth, N.J.

under

Electronic Components Research
Department Technical Guidelines,
28 September 1960
PR & C No. 61 - ELP/R - 4306

6th Quarterly Progress Report
(15 August 1962 to 15 November 1962)

Prepared by C. O. Alley, Principal Investigator

TABLE OF CONTENTS

| | Page |
|--|------|
| I. Purpose..... | 1 |
| II. Abstract..... | 1 |
| III. Publications, Lectures, Reports, and Conferences. | 1 |
| IV. Factual Data | |
| A. Optical Pumping in Atomic Hydrogen..... | 2 |
| B. Optical Pumping in Rubidium..... | 3 |
| V. Conclusions..... | 3 |
| VI. Program for Next Quarter..... | 3 |
| VII. Identification of Technical Personnel..... | 4 |

I. PURPOSE

The purpose of this investigation is to conduct experimental and theoretical research on optical pumping techniques for obtaining non-equilibrium population distributions among atomic states, and on optical detection of Zeeman and hyperfine resonances in alkali vapors with particular reference to rubidium gas cell frequency standards. The investigation is a continuation and extension of research performed at Princeton University under Signal Corps contract DA-36-039 SC 70147. Some of the particular areas to be investigated further are the use of coherent pulse techniques for the reduction of line widths and the use of wall coatings for the inhibition of spin relaxation.

II. ABSTRACT

Preliminary experiments on treating cleaved lithium fluoride surfaces with Dri-Film (alkyl chloro silane) vapor to produce a surface that will inhibit spin relaxation were not successful as judged by the failure of water droplets to exhibit a large angle of contact on the treated surface. Other types of Dri-Film or other kinds of surfaces such as Teflon or wax have not yet been tried. It is intended to make direct relaxation measurements for oriented hydrogen atoms rather than rely on the water droplet test, which may not be suitable since LiF is very hygroscopic.

III. PUBLICATIONS, LECTURES, REPORTS, AND CONFERENCES

A lecture was given in September by C. O. Alley to the Rochester section of the Institute of Radio Engineers with the

title "Optical Masers: Principles, Practices, and Potentialities."

A colloquium talk was given in November by C. O. Alley at the Institute of Optics of the University of Rochester on optical pumping and optical masers to acquaint graduate students with current research and future research possibilities.

A graduate course of lectures, Optics 591-592, "Atomic Structure and Quantum Optics" was begun in September by C. O. Alley.

IV. FACTUAL DATA

A. Optical Pumping in Atomic Hydrogen

A first attempt to coat lithium fluoride with Dri-Film SC-02 and SC-77 was not successful. Water droplets did not exhibit a large angle of contact with the coated surface. Also after the treatment with Dri-Film the transmission of Lyman- α was reduced from 50% to around 20%.

Other types of Dri-Film may work better with LiF but these have not yet been tried. Also, other surfaces than cleaved ones may be more suitable, although these yield the highest transmission for Lyman- α radiation. The hygroscopic nature of LiF may be the chief difficulty in getting a good Dri-Film coating.

Other types of coating such as Teflon should be tried, and it is intended to try this in collaboration with Dr. Robert Vessot of the Bomac Division of Varian Associates who has successfully coated bulbs with Teflon for the hydrogen 21 cm maser. Lithium fluoride blanks so coated will be examined at

Rochester for any change in transmission of Lyman- α radiation.

The best test of a coating is whether it gives a long relaxation time for oriented hydrogen atoms and this will be examined. It may be that the water droplet test is not suitable for lithium fluoride because of its hygroscopic nature.

B. Optical Pumping in Rubidium

The three concentric cylindrical mu-metal shields designed to enclose the solenoid to reduce the effect of external magnetic fields on the homogeneity of the field in the volume occupied by the optical pumping cell have been received.

V. CONCLUSIONS

The failure of the initial attempt to produce a Dri-Film coating on cleaved lithium fluoride surfaces should not be too discouraging. Other types of Dri-Film and surface conditions may be successful. Also other types of surface coating, such as Teflon or very thin wax, give promise of being satisfactory.

VI. PROGRAM FOR NEXT QUARTER

Little activity is planned since no graduate assistants in research will be available. The principal investigator will be occupied largely by research on optical masers, by activities as a government consultant on optical masers, and by preparation of his graduate course in Atomic Structure and Quantum Optics.

Planning for optical pumping experiments using an operating 21 cm hydrogen maser will continue in collaboration with Dr. Robert Vessot of the Bomac Laboratories.

VII. IDENTIFICATION OF TECHNICAL PERSONNEL

| | | Number of Hours Charged to Contract |
|-------------|--|---|
| C. O. Alley | Principal Investigator Assistant Professor of Optics | 80 |

| | | |
|-----------|---|--|
| <p>AD</p> | <p>Accession No. _____</p> <p>University of Rochester, Rochester, New York</p> <p>INVESTIGATIONS OF THE OPTICAL DETECTION OF HYPERFINE RESONANCES IN ALKALI VAPORS - C.O. ALLEY</p> <p>Sixth Quarterly Progress Report, 15 Aug 1962 to 15 Nov 1962</p> <p>11 pp. (Contract No. DA-36-039 SC-87273)</p> <p>Unclassified Report</p> | <p>Unclassified</p> <p>1. Gas Cell Atomic Frequency Standard Optical Pumping Optical Detection</p> <p>2. Contract DA-36-039 SC-87273</p> |
| | <p>Preliminary experiments on treating cleaved lithium fluoride surfaces with Dri-Film (allyl chloro silane) vapor to produce a surface that will inhibit spin relaxation were not successful as judged by the failure of water droplets to exhibit a large angle of contact on the treated surface. Other types of Dri-Film or other kinds of surfaces such as Teflon or wax have not yet been tried. It is intended to make direct relaxation measurements for oriented hydrogen atoms rather than rely on the water droplet test, which may not be suitable since LIP is very hygroscopic.</p> | |

| | | |
|-----------|---|--|
| <p>AD</p> | <p>Accession No. _____</p> <p>University of Rochester, Rochester, New York</p> <p>INVESTIGATIONS OF THE OPTICAL DETECTION OF HYPERFINE RESONANCES IN ALKALI VAPORS - C.O. ALLEY</p> <p>Sixth Quarterly Progress Report, 15 Aug 1962 to 15 Nov 1962</p> <p>11 pp. (Contract No. DA-36-039 SC-87273)</p> <p>Unclassified Report</p> | <p>Unclassified</p> <p>1. Gas Cell Atomic Frequency Standard Optical Pumping Optical Detection</p> <p>2. Contract DA-36-039 SC-87273</p> |
| | <p>Preliminary experiments on treating cleaved lithium fluoride surfaces with Dri-Film (allyl chloro silane) vapor to produce a surface that will inhibit spin relaxation were not successful as judged by the failure of water droplets to exhibit a large angle of contact on the treated surface. Other types of Dri-Film or other kinds of surfaces such as Teflon or wax have not yet been tried. It is intended to make direct relaxation measurements for oriented hydrogen atoms rather than rely on the water droplet test, which may not be suitable since LIP is very hygroscopic.</p> | |

| | | |
|-----------|---|--|
| <p>AD</p> | <p>Accession No. _____</p> <p>University of Rochester, Rochester, New York</p> <p>INVESTIGATIONS OF THE OPTICAL DETECTION OF HYPERFINE RESONANCES IN ALKALI VAPORS - C.O. ALLEY</p> <p>Sixth Quarterly Progress Report, 15 Aug 1962 to 15 Nov 1962</p> <p>11 pp. (Contract No. DA-36-039 SC-87273)</p> <p>Unclassified Report</p> | <p>Unclassified</p> <p>1. Gas Cell Atomic Frequency Standard Optical Pumping Optical Detection</p> <p>2. Contract DA-36-039 SC-87273</p> |
| | <p>Preliminary experiments on treating cleaved lithium fluoride surfaces with Dri-Film (allyl chloro silane) vapor to produce a surface that will inhibit spin relaxation were not successful as judged by the failure of water droplets to exhibit a large angle of contact on the treated surface. Other types of Dri-Film or other kinds of surfaces such as Teflon or wax have not yet been tried. It is intended to make direct relaxation measurements for oriented hydrogen atoms rather than rely on the water droplet test, which may not be suitable since LIP is very hygroscopic.</p> | |

| | | |
|-----------|---|--|
| <p>AD</p> | <p>Accession No. _____</p> <p>University of Rochester, Rochester, New York</p> <p>INVESTIGATIONS OF THE OPTICAL DETECTION OF HYPERFINE RESONANCES IN ALKALI VAPORS - C.O. ALLEY</p> <p>Sixth Quarterly Progress Report, 15 Aug 1962 to 15 Nov 1962</p> <p>11 pp. (Contract No. DA-36-039 SC-87273)</p> <p>Unclassified Report</p> | <p>Unclassified</p> <p>1. Gas Cell Atomic Frequency Standard Optical Pumping Optical Detection</p> <p>2. Contract DA-36-039 SC-87273</p> |
| | <p>Preliminary experiments on treating cleaved lithium fluoride surfaces with Dri-Film (allyl chloro silane) vapor to produce a surface that will inhibit spin relaxation were not successful as judged by the failure of water droplets to exhibit a large angle of contact on the treated surface. Other types of Dri-Film or other kinds of surfaces such as Teflon or wax have not yet been tried. It is intended to make direct relaxation measurements for oriented hydrogen atoms rather than rely on the water droplet test, which may not be suitable since LIP is very hygroscopic.</p> | |

DA36-039 sc-87273
University of Rochester

6th Quarterly Report
15 Aug - 15 Nov 62

Distribution List

| | <u># of Copies</u> |
|--|--------------------|
| OASD(R&E), Rm3E1065 Attn: Technical Library The Pentagon Washington 25, D.C. | 1 |
| Chief of Research & Development OCS, Department of the Army Washington 25, D.C. | 1 |
| Commanding Officer U.S. Army Electronics Command Attn: AMSEL-AD Fort Monmouth, New Jersey | 1 |
| Director U.S. Naval Research Laboratory Attn: Code 2027 Washington 25, D.C. | 1 |
| Commanding Officer & Director U.S. Navy Electronics Laboratory San Diego 52, California | 1 |
| Commander Aeronautical Systems Division Attn: ASAPRL Wright-Patterson Air Force Base, Ohio | 1 |
| Commander Air Force Cambridge Research Laboratories Attn: CRXL-R L. G. Hanscom Field Bedford, Massachusetts | 1 |
| Commander Air Force Command & Control Development Division Attn: CRZC L. G. Hanscom Field Bedford, Massachusetts | 1 |
| Commander Rome Air Development Center Attn: RAALD Attn: RASGR Griffiss Air Force Base, New York | 1 1 |
| Commanding General U.S. Army Material Command Attn: R&D Directorate Washington 25, D.C. | 1 |

DA36-039 sc-87273

of Copies

| | |
|---|----|
| Commanding Officer U.S. Army Communications & Electronics Combat Development Agency Fort Huachuca, Arizona | 1 |
| Commander Armed Services Technical Information Agency Attn: TISIA Arlington Hall Station Arlington 12, Virginia | 10 |
| Chief U.S. Army Security Agency Arlington Hall Station Arlington 12, Virginia | 2 |
| Deputy President U.S. Army Security Agency Board Arlington Hall Station Arlington 12, Virginia | 1 |
| Commanding Officer Harry Diamond Laboratories Attn: Library, Rm. 211, Bldg. 92 Washington 25, D.C. | 1 |
| Commanding Officer U.S. Army Electronics Material Support Agency Attn: SELMS-ADJ Fort Monmouth, New Jersey | 1 |
| Corps of Engineers Liaison Office U.S. Army Electronics R&D Laboratory Fort Monmouth, New Jersey | 1 |
| AFSC Scientific/Technical Liaison Office U.S. Naval Air Development Center Johnsville, Pennsylvania | 1 |
| Advisory Group on Electron Devices 346 Broadway New York 13, New York | 2 |
| Marine Corps Liaison Office U.S. Army Electronics R&D Laboratory Fort Monmouth, New Jersey | 1 |
| Commanding General U.S. Army Combat Developments Command Attn: CDCMR-E Fort Belvoir, Virginia | 1 |
| Headquarters Electronic Systems Division Attn: ESAT L.G. Hanscom Field Bedford, Massachusetts | 1 |

DA36-039 sc-87273

of Copies

| | |
|--|----|
| Director Fort Monmouth Office U.S. Army Communications & Electronics Combat Development Agency Fort Monmouth, New Jersey | 1 |
| Mr. A. H. Young Code 618AIA Semiconductor Group Bureau of Ships Department of the Navy Washington 25, D.C. | 1 |
| Dr. Virgil Bottom McMurray College Abilene, Texas | 1 |
| Bell Telephone Laboratories Attn: Mr. Roger Sykes 1600 Osgood Street North Andover, Massachusetts | 1 |
| National Company 34 Essex Street Melrose, Massachusetts | 1 |
| National Bureau of Standards Boulder Labs Attn: Mr. W. D. George Boulder, Colorado | 1 |
| Secretariat Advisory Group on Electronic Parts, R&E Moore School Building 200 South 33rd Street Philadelphia 4, Pennsylvania | 1 |
| Commanding Officer U.S. Army Electronics R&D Laboratory Fort Monmouth, New Jersey Attn: Director of Research/Engineering | 1 |
| Attn: Technical Documents Center | 1 |
| Attn: Technical Information Division | 3 |
| Attn: Rpts Dist Unit, Solid State & Freq Cont Div (Record Cy) | 1 |
| Attn: Ch, S&M Br., Solid State & Frequency Control Division | 1 |
| Attn: Director, Solid State & Frequency Control Division | 1 |
| Attn: Dr. Moeller, Solid State & Frequency Control Division | 1 |
| Total number of copies to be distributed | 50 |

This contract is supervised by the Solid State & Frequency Control Division, Electronic Components Department, USAELRDL, Fort Monmouth, New Jersey. For further technical information contact Dr. Moeller, Project Engineer. Telephone 53-52031.