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FOREWORD

The Summary Report of the Physics Division of the Argonne National Laboratory is issued monthly for the information of the members of the Division and a limited number of other persons interested in the progress of the work. Each active project reports about once in 3 months, on the average. Those not reported in a particular issue are listed separately in the Table of Contents with a reference to the last issue in which each appeared.

This is merely an informal progress report. The results and data therefore must be understood to be preliminary and tentative.

The issuance of these reports is not intended to constitute publication in any sense of the word. Final results either will be submitted for publication in regular professional journals or, in special cases, will be presented in ANL Topical Reports.

TABLE OF CONTENTS

The date of the last preceding report is indicated after the title of each project below. Projects which are not reported in this issue are listed on subsequent pages.

<u>I. EXPERIMENTAL NUCLEAR PHYSICS</u>	<u>PAGE</u>
<p>I-19-5 NUCLEAR RESONANCE ABSORPTION OF GAMMA RAYS (ANL-6130, March, 1960)</p> <p style="padding-left: 40px;">M. Hack and M. Hamermesh.....</p> <p style="padding-left: 40px;">Calculations have been carried out to determine the effect on Zeeman lines of applying a resonant rf field.</p>	<p>1</p>
<p>I-30-1 DECAY OF ${}_{68}^{161}\text{Er}$ (3.1 hr) (ANL-5937, November, 1958)</p> <p style="padding-left: 40px;">H. A. Grench and S. B. Burson.....</p> <p style="padding-left: 40px;">Thirty-two gamma rays from ${}_{68}^{161}\text{Er}$, produced by (n,2n) and (γ,n) reactions, were measured and fitted into a decay scheme. Spin and parity assignments of some levels are indicated.</p>	<p>2</p>
<p>I-80-25 MOLECULAR BEAM STUDIES (ANL-6130, March, 1960)</p> <p style="padding-left: 40px;">Williams Childs, John Dalman, and Leonard Goodman..</p> <p style="padding-left: 40px;">Results are presented for Ho^{166} and Ge^{71}.</p>	<p>9</p>
<p>I-98-26 NEUTRON TOTAL CROSS SECTIONS IN THE KEV REGION (ANL-6169, June, 1960)</p> <p style="padding-left: 40px;">Carl T. Hibdon.....</p> <p style="padding-left: 40px;">Erratum.</p>	<p>13</p>
<h2 style="text-align: left;"><u>II. MASS SPECTROSCOPY</u></h2>	
<p>II-34-16 $\text{A}^{40} - \text{K}^{40}$ Dating of Meteorites (ANL-5818, Oct.-Dec., 1957)</p> <p style="padding-left: 40px;">David C. Hess.....</p> <p style="padding-left: 40px;">A method has been developed for pumping down atmospheric cutoffs, Toepler pumps, and other apparatus without carefully matching pumping rates.</p>	<p>14</p>

	<u>PAGE</u>
PUBLICATIONS.....	19
PERSONNEL CHANGES.....	21
<u>PROJECTS NOT REPORTED IN THIS ISSUE</u>	

A reference to the last preceding report is given in parenthesis for each project.

I. EXPERIMENTAL NUCLEAR PHYSICS

- I-1- The Argonne Fast-Neutron Velocity Selector (ANL-6169, June 1960), L. M. Bollinger and R. E. Cote¹.
- I-2- Neutron Detectors (ANL-6072, October-November, 1959), L. M. Bollinger and G. E. Thomas.
- I-3- Cross-Section Measurements with the Fast Neutron Velocity Selector (ANL-6072, October-November, 1959), L. M. Bollinger and R. E. Cote¹.
- I-7- Gamma-Ray Spectra from Capture in Neutron Resonances (ANL-6146, April-May, 1960), L. M. Bollinger and R. E. Cote¹.
- I-11- Installation and Operation of the Van de Graaff Generator (ANL-6130, March 1960), Jack R. Wallace.
- I-14- Pulsed Beam for the Van de Graaff Machine (ANL-5978, Feb.-Apr., 1959), R. E. Holland and F. J. Lynch.
- I-18- Differential Cross Section for Neutron Resonance Scattering (ANL-6169, June 1960), Raymond O. Lane.
- I-22- Scattering of Charged Particles (ANL-6130, March, 1960), J. L. Yntema.
- I-28- Angular Correlations in Charged-Particle Reactions (5978, Feb.-Apr., 1959), T. H. Braid, J. L. Yntema, and B. Zeidman.
- I-31- Decay of Pm^{146} (80.2 hr) (ANL-6038, July-August, 1959), S. B. Burson and R. G. Helmer.
- I-55- Capture Gamma-Ray Spectra for Neutrons with Energies from 0.1 to 10 ev (ANL-6052, Sept., 1959), Sol Raboy and C. C. Trail.
- I-60- 7.7-Meter Bent-Crystal Spectrometer (ANL-6052, Sept., 1959), R. Smither.
- I-90- Cross Sections for 14-Mev Neutrons (ANL-6072, Oct.-Nov., 1959), Harvey Casson and L. A. Rayburn.
- I-98- Neutron Total Cross Sections in the Kev Region (ANL-6146, April-May, 1960), Carl T. Hibdon.

- I-110- Storage of Pulse-Height Data on Magnetic Tape (ANL-6072, Oct. - Nov., 1959), James Baumgardner.
- I-115- High-Temperature Diffusion Cloud Chamber (ANL-6072, Oct. - Nov., 1959), Charles M. Huddleston.
- I-129- The Helicity of the Neutrino Emitted in the Electron-Capture Decay of Beryllium-7 (ANL-6020, May-June, 1959), T. B. Novey, P. Rice-Evans, and V. L. Telegdi.
- I-144- Investigation of Scintillators (ANL-6146, April-May, 1960), L. J. Basile, W. L. Buck, E. A. Mroz, and A. Weinreb.

II. MASS SPECTROSCOPY

- II-18- Lead Ages of Meteorites (ANL-6169, June 1960), D. C. Hess.
- II-22- Pulsed-Beam Mass Spectrometer (ANL-6130, March 1960), M. Kaminsky.
- II-28- Kinetics of Chemical Reactions in the Gas Phase (ANL-5818, Oct. - Dec., 1957), William A. Chupka.
- II-29- Gaseous Species in Equilibrium at High Temperatures (ANL-6105, January, 1960), M. G. Inghram and Wm. A. Chupka.
- II-38- Mass Spectrometric Study of Charged Atomic and Molecular Products of Nuclear Transformation (ANL-6088, December 1959), S. Wexler.
- II-40- Fragmentation of Organic Molecules (ANL-6169, June 1960), Henry E. Stanton.

III. CRYSTALLOGRAPHY

- III-4- Crystal Structure Studies of Compounds of Elements Ac-Am (ANL-6038, July-August, 1959), William H. Zachariasen.
- III-10- The Crystal Structure of Li_2WO_4 (ANL-6169, June 1960), H. A. Plettinger and W. H. Zachariasen.

V. THEORETICAL PHYSICS, GENERAL

- V-2- Excited States of Light Nuclei (ANL-6105, January 1960), D. Kurath.
- V-3- Dynamics of Nuclear Collective Motion (ANL-6072, Oct.-Nov., 1959), David R. Inglis, Kiuck Lee.
- V-7- Beta Decay of lp-Shell Nuclei (ANL-5955, Dec., 1958-Jan., 1959), D. Kurath.
- V-8- Relationships of Collective Effects and The Shell Model (ANL-6130, March 1960), Dieter Kurath.
- V-11- Some Aspects of p-Shell Hypernuclei (ANL-6111, February 1960), R. D. Lawson and Manuel Rotenberg.
- V-13- One-Body Spin-Orbit Interaction and Tensor Force (ANL-6130, March 1960), Akito Arima.
- V-15- Statistical Properties of Nuclear Energy States (ANL-6088, Dec.-1959), Norbert Rosenzweig.
- V-18- Parametric Formulation of Quantum Mechanics (ANL-6038, July-August, 1959), William C. Davidon.
- V-32- Relativistic Mechanics of Elastic Bodies (ANL-6105, January 1960), W. C. Davidon.
- V-45- Meson-Nucleon Interaction (ANL-6146, April-May, 1960), K. Tanaka.

I. EXPERIMENTAL NUCLEAR PHYSICSI-19-5 Nuclear Resonance Absorption of Gamma Rays (51210-01)

M. Hack and M. Hamermesh

SPLITTING OF SPECTRAL LINES BY APPLICATION OF RADIO-FREQUENCY MAGNETIC FIELDS

Preliminary experiments have been made here to detect the effects of rf magnetic fields by making use of the Mossbauer effect. Though the experiments have given no definite results as yet, we want to exhibit an interesting effect which should occur.

Suppose that we have two multiplets (excited and ground states), between which radiative transitions occur as indicated in Fig. 1. If we apply a sufficiently large rf magnetic field at a frequency close to resonance with the Zeeman separation in the upper state, the lines resulting from the transitions to the ground state will each be split. As a result, the transmission of the Mossbauer radiation through an absorber will be increased by applying the rf field.

For the two states with spin $\frac{1}{2}$ shown in the diagram, consider a particular line of energy E_0 . When the rf field is applied with a frequency ω close to ω_r , the line E_0 will split into two components $E_1 = E_0 + \delta_1$, $E_2 = E_0 - \delta_2$. At resonance ($\omega = \omega_r$), $\delta_1 = \delta_2$, and the line is split into two components of equal intensity.

I-30-1

Decay of ${}_{68}\text{Er}^{161}$ (3.1 hr)

(51210-01)

H. A. Grench and S. B. Burson

INTRODUCTION

An erbium isotope of 3.6-hour half-life was produced by Handley and Olson¹ by bombarding Er_2O_3 with 24-Mev protons. They assigned it the mass number 161. These investigators found gamma rays of 0.824 and 1.12 Mev and possible gamma rays of 0.065 and 0.195 Mev. They determined that the daughter is Ho and, from the absence of annihilation radiation, inferred that the nuclide decays predominantly by K capture.

The mass assignment was confirmed by Michel and Templeton² by the use of a time-of-flight isotope separator. Dneprovskii and Kolesov³ also produced neutron-deficient isotopes of Er and Ho by the proton spallation of tantalum. They used a β -ray spectrometer to study the internal-conversion-electron spectrum and found four groups of lines with approximate half-lives of 30, 3.5, 2.5, and 1 hr. In the 3.5-hr group they found lines which they assigned to Er^{161} . These lines corresponded to gamma rays with energies of 67.0 ± 0.1 , 210.6 ± 0.2 , and 826.5 ± 0.5 kev. They also found electrons with energies of 62.0, 69.2, and 164.2 kev which they were not able to identify.

Harmatz et al.⁴ found internal-conversion-electron lines corresponding to a transition with an energy of 211.4 ± 0.3 kev. They assigned it the character E3, which is in agreement with Dneprovskii and Kolesov.

¹ T. H. Handley and E. L. Olson, Phys. Rev. 93, 524 (1954).

² M. C. Michel and D. H. Templeton, Phys. Rev. 93, 1442 (1954).

³ I. S. Dneprovskii and G. M. Kolesov, Bull. Acad. Sci. U.S.S.R. 22, 935 (1958).

⁴ B. Harmatz, T. H. Handley, and J. W. Mihelich, Phys. Rev. 114, 1082 (1959).

The investigation reported here was undertaken to determine the decay scheme of Er^{161} , principally by means of scintillation coincidence spectrometry.

SOURCE PREPARATION AND EXPERIMENTAL APPARATUS

Sources of Er^{161} were produced by the $\text{Er}^{162}(n,2n)\text{Er}^{161}$ reaction in a target of Er_2O_3 enriched to 6.1%⁵ in Er^{162} . A Cockcroft-Walton accelerator was used to provide fast neutrons for most of the irradiations.⁶ An average flux of 10^9 14-Mev neutrons/cm²/sec was obtained via the $\text{H}^3(d,n)\text{He}^3$ reaction. For a few irradiations the Argonne 60-in. cyclotron was used as an irradiation facility. A flux of approximately 10^{10} neutrons/cm²/sec at about 23 Mev maximum energy was obtained by means of the $\text{Be}^9(d,n)\text{B}^{10}$ reaction. Near the conclusion of this work the Argonne 20-Mev linear accelerator was put into operation. Three sources were activated by the (γ,n) reaction. This facility provided the most intense sources as well as those most free of spurious activities produced by neutron capture in other isotopes and contaminants.

The gamma-ray spectra were studied by means of cubic NaI(Tl) crystals, about $2\frac{1}{4}$ in. on an edge, coupled to Dumont Type 6292 photomultipliers. The pulse-height analysis was accomplished by means of the Argonne 256-channel analyzer. For coincidence experiments a single-channel analyzer and conventional "fast-slow" coincidence circuit (resolving time $2\tau = 40 \times 10^{-9}$ sec) were used in conjunction with the multichannel analyzer.

⁵

Enriched oxide obtained from Isotopes Division, Oak Ridge National Laboratory.

⁶

The authors wish to gratefully acknowledge the cooperation of Dr. L. A. Rayburn and Dr. H. Casson in making the accelerator available for the irradiations.

Fig. 2. Gamma-ray spectrum of Er^{161} .

x rays from the source would not cause excessive dead time in the analyzer. The beryllium absorbed secondary electrons from the lead.

As indicated in the figure, the total spectrum was decomposed in order to determine the energies and relative intensities of its components. The analysis started with the high-energy side of the most energetic photopeak. The spectrum of a single radiation of similar energy obtained in the same geometric arrangement was fitted. The original spectral shape was rather ideal for such an analysis since the counting rate decreased sharply with increasing energy. Small errors in the spectral shape of a subtracted component did not influence the shape below it.

A 180° magnetic spectrograph was used in an attempt to study the internal-conversion-electron spectrum. With the source activities available from a single irradiation, no lines were observed. Iterated exposures were not attempted.

EXPERIMENTS

Gamma-Ray Spectrum

The scintillation spectrum of gamma rays from Er^{161} is shown in Fig. 2. A lead collimator⁷ was used to confine the incident beam to the central region of the crystal. The lead filter shown was used so that the intense

⁷

S. B. Burson, H. A. Grench, and L. C. Schmid, Phys. Rev. 115, 188 (1959).

TABLE I. Gamma rays of Er^{161} .

Energy (kev)	Gamma-ray intensity
Ho x ray	175 ± 50
84	1.7 ± 1.0
88	5.2 ± 2.0
125	3.0 ± 2.0
132	3.4 ± 2.0
203 ± 4	3.8 ± 0.6
211 ± 2	15.0 ± 2.0
267 ± 15	1.6 ± 1.0
305 ± 5	4.3 ± 0.6
367 ± 20	1.2 ± 0.5
414 ± 10	1.2 ± 0.5
429 ± 10	0.02 ± 0.01
452 ± 10	2.2 ± 0.4
510 ± 7	2.5 ± 0.7
592 ± 5	7.6 ± 0.8
652 ± 15	1.8 ± 0.5
705 ± 15	3.8 ± 2.0
785 ± 15	0.23 ± 0.09
826 ± 4	100
865 ± 8	12 ± 5
877 ± 13	0.10 ± 0.06
945 ± 20	4.6 ± 1.3
1020 ± 25	1.7 ± 0.5
1105 ± 10	1.8 ± 0.3
1115 ± 20	0.9 ± 0.3
1167 ± 10	7.1 ± 0.4
1240 ± 20	4.0 ± 0.4
1326 ± 20	3.6 ± 0.8
1410 ± 20	3.8 ± 0.8
1489 ± 30	2.2 ± 0.5
1616 ± 20	1.4 ± 0.2
1705 ± 20	1.2 ± 0.4
1820 ± 30	0.25 ± 0.05
1968 ± 40	0.07 ± 0.03

TABLE II. Coincidence relationships of gamma rays. x—strong evidence of coincidence; 0—strong evidence of noncoincidence; ?—some, but inconclusive, evidence of coincidence; no mark—no evidence either way. Energies are in kev.

	1968	1705	1489	1326	1167	1105	945	865	785	652	510	429	367	267	203	125	
	1820	1616	1410	1240	1115	1020	877	826	705	592	452	414	305	211	132	88	
84	0	0	0	0	0		x		0								
88	0	0	0	0	0		0		x								
125	0	0	0	0	0		x		0								
132	0	0	0	0	0		0	x	x								
203	0	0	0	0	0	0	0	x	x								
211	0	0	0	0	0	0	0										
267	0	0	0	0	0	0	0		x								
305	0	0	0	0	0	0	0	0	0								
367	0	0	0	0	0	0	0	0	0								
414	0	0	0	0	0	0	0	0	0								
429	0	0	0	0	0	0	0	0	0								
452	0	0	0	0	0	x		x	x								
510	0	0	0	0	0	0	0	0	0								
592	0	0	0	0	0	0	0	0	0	x							
652	0	0	0	0	0	0	0	0	0								
705	0	0	0	0	0	0	0	0	0	0	0						
785	0	0	0	0	0	0	0	0	0	0	0	0					
826	0	0	0	0	0	0	0	0	0	0	0	0					
865	0	0	0	0	0	0	0	0	0	0	0	0					
877	0	0	0	0	0	0	0	0	0	0	0	0					
945	0	0	0	0	0	0	0	0	0	0	0	0					
1020	0	0	0	0	0	0	0	0	0	0	0	0					
1105	0	0	0	0	0	0	0	0	0	0	0	0					
1115	0	0	0	0	0	0	0	0	0	0	0	0					
1167	0	0	0	0	0	0	0	0	0	0	0	0					
1240	0	0	0	0	0	0	0	0	0	0	0	0					
1326	0	0	0	0	0	0	0	0	0	0	0	0					
1410	0	0	0	0	0	0	0	0	0	0	0	0					
1489	0	0	0	0	0	0	0	0	0	0	0	0					
1616	0	0	0	0	0	0	0	0	0	0	0	0					
1705	0	0	0	0	0	0	0	0	0	0	0	0					
1820	0	0	0	0	0	0	0	0	0	0	0	0					

DISCUSSION

Since the nuclide ${}_{67}\text{Ho}^{161}$ has many particles outside of closed shells, its nuclear shape is expected not to be spherically symmetric. Its intrinsic states are expected to be governed by the 67th proton. Current theories⁸ predict bands of rotational states based upon these levels.

On the basis of systematics and the Nilsson level diagram, the Er^{161} ground state would be predicted to have $\frac{3}{2}^-$ character. However, there is little experimental evidence to support this assignment.

The ground state of Ho^{161} is expected to have $\frac{7}{2}^-$ character in analogy with the measured spin⁹ of Ho^{165} . The assignment of $\frac{1}{2}^+$ character to the 211-kev state is strengthened by the 305-kev E3 transition observed¹⁰ in Ho^{163} .

The log ft values for the decays to the 211-kev state and ground state of Ho are consistent with the $\frac{3}{2}^-$ assignment of the Er ground state. This $\frac{3}{2}^-$ assignment will be assumed in the following discussion.

Since the capture branch to the 826-kev level is an allowed transition, the spin of the 826-kev state must be $\frac{1}{2}^-$, $\frac{3}{2}^-$, or $\frac{5}{2}^-$. The first two possibilities are rejected since the transitions to the 211-kev state would be much more intense than the ground-state transition. The choice of $\frac{5}{2}^-$ implies that the ground-state transition has M1 or M1 + E2 character. From the work of Dneprovskii and Kolesov³ one obtains the ratio

$$e_K(211)/e_K(826) = 5.0 \pm 0.8.$$

⁸ For references on and summary of properties of odd-A nuclei, see B. R. Mottelson and S. G. Nilsson, Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd. 1, No. 8 (1959).

⁹ J. M. Baker and B. Bleaney, Proc. Phys. Soc. (London) 68A, 1090 (1955).

¹⁰ C. L. Hammer and M. G. Stewart, Phys. Rev. 106, 1001 (1957).

From the tables of Rose¹¹ we find $a_K(211) = 0.46$. With this information and the gamma-ray intensities of the 211- and 826-kev transitions reported here, one finds $a_K(826) = 0.014 \pm 0.003$. The theoretical value of $a_K(826)$ for an M1 transition is 0.007 and for an E2 transition is 0.004. Thus we do not have very good confirmation of the $\frac{5}{2}^-$ assignment. Since arguments concerning possible spins for the other levels must be based in part on the spin of the 826-kev state and since the latter is uncertain, further interpretation is not attempted.

None of the states identified in this work were shown to have rotational character. The theory predicts that the first excited state of a rotational band based upon the 211-kev level would be but a few kev higher. Population of this level would then appear merely as enhanced intensity of the 211-kev transition.

¹¹ M. E. Rose, Internal Conversion Coefficients (North Holland Publishing Co., Amsterdam, 1958).

I-80-25

Molecular Beam Studies

(51210-01)

William Childs, John Dalman, and Leonard Goodman

In the period since the last report, 27-hour Ho^{166} and 12-day Ge^{71} have been investigated. A report on the former was given at the Montreal meeting in June. Only a brief summary will be given here.

Within experimental error, the resonance observed in Ho^{166} displayed no nonlinearity with magnetic field for $0.15 \leq H \leq 150$ gauss. Because of our failure to detect any nonlinearity, no positive statement concerning the nuclear spin can be made, but the simplest and very probably the correct interpretation is that $I = 0$, in agreement with the results from nuclear spectroscopy.

The electronic g-factor was measured to be

$$g_J = 1.19509 \pm 0.00007,$$

a result very close to the Russell-Saunders value $6/5$ calculated for a $^4I_{15/2}$ atomic ground state (which may arise from an f^{11} electronic configuration). A paper on the Ho^{166} measurements is being prepared for submission to the Physical Review.

The isotope Ge^{71} presented a challenge since J is integral ($^3P_{0,1,2}$) and thus, with the design of the present atomic-beam machine, only multiple-quantum transitions could be refocused. The early runs immediately gave the result

$$I(\text{Ge}^{71}) = \frac{1}{2}.$$

Although it is difficult to interpret such a result reliably with no knowledge of the nuclear moments, it is likely that the state arises from the last neutron occupying the $3p_{1/2}$ shell, all lower shells being filled.

Atoms were observed in the beam from both the 3P_1 and 3P_2 atomic states, and resonances in both were followed as a function of magnetic field strength. Atoms in the 3P_0 state were blocked from the detector by a central obstacle. The results for the nuclear magnetic dipole moment and the hyperfine interaction constants, to date, are

$$\mu_I = +0.7 \pm 1.3 \text{ nm}$$

$$a(^3P_1) = 87.1 \pm 0.6 \text{ Mc/sec}$$

$$a(^3P_2) = 356.6 \pm 5.9 \text{ Mc/sec.}$$

The large uncertainties quoted result from the lack of information on the other

Ge isotopes. If I , μ_I , and either $a(^3P_1)$ or $a(^3P_2)$ were known within 3% for any other isotope, we could improve our precision on $\mu_I(\text{Ge}^{71})$ to the same order through the Fermi-Segre relation by using only the data already obtained. If this information is not available by the time our new atomic-beam machine begins operation, we shall make the necessary measurements here.

It is of interest

to examine the data on the double-quantum transitions observed in Ge^{71} . Figure 4 shows three adjacent substates at some magnetic field. They are characterized by the quantum numbers F ($3/2$ for 3P_1 atoms and $5/2$ for 3P_2 atoms) and m_F . The focusing properties of the atomic-beam machine are such that transitions between adjacent substates are unobservable, while the cross-over transitions are of higher multipolarity and are thus effectively forbidden. Thus, if we label the upper transition frequency ν_1 , the lower ν_2 , and the cross-over ν_3 , we cannot observe resonances at ν_1 , ν_2 , or ν_3 . We can and do, however, observe the double-quantum transition at the frequency $\frac{1}{2} \nu_3 \equiv \frac{1}{2} (\nu_1 + \nu_2)$. Table III lists the frequencies for the two atomic states. The quantity $|\frac{1}{2} \nu_3 - \nu_1| / \Gamma \equiv |\frac{1}{2} \nu_3 - \nu_2| / \Gamma$, where Γ is the observed width of the resonance at $\frac{1}{2} \nu_3$, has the observed value 143 for the 3P_2 resonance at 70 gauss. It is clear that if the two-quantum jumps are considered as a single event, energy is indeed conserved.

Since the last report, more experience has been obtained with the new C-magnet assembly. Figure 5 shows the marked reduction in line width achieved by reducing field inhomogeneities. The transition shown is a field-dependent $\Delta F = 1$ resonance in Ga^{72} . An attempt to determine

Fig. 4. Energy differences involved in double-quantum transitions in Ge^{71} .

TABLE III. Data illustrating the degree of resolution of the two-quantum transition from the calculated positions of the single-quantum transitions at the largest fields used. All frequencies are given in Mc/sec. The quantity δ is defined as

$$\delta = \left| \frac{\frac{1}{2} \nu_3 - \nu_1}{\Gamma} \right| \equiv \left| \frac{\frac{1}{2} \nu_3 - \nu_2}{\Gamma} \right|.$$

Atomic state	H (gauss)	ν_1	ν_2	$\frac{1}{2} \nu_3$	δ	Γ	δ/Γ
3P_1	21	30.105	32.324	31.215	1.110	0.060	18.5
3P_2	70	122.922	113.744	118.333	4.589	0.032	143

Fig. 5. Two observations of a $\Delta F = 1$ transition in Ga^{72} . The narrowing of the line results from reducing the inhomogeneity of the field.

the extent to which remaining field inhomogeneity depends on magnet history failed because of the small size of the effect to be measured. The effort did, however, establish that radically altering the magnet history does not introduce measurable inhomogeneities over a 3 cm region. The inhomogeneity measured over this region at 150 gauss with three quite different histories, was not greater than 1 part in 25 000.

Progress on the new machine is dependent on further deliveries from Central Shops. The mass spectrometer

I-98-26

has arrived and achieves its designed field rating. Coils are being wound to energize the Anico-V slugs in the "B" magnet. One section of the vacuum box has been delivered, and in initial tests was pumped down to 5×10^{-7} mm Hg. Experiments with the Ultech titanium pump, and a homemade duplicate, indicate that a vacuum of 2×10^{-8} is not difficult to obtain in a system of modest volume.

A paper on Ga⁷² for the Physical Review is ready for a final draft, and a rough draft of the paper on Ho¹⁶⁶ has been prepared. A report on the Ge⁷¹ measurements will be given at the Thanksgiving meeting of the Physical Society in Chicago.

I-98-26

Neutron Total Cross Sections in the Kev Region (51210-01)

Carl T. Hibdon

ERRATA:

In the Physics Division Summary Report ANL-6146 (April-May 1960), the wrong graphs were used for Figs. 8 and 9 on pp. 19 and 20. The correct figures are given below. (The figures here carry the correct numbers for the earlier report.)

Fig. 8. Distribution of the nuclear energy levels of Al²⁸. Curve A was obtained from Eq. (7) (times a factor of 1.8) for a value of $\delta = 0.50$ Mev and curve B for $\delta = 0.60$ Mev. The arrow indicates the binding energy.

Fig. 9. Distribution of the nuclear energy levels of Na²⁴. Curve A was obtained from Eq. (7) (times a factor of 1.8) for a value of $\delta = 0.50$ Mev and curve B for $\delta = 0.60$ Mev. The arrow indicates the binding energy, 6.956 Mev.

II. MASS SPECTROSCOPY

II-34-16

A⁴⁰ - K⁴⁰ Dating of Meteorites

(51300-01)

David C. Hess

THE USE OF MERCURY CUTOFFS AT ATMOSPHERIC PRESSURE

In some experiments, it is necessary to manipulate small quantities of gas and yet avoid contamination of the sample. For example, if a small amount of argon is to be chemically purified, it is obviously desirable that the cleaning apparatus not introduce further impurities. Although there are stopcock greases that have a low vapor pressure, when extremely small quantities of gas (10^{-6} cc STP) are involved, the hydrocarbons from such a grease may present a problem. More important, most or all of a small sample of gas may be lost by sorption on the stopcock grease. Xenon is especially vulnerable to this loss but some organic vapors might also be subject to such an effect. For these reasons, grease-free gas-handling systems have been used for many years.¹ A substitute for a greased stopcock consists of a U tube with a "T" at the bottom so that mercury can be raised to isolate the two parts of the U. Many other types of mercury cutoffs are used, but most of them are designed to isolate sections of a line which are at essentially the same pressure.^{2,3} When it is necessary to isolate two sections of a line which are at considerably different pressures, such as a mass spectrometer and the sample line while

¹ M. G. Inghram, H. Brown, C. C. Patterson, and D. C. Hess, Phys. Rev. 80, 916 (1950).

² G. H. Miller, G. O. Pritchard, and M. Weston, Rev. Sci. Instr. 31, 466 (1960).

³ Z. Knor, Rev. Sci. Instr. 31, 351 (1960).

Fig. 6. Atmospheric cutoffs. a. Early type. b. New design. c. As applied to a cutoff without a ring seal. L_1 and L_2 are connections to the vacuum line. Vac. is connected to a mechanical pump.

samples are being "glass blown" on, the sides of the U tube are lengthened to somewhat more than a barometer height (76 cm). Such a unit is shown in Fig. 6a. Use of this arrangement (or other types of cutoffs designed to withstand a pressure difference of an atmosphere) requires care in pumping down whenever the whole system has been at atmospheric pressure. The bulb must be evacuated at a controlled rate while the main system is being evacuated. If the rate is too low, mercury will rise and cut off part of the system. If it is too great, the mercury level will drop to uncover the bottom of tube 2 and the mercury will "bump" in the bulb, with at least an unpleasant effect.

In order to overcome this inconvenience (which can be great if several such cutoffs are used on one system) the changes shown in

tube 2 is adequate. In the type shown, the stopcock included in the commercial model has been eliminated to avoid contamination of the mercury by stopcock grease. Reservoir 4 is incorporated in the original model as a "momentum absorber." It may be eliminated, but it seemed safer at first merely to assure that sufficient mercury is available to fill it and tube 1 when needed. The extra volume of mercury is supplied by bulb 3 which is conveniently inserted when the stopcock is removed. Bulb 4 has been eliminated in a later model which does not use the electrical contacts.

When it is desired to close off one side of a line in Fig. 6b or 6c while atmospheric pressure is admitted to the other side, the stopcock is turned to admit air (or other gas) until there is atmospheric pressure in the bulb and tube 1. The stopcock is then closed. (A good rule is always to have the stopcock closed when the procedure permits.) There is then something less than a barometer height of mercury above B. Without using a squeeze bulb or other external means to increase the pressure in the bulb, atmospheric pressure may be admitted to one side of the cutoff. As the pressure increases on one side, mercury is forced down into the bulb where it compresses the gas confined by the stopcock in tube 1. The increased pressure keeps the mercury above B and the cutoff remains closed. The pressure actually increases by more than 25% so that the lowest level reached by the mercury in the high-pressure arm of the cutoff is 20 cm above the surface in the bulb.

Some of the design requirements are obvious. Since tube 1 contributes to the volume in which air is compressed, a greater percentage change will be caused by a given amount of mercury if the volume of tube 1 is made smaller. This permits a larger safety factor and also means that the volume of tube 2 can be made smaller. (To have the maximum safety factor, the bulb should always be filled to the level A before starting. Any space left

unfilled decreases the compression ratio. The margin of safety can be increased a few centimeters by making the bulb spherical instead of the long cylinder as shown in Fig. 6b. The cylinder was used to save space.) A lower limit on the volume of tube 1 is set by the reduction in speed of response as a result of the resistance to flow in a tube of small diameter. Capillary tubing of 3 mm i.d. has been used without any attempt to make it as small as feasible. The volume of the bulb must be adequate to hold the mercury required for full cutoff under vacuum. Any greater volume means that some mercury is "stored." This fact might be utilized to somewhat isolate the mercury "seen" by the system from that exposed to air.

I wish to thank Mr. Julius Ostapowicz and Mr. Sigmund Omiecinski of our glass shop for fabricating the various forms of this cutoff that have been used.

PUBLICATIONS SINCE THE LAST REPORT

PAPERS

VIBRATIONAL FREQUENCIES OF ALKALI HALIDE DIMERS: II-BENDING, SYMMETRIC STRETCH, AND B_{1g} MODES

Joseph Berkowitz.....(Project II-28)
J. Chem. Phys. 32, 1519-1522 (May 1960).

NUCLEAR SPIN AND HYPERFINE INTERACTION OF In^{113m}

W. J. Childs and L. S. Goodman.....(Project I-80)
Phys. Rev. 118, 1578-1581 (June 15, 1960).

THE DEPENDENCE OF SOLVENT-SOLUTE ENERGY TRANSFER IN LIQUID ORGANIC SOLUTIONS ON EXCITATION WAVELENGTH

S. G. Cohen (U. of Cal., Berkeley) and A. Weinreb..(Project I-144)
Proc. Phys. Soc. (London) 75, 623-625 (April 1960).

DECAY OF $^{166}_{66}Dy$

R.G. Helmer and S. B. Burson.....(Project I-31)
Phys. Rev. 119, 788-795 (July 15, 1960).

DETERMINATION OF VERY SMALL QUANTITIES OF LEAD

D.C. Hess and R. R. Marshall.....(Project II-18)
Anal. Chem. 32, 960-966 (July 1960).

HEAVY-ISOTOPE ABUNDANCES IN MIKE THERMONUCLEAR DEVICE

D. C. Hess, M. G. Inghram, and 15 others from ANL, U. of Cal., and Los Alamos.....
Phys. Rev. Letters 5, 83 (July 15, 1960).

NUCLEAR COUPLING SCHEMES

D. Kurath.....(Project V-8)
Nuclear Spectroscopy, edited by Fay Ajzenberg-Selove (Academic Press, New York, 1960), Part B, pp. 983-1008.

STATISTICAL PROPERTIES OF ATOMIC AND NUCLEAR SPECTRA

Charles E. Porter (U. of Minnesota) and Norbert Rosenzweig (Project V-15)
Suomalaisen Tiedeakatemia Toimituksia, Ser. A, VI, 44 (1959)
pp. 1-66.

ADDITIONAL PAPERS ACCEPTED FOR PUBLICATION

SPIN-ORBIT SPLITTING AND TENSOR FORCE. III

Akito Arima.....(Project V-13)
Nuclear Physics.

TRANSFER OF EXCITATION ENERGY IN SOLID SOLUTIONS OF
ANTHRACENE-POLYSTYRENE AND 9,10-DIPHENYLANTHRACENE -
POLYSTYRENE

L. J. Basile and A. Weinreb.....(Project I-144)
J. Chem. Phys. in October 1960 issue.

TIME DEPENDENCE OF RESONANTLY FILTERED GAMMA RAYS
FROM Fe^{57}

F. J. Lynch, R. E. Holland, and M. Hamermesh..(Project I-19)
Phys. Rev.

THE THRESHOLD LAW FOR THE PROBABILITY OF EXCITATION OF
MOLECULES BY PHOTON IMPACT—A STUDY OF THE PHOTOIONIZATION
EFFICIENCIES OF Br_2 , I_2 , HI , and CH_3I

J. D. Morrison, H. Hurzeler, M. G. Inghram, and H. E. Stanton
(Project II-37)
J. Chem. Phys.

DECAY OF Pm^{149} (53 hr)

L. C. Schmid and S. B. Burson.....(Project I-40)
Phys. Rev. in October 1960 issue.

DISSOCIATION OF METHYL BROMIDE BY NUCLEAR ISOMERIC TRANSITION
OF 4.4-Hr $\text{Br}^{80\text{m}}$

S. Wexler and G. R. Anderson.....(Project II-38)
J. Chem. Phys. in September 1960 issue.

IMAGINARY PART OF THE DELBRÜCK SCATTERING AMPLITUDE

W. Zernik.....(Project V-24)
Phys. Rev.

PERSONNEL CHANGES IN THE ANL PHYSICS DIVISION

NEW MEMBERS IN THE DIVISION

Student Aide (Co-op)

Mr. Harold L. Yarger, Antioch College. Working with J. R. Wallace on various problems associated with the Van de Graaff generator. Came to ANL on July 11, 1960.

Research Technician

Mr. Arthur E. Froehlich. Transferred from Reactor Engineering to Physics on July 4, 1960. Plasma research with A. J. Hatch.

DEPARTURE

Dr. Harvey Casson joined the Physics Division on December 31, 1952 (after an earlier period from 1944-1947). He has used the Cockcroft-Walton accelerator to produce the $H^3(d,n)He^4$ reaction for a study of the inelastic scattering of 14-Mev neutrons from various nuclides (Project I-90). He transferred from the Physics Division to the International Institute of Nuclear Science and Engineering on June 1, 1960.

Leave of Absence

Dr. Leonard S. Goodman left ANL on August 1, 1960 on a Guggenheim fellowship for a year of study and research with Prof. H. Kopfermann at the Erstes Physikalisches Institut der Universität Heidelberg, Philosophenweg 12, (17a) Heidelberg, Germany. His interest will be in atomic beam research and hyperfine interactions. He expects to return to Argonne in September 1961.