

FIG. 1. Sr^{89} FK plots. "Allowed" plot (upper) and "Forbidden" plot (lower), with ordinates as indicated.

and Y^{90} , was obtained from Oak Ridge. Contributions to the spectrum from Sr^{90} and Y^{90} have been subtracted from the data. The data are shown in Fig. 1 in the form of FK (Fermi-Kurie) plots. The ordinate for the upper curve ("allowed" plot) is $(N/p^2F)^{1/2}$ and for the lower ("forbidden" plot) is $(N/Gp^2F)^{1/2}$. No attempt has been made to use a closer approximate form of G because of the relatively high value of W_0 .⁶ The upper curve shows the characteristic upward bulge for energies higher than $W_0/2$. The lower curve is satisfactorily straight, and confirms the prediction made above.¹²

Goldsmith and Inglis¹³ list the spin of Y^{89} as $1/2(?)$, (original source of this value is not mentioned). If true, the spin of Sr^{89} ground state is $5/2$. These spin values are in harmony with the nuclear shell model.

- * Assisted by the joint program of the ONR and the AEC.
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² F. B. Shull and E. Feenberg, *Phys. Rev.* **75**, 1768 (1949).
³ E. J. Konopinski and G. E. Uhlenbeck, *Phys. Rev.* **60**, 308 (1941).
⁴ L. M. Langer and H. C. Price, Jr., *Phys. Rev.* **75**, 1109 (1949).
⁵ A. C. G. Mitchell and C. L. Peacock, *Phys. Rev.* **75**, 1272 (1949).
⁶ J. S. Osoba, *Phys. Rev.* (in press).
⁷ Braden, Slack, and Shull (preceding letter).
⁸ Zaffarano, Kern, and Mitchell, *Phys. Rev.* **74**, 682 (1948), and private communication from Dr. Mitchell.
⁹ K. Siegbahn, *Arkiv. f. Math., Astr. o. Fysik* **34B**, No. 4 (1946).
¹⁰ Private communications from L. J. Laslett and E. Jensen.
¹¹ Kurie, Osoba, and Slack, *Rev. Sci. Inst.* **19**, 771 (1948).
¹² Similar results have been observed by L. J. Lazlett and L. M. Langer (private communication).
¹³ H. H. Goldsmith and D. R. Inglis, *The Properties of Atomic Nuclei*, L., Brookhaven National Lab. (1948).

Measurements Concerning the Vapor-Liquid Equilibrium of Solutions of He^3 in He^4 below 2.19°K

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 April 22, 1949

A SMALL vessel having a volume of 0.33 cm^3 had condensed in it a known amount of helium in which the He^3 concentration was about 5×10^{-4} . The vessel was placed in a bath of normal liquid helium and the vapor pressure difference, Δp , between the vessel and bath was measured while the vapor and liquid in the vessel were effectively stirred. In the top of the vessel we inserted a ground copper plug just below the capillary tube which connects the vessel with the apparatus outside the cryostat. The plug gives the helium film sufficient means for creeping out of the vessel, leaving the He^3 below the plug.¹ The film helium could be pumped out of the capillary by means of a Toeppler pump, and mass spectrometric analysis of this gas confirmed that no measurable amount of

He^3 was going out. Thus the pumping effected a very considerable increase in the He^3 concentrations inside of the vessel.

If one assumes (a) perfect solution, i.e. independence of the energy of one atom of He^3 or He^4 of the concentration, (b) liquid helium to be a two fluid system with He^3 soluble in the normal fluid only, and (c) helium to act as a perfect gas in the vapor phase, then a determination of Δp as a function of the known He^3 content at constant temperature (below the λ -point) enables one to test the relations which follow.

According to Henry

$$p_3 = N_3^L \pi_3 / (N_3^L + N_4^L) \quad (1)$$

and

$$p_4 = N_4^L \pi_4 / (N_3^L + N_4^L) \quad (2)$$

in which p_3 and p_4 are the partial pressures of the two isotopes in the vapor, N_3^L and N_4^L the number of molecules of He^3 and normal fluid He^4 in the liquid, π_3 and π_4 the saturated vapor pressures. We derive from (1) and (2):

$$p_3/p_4 = N_3^L \pi_3 / N_4^L \pi_4 \quad (3)$$

and

$$\Delta p = p_3 + p_4 - \pi_4 = N_3^L (\pi_3 - \pi_4) / (N_3^L + N_4^L). \quad (4)$$

Accepting provisionally Tisza's relation $N_4^L/N_4^L = \alpha = S/S_\lambda$ (S is the entropy of the pure He^4 at the temperature used and S_λ its entropy at the λ -point), we were able to calculate from the measured value of Δp at each temperature the absolute and relative concentrations in liquid and vapor, i.e.: $C_L = N_3^L/N_4^L$, $C_V = p_3/p_4$, $X_L = N_3^L/(N_3^L + N_4^L)$ and $X_V = p_3/(p_3 + p_4)$.

TABLE I. $T = 1.75^\circ\text{K}$.

Δp mm Hg	$K_L 10^4$	$X_V 10^8$	$N_3^L \cdot 10^8$	$N_3^V \cdot 10^8$	$N_3^{\text{tot}} \cdot 10^8$
0.16	5	16	435	22	457
0.33	10	35	284	88	372
0.54	17	58	221	172	393
0.67	21	70	189	219	408
0.78	24	80	168	258	426
0.84	26	85	130	280	410
0.91	28	91	84	306	390
1.11	35	112	35	390	425

The so calculated values of X_L and X_V together with the known volumes of vapor and liquid in the vessel made it possible to compute the total number of molecules He^3 present in the vessel. We could finally compare this number with our original amount of He^3 , viz.: 440×10^{-8} mole.

Table I shows in column 6 the number of N_3^{tot} at 1.75°K , which is, considering the accuracy of measurement, quite satisfactory. Similar isotherms were investigated at 2.0 and 1.9°K and analogous results were obtained. Lowering the temperature at constant filling gave again a good confirmation of our assumption. At 1.2°K we reached concentrations in the vapor as high as about 70 percent for a liquid concentration of 2 percent.

On the whole our chief assumption that He^3 is soluble in the normal fluid fraction of helium II appears to be remarkably well realized. Details will be published in *Physica*.

¹ Daunt, Probst, Johnston, Aldrich, and Nier, *Phys. Rev.* **72**, 502 (1947)

A Search for Crystals That Exhibit Conduction Pulses Under Alpha-Particle Bombardment

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 April 23, 1949

AFTER conduction pulses were observed in diamond¹ under polonium alpha-particle bombardment, a search was made for other crystals that exhibit this phenomenon. The choice of crystal species that were selected for test was

guided by desiderata outlined elsewhere,² where such species were available.

The experimental techniques employed were like those reported earlier.¹ In most cases, specimens $0.25 \times 0.25 \times 0.020$ inch with polished major faces were used. Conduction pulses were sought by applying the voltage first across electrodes separated by a gap of 0.002 inch on one face of the specimen and next across the electrodes on the opposite major faces of the specimen.

The first stage of the amplifier was put inside the experimental tube thereby attaining an input capacity of 10 to 15 μmf . With an estimated noise level of about 20 microvolts r.m.s. a 40 microvolt alpha-conduction pulse would be about the minimum that could be detected visually.

All measurements were made at room temperature. In general, at least two specimens of each species were tested. In many cases, the specimens probably were single crystals as they were cut from much larger crystalline pieces of the material. When the specimens were prepared from relatively small samples they may have been polycrystalline but in all probability the grain size was at least as large as the electrode separation.

Table I lists the species in which conduction pulses were observed. In general, no quantitative measurements either of counting efficiency or of pulse size were made. The species are listed in Table I in the order of decreasing response to alpha-

particle bombardment. This rough classification is based on visual observations of the pulses as they are displayed on a cathode-ray oscilloscope.

The crystal species with which alpha-conduction pulses were not observed are listed in Table II. In most of these cases, a potential of at least 300 volts was applied in each of the two test procedures.

These negative results were obtained with a limited number of specimens of each species. In a number of cases indicated in Table II negative results in similar tests have been reported also by other investigators. This failure to observe conduction pulses even where confirmed by other workers does not necessarily preclude the possibility that sufficiently favorable conditions are attainable under which some or all of these species might yield positive results.

¹ Wooldridge, Ahearn, and Burton, Phys. Rev. **71**, 913 (1947). A. J. Ahearn, Phys. Rev. **73**, 1113 (1948).

² K. G. McKay, Phys. Rev. **74**, 1606 (1948).

In¹¹⁸ and In¹¹⁹ Produced by Photo-Disintegration of Tin*

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April 28, 1949

THE irradiation of tin with 17.5-Mev x-rays has been previously shown to produce 13-second In¹¹⁸ and 117-minute In¹¹⁷ by (γ, p) reactions.¹ An examination of the indium activities produced by the irradiation of tin with 23-Mev betatron x-rays at this laboratory has led to the identification of two additional periods which can be assigned to In¹¹⁸ and In¹¹⁹ on the basis of evidence outlined below. The properties of these two isotopes are summarized in Table I.

TABLE I. Species in which conduction pulses were observed.

1. Diamond
2. Sphalerite ^a (ZnS, cubic form)
Wurztite ^b (ZnS, hexagonal form)
Greenockite (CdS) ^{c,d}
3. Cinnabar (HgS)
4. Periclase ^e (MgO)
5. Stibnite (Sb ₂ S ₃)
Realgar (As ₂ S ₃)
Carborundum ^f (SiC)

^a A. J. Ahearn, Phys. Rev. **73**, 524 (1948).

^b Synthetic zinc sulfide through courtesy of Dr. J. M. Jauch, University of Iowa, Iowa City, Iowa.

^c Synthetic cadmium sulfide prepared by Dr. R. Frerichs (see reference d) and supplied through courtesy of Dr. R. J. Cashman, Northwestern University, Evanston, Illinois.

^d For other published work on bombardment conductivity in cadmium sulfide see R. Frerichs, Phys. Rev. **72**, 594 (1947), Report of Conference on Scintillation Counters and Crystal Counters, Rochester, New York, 1948; G. J. Goldsmith and K. Lark-Horowitz, Phys. Rev. **75**, 526 (1949).

^e Synthetic crystals through courtesy of Dr. E. G. Rochow, General Electric Company and Norton Company, Niagara Falls, Canada.

^f Synthetic crystals possessing an unusually high resistivity through courtesy of Dr. G. Busch, Zürich University, Switzerland.

TABLE I. Properties of In¹¹⁸ and In¹¹⁹.

Isotope	Made by	Observed half-life	Decay
In ¹¹⁸	Sn ¹¹⁹ (γ, p)	4.5 \pm 0.5 min.	β^- 1.5 Mev γ
In ¹¹⁹	Sn ¹²⁰ (γ, p)	17.5 \pm 1 min.	β^- 2.7 Mev no γ

TABLE II. Species in which alpha-conduction pulses were not observed.

Arsenic Trioxide*	Wulfenite
Orpiment	Mica
Sapphire*	Magnesium Meta Aluminate*
Topaz	Naphthalene*
Beryl	Orthoclase
Emerald	Potassium Bromide
Tourmaline	Rochelle Salt ^{a,*}
Barium Titanate*	Pyrargyrite
Apatite	Quartz
Calcite*	Sodium Chloride ^a
Fluorite ^a	Sodium Nitrate*
Lithium Fluoride ^{a,*}	Sulfur ^{a,b}
Cerussite	Titanium Dioxide ^{c,*}
Crocoite	Zinc Manganese Ferrite*
Potassium chloride* (also natural crystals)	
Scheelite ^{d,*} (also natural crystals)	
50 other species† of ionic crystals including tartrates, halides, sulfates, etc. of both organic and inorganic cations.	

* Synthetic crystal.

^a R. Hofstadter (Nucleonics, May, 1949) reports similar negative results.

^b W. Jentschke (Phys. Rev. **73**, 77 (1948)) reports similar negative results with sulfur and alkali halides.

^c Courtesy of Dr. R. Dahlstrom, National Lead Company, South Amboy, New Jersey.

^d Courtesy of Linde Air Products Company.

† In order to conserve space, these species are not itemized since they are less common than those specifically listed in Table II. However the complete list will gladly be furnished on request.

The identity of the In¹¹⁸ was established by an 8-minute irradiation with 23-Mev x-rays of a sample of tin foil enriched to 78.5 percent in Sn¹¹⁹.² This sample decayed with a 4.5 ± 0.5

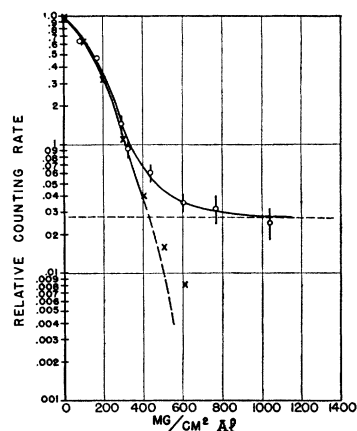


FIG. 1. Aluminum absorption curve of radiation from In¹¹⁸.