Capture of Polarized Neutrons by Polarized Sm^{149} Nuclei

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The Sm^{149} nuclei in the paramagnetic salt, samarium ethyl sulfate, were polarized by use of the hyperfine structure coupling, which was known to be large from paramagnetic resonance measurements. The Sm salt was placed in a field of 11 000 gauss after being cooled by thermal contact with a sample of iron ammonium alum which was demagnetized to zero field from 15 500 gauss and 1.2°K. The nuclear polarization was observed and measured by observations on the state of polarization of the neutrons transmitted by the Sm sample. A single crystal of magnetized magnetite, set to reflect neutrons of 0.07 ev in first order from the 220 planes was used as the analyzer. A nuclear polarization of about 0.12 was deduced from the data. The observed polarization direction of the transmitted neutrons gives $J=I+\frac{1}{2}$ for the 0.094-ev resonance level in Sm^{149}. A temperature of about 0.13°K for the Sm-containing salt was deduced from the observed neutron polarization.

I. INTRODUCTION

THE polarization of nuclei by use of hyperfine structure coupling was suggested by Rose[1] and by Gorter.[2] In this method a large electron polarization is produced by subjecting a suitable paramagnetic salt to appropriate magnetic field and temperature conditions. The large effective magnetic field produced by the electrons at the nucleus serves to polarize the nuclei by means of the large electron nuclear coupling. This method of nuclear polarization has been used at the Clarendon Laboratory to study the angular distribution of γ rays emitted by polarized nuclei.[3] We have used this method[4] for polarizing Mn^{55} nuclei in the salt, manganous ammonium sulfate, at a temperature of 0.2°K, in a field of 2350 gauss. The spin dependence of the capture cross section for thermal neutrons of Mn^{55} was studied by bombarding the sample with polarized neutrons and observing the dependence of the Mn^{56} activity upon relative spin directions of incident and bombarded particles. In the Mn experiment, the final conditions of 0.2°K and 2350 gauss came about by demagnetizing the salt containing the nuclei to be polarized, from the initial conditions, 1.2°K and 15 500 gauss.

In this paper we present the results of an experiment in which the nucleus Sm^{149} in samarium ethyl sulfate was polarized through the use of hyperfine structure coupling. In this case, for reasons explained in Sec. II, the samarium ethyl sulfate was cooled indirectly by thermal contact through a copper bar with a sample of ferric ammonium sulfate which served as the paramagnetic salt refrigerant in the adiabatic demagnetization. The nuclear polarization was measured by observations on the state of polarization of the neutrons transmitted by the sample. The state of polarization of the transmitted neutron beam is interpreted in terms of the angular momentum of the 0.094-ev resonance level in Sm^{149}. The neutron effects observed serve also as a "thermometer" giving a value for the average temperature of the salt in a region of temperature well below 1°K.

II. PRODUCTION OF THE POLARIZATION OF Sm^{149} NUCLEI

Recently, Bogle and Scovil reported the results[5] of paramagnetic resonance experiments on the trivalent samarium ion in the salt samarium ethyl sulfate $Sm(C_2H_5SO_4)_3\cdot 9H_2O$, which crystallizes in hexagonal form. Their measurements were performed at 4°K where the electronic ground state was found to be a Kramers' doublet. Their results relative to Sm^{149} may be summarized in terms of the "spin" Hamiltonian $\mathcal{H}$,

$$\mathcal{H}=g_{\parallel}\beta H_z S_z+g_{\perp}\beta(H_x S_x+H_y S_y)+AS_z I_z+B(S_x I_x+S_y I_y)+\mathcal{H}_1. \quad (1)$$

Here, the spectroscopic splitting factor for the magnetic field parallel to the hexagonal axis is $g_{\parallel}=0.596$ and for the field perpendicular to this axis, it is $g_{\perp}=0.604$. In the following it is sufficiently precise to neglect this small asymmetry and take an average spectroscopic splitting factor $g=0.60$. β is the Bohr magneton. The nuclear spin I is $7\hbar/2$. H_x, H_y, and H_z are the components of the magnetic field; S_x, S_y, and S_z are the components of the electron spin operator; and I_x, I_y, and I_z are the components of the nuclear spin operator with the z direction taken along the hexagonal axis. The hyperfine structure coupling constants for Sm^{149} have the values $A=-0.0049$ cm^{-1} and $B=-0.0205$ cm^{-1}. The negative sign of the hyperfine structure coupling is obtained from the work of Murakawa and Ross[6] and from the theoretical treatment by Elliot and Stevens[7] of the samarium ethyl sulfate paramagnetic resonance measurements. The term $\mathcal{H}_1$, which includes the electron spin-spin interactions, nuclear

[1] M. E. Rose, Phys. Rev. **75**, 213 (1949).
[2] C. J. Gorter, Physica **14**, 504 (1948).
[3] Ambler, Grace, Halban, Kurti, Durand, Johnson, Lemmer, Phil. Mag. **44**, 216 (1953).
[4] Bernstein, Roberts, Stanford, Dabbs, and Stephenson, Phys. Rev. **94**, 1243 (1954).
[5] G. S. Bogle and H. E. D. Scovil, Proc. Phys. Soc. (London) **A65**, 368 (1952).
[6] K. Murakawa and J. S. Ross, Phys. Rev. **82**, 967 (1951).
[7] R. J. Elliot and K. W. H. Stevens, Proc. Roy. Soc. (London) **A219**, 387 (1953).

quadrupole coupling, and the direct interaction of the nucleus with the external field, may be expected to be small compared to the first two terms in $\mathcal{H}$ for values of the magnetic field of interest here, and is neglected.

Following our earlier report,[4] the average nuclear polarization f_N for a powder sample is

$$f_N=\frac{S(I+1)hc(A/3+2B/3)}{3kT}\tanh\frac{g\beta H}{2kT}, \quad (2)$$

where the electron spin S is taken as $\frac{1}{2}$ to describe the doublet ground state, h is Planck's constant, c is the velocity of light, k is Boltzmann's constant, H is the magnetic field, and T is the absolute temperature. Substituting the values for the several constants we obtain

$$f_N=(0.0165/T)\tanh(2.02\times10^{-5}H/T). \quad (3)$$

The maximum value of H available with our Weiss magnet is 15 500 gauss and the minimum temperature available by pumping on liquid helium in our nuclear polarization cryostat is about 0.9°K. For these conditions (3) gives an f_N of only 0.006 which is too small to be readily usable.

This polarization may be enhanced by a partial demagnetization as was done[4] in case of Mn^{55}. This enhancement may be estimated as follows: We assume Curie law behavior for the samarium electron moments. Also we assume that the specific heat of $Sm(C_2H_5SO_4)_3\cdot9H_2O$ is primarily due to hyperfine structure coupling and that it has a $1/T^2$ behavior. Then it follows that the optimum value for the nuclear polarization f_N' is given by

$$f_N'=-\frac{1}{6}\frac{S(I+1)}{[I(I+1)]^{\frac{1}{2}}}\frac{g\beta H_i}{kT_i}\tanh\frac{g\beta H_i}{2kT_i},$$

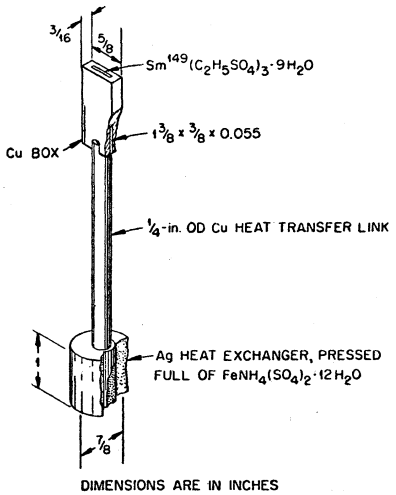

FIG. 1. Heat transfer arrangement.

where the subscript i refers to the initial conditions of the demagnetization. Assuming $H_i=15\,500$ gauss and $T_i=0.9$°K, this leads to an f_N' of 0.027, which is still rather small. The reason for this lies in the fact that the spectroscopic splitting factor $g=0.60$ is relatively small and correspondingly, the initial entropy removal is small.

To increase this initial entropy removal, we decided to cool the $Sm(C_2H_5SO_4)_3\cdot9H_2O$ by the adiabatic demagnetization of an additional coolant salt thermally connected to the samarium sample. In this heat transfer equipment, shown in Fig. 1, the samarium ethyl sulfate powder sample is pressed into a rectangular copper box which is connected by a copper tube to a "heat exchanger" consisting of two concentric silver tubes pressed full of $Fe(NH_4)(SO_4)_2\cdot12H_2O$. In using this equipment to polarize the Sm^{149} nuclei, the iron ammonium alum was demagnetized to a temperature[8] of about 0.043°K, but this temperature was increased to about 0.06°–0.07°K at the time the neutron observations were made, primarily by eddy-current heating effects. The samarium salt is cooled by heat conduction through the copper heat transfer link (Fig. 1) and partially by stray field adiabatic demagnetization. Finally, to produce the nuclear polarization it is necessary to apply a magnetic field exclusively to the samarium salt. This magnetic field must not be applied to the coolant salt since this would raise the temperature of the sample assembly.

Figure 2 shows a diagram of the cryostat built to perform the above operations. It consists fundamentally of two concentric Dewars containing liquid helium jacketed by liquid nitrogen. The heat transfer link shown in Fig. 1 is mounted within the sample tube on a string suspension as is customary in adiabatic demagnetization experiments. This suspension is designed to minimize vibration-induced heat leak to the sample. Heat leaks of the order of 20–40 ergs per minute to the sample assembly at temperatures below 1°K were usual. Four radiation shields recently described elsewhere[9] are inserted in the sample tube above the sample assembly. The sample tube was inserted into the cryostat through an "O"-ring seal so that this tube and the enclosed samarium heat transfer assembly could be raised and lowered. Figure 2 shows the tube in the mid-position. In a typical experiment, we began with this tube in the upper position with the coolant salt—"heat exchanger" in the magnet gap. The coolant salt was magnetized for 15 minutes with a helium exchange gas pressure of about 50μ, at an $H_i/T_i=12\,300$ gauss per degree. Then, opening valves A and B, the exchange gas was pumped for 30 minutes to a final pressure as measured at the VG1A vacuum gauge of 5×10^{-6} mm of Hg pressure. Then the Weiss magnet field was decreased slowly to zero, this process taking

[8] A. H. Cooke, Proc. Phys. Soc. (London) **A62**, 269 (1949).
[9] Erickson, Roberts, and Dabbs, Rev. Sci. Instr. (to be published).

of the order of 10 minutes to reduce eddy-current heating in the metal parts of the sample assembly. Valves A and B were then closed and the sample tube was slowly moved to the lower position, in which the coolant salt was surrounded by a magnetic field shield and the samarium sample was in the magnet gap. The magnetic shield, which consisted of concentric cylinders of Armco iron with inner and outer radii in geometric progression, was quite effective. A field of 10 000 gauss applied to the samarium sample produced a field, on the coolant salt 5 inches below, of less than one gauss. Storage batteries were used to excite the magnet in the lower position of the experiment in order to obtain a very steady field. This field was turned on slowly to decrease eddy-current heating. About twenty minutes after the application of this field, nuclear polarization effects were observed as described in the next section.

III. OBSERVATION OF THE NUCLEAR POLARIZATION OF Sm^{149}

The cross section of polarized nuclei for polarized neutrons is given by[1]

$$\sigma=\sigma_0\left(1+\frac{I}{I+1}f_nf_N\right), \quad J=I+\tfrac{1}{2}; \tag{4a}$$

$$\sigma=\sigma_0(1-f_nf_N), \quad J=I-\tfrac{1}{2}. \tag{4b}$$

σ_0 is the cross section in the absence of polarization. The quantity I is the spin quantum number of the polarized nuclei, f_n is the neutron polarization, f_N is the nuclear polarization. The quantity J is the angular momentum quantum number of the compound state. If an unpolarized neutron beam is incident upon a sample containing polarized nuclei, the cross section σ can be expressed as

$$\sigma=\sigma_0\pm p, \tag{5}$$

in which

$$p=\sigma_0\frac{I}{I+1}f_N \quad \text{if} \quad J=I+\tfrac{1}{2}, \tag{6a}$$

$$p=\sigma_0 f_N \quad \text{if} \quad J=I-\tfrac{1}{2}. \tag{6b}$$

For $J=I+\frac{1}{2}$, the plus sign of (5) applies to that half of the incident number of neutrons whose polarization is parallel to the nuclear polarization, the minus sign to that half whose polarization is antiparallel. For $J=I-\frac{1}{2}$, the positive sign in (5) applies to those neutrons whose spin direction is antiparallel to the spin direction of the nuclei. Because of the different cross section for the two neutron spin states, the neutron beam emerging from the sample will be polarized. Its polarization P_1 is given by

$$P_1=\tanh(Npd), \tag{7}$$

in which N is the number of nuclei per unit volume and d is the thickness of the sample. The neutron polarization produced by the sample is a measure of the amount of nuclear polarization of the sample. Since the neutron polarization produced by the sample increases with its thickness, a value of d as large as is consistent with intensity requirements is desirable.

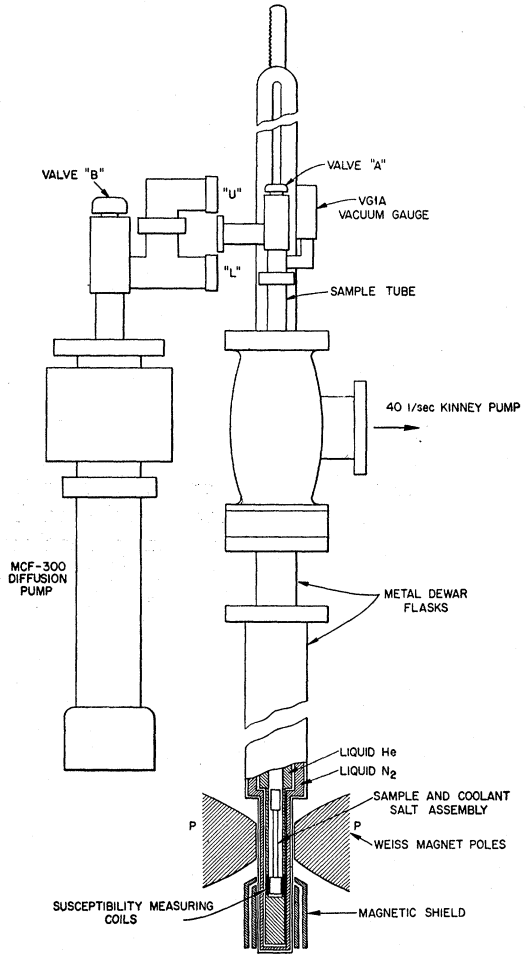

FIG. 2. Nuclear polarization cryostat.

The polarization of a beam of neutrons of a single energy (produced by a given polarizer) can be measured easily if the polarization produced by a second polarizer from the same incident unpolarized beam is known.[10] In this method the neutron beam passes from the polarizer to the analyzer (second polarizer) and then into the detector. The counting rate C_1 is measured with the magnetic field conditions along the beam arranged so that only adiabatic changes of neutron spin can take place between polarizer and analyzer. The counting rate C_2 is obtained when the polarization of the beam is brought to zero between polarizer and analyzer by transmission through a thin foil of iron placed in near-zero field in this region. Then

$$G=C_1/C_2=1+P_1P_2, \tag{8}$$

[10] Stanford, Stephenson, Cochran, and Bernstein, Phys. Rev. **93**, 374 (1954),

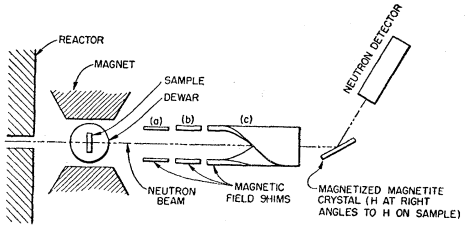

FIG. 3. Schematic arrangement of apparatus for observing nuclear polarization of Sm^{149}.

in which P_1 is the polarization produced by polarizer alone from the incident unpolarized beam of neutrons, and P_2 is the polarization produced by analyzer alone from the same incident unpolarized beam. We call G the "shim effect."

The arrangement of the apparatus is shown schematically in the plan view of Fig. 3. A thermal beam of neutrons emerges from the reactor and passes through the sample of samarium ethyl sulfate. The sample is located within the cryostat (at a temperature estimated below to be between 0.12°K and 0.15°K) where it is subjected to a horizontal magnetic field of about 11 000 gauss. Those neutrons transmitted by the sample are then reflected into the window slit of the $B^{10}F_3$ proportional counter neutron detector from the 220 planes of a single crystal of magnetite subjected to a magnetic field of several thousand gauss. The purpose of the magnetized magnetite crystal is to select neutrons of a given spin state and a given energy from the continuous energy spectrum transmitted by the sample. The direction and magnitude of the magnetic field along the path of the neutron beam were controlled by means of the parallel plate shims (a), (b), and (c). The magnetic field between the plates was adjusted according to the requirements of the two types of observation, C_1 and C_2, by bridging the distance between the plates at various points with numerous U-shaped permanent magnets. The polarization produced by the magnetite crystal is greatest when the field applied to it is perpendicular to the neutron scattering plane.[11] The field was therefore applied to the crystal in the vertical direction. The purpose of the "twister" shim (c) was to produce a slowly varying change in the magnetic field direction along the beam path from the horizontal at the Sm sample to the vertical at the magnetite crystal. Magnetic field measurements were made, and the permanent U-shaped magnets adjusted so that the conditions necessary for the neutron spin to "follow" the field obtained during the measurement of the counting rate C_1. For the measurements of C_2, the permanent magnets were adjusted so that the field was close to zero in (b). Several sheets of iron, each 0.005 in. thick, were placed in the path of the beam at the point of near-zero field to destroy the neutron polarization produced by the Sm^{149} nuclei. The depolarizing foils of iron reduce the intensity of the beam C_2 by a small amount due to scattering and capture. This decrease in intensity was compensated for by inserting the depolarizing foils in the path of the beam during measurements of C_1 at a point between the crystal and the detector, where their depolarizing action is of no consequence.

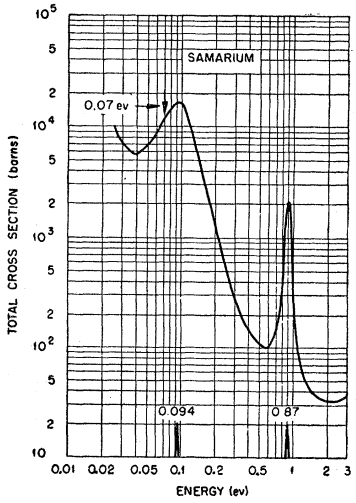

FIG. 4. Total cross section of Sm^{149} *vs* energy. See *Neutron Cross Sections*, Atomic Energy Commission Report AECU-2040 (Technical Information Division, U. S. Department of Commerce, Washington, D. C., 1952).

All of the data were taken with the 220 planes of the magnetite crystal set to reflect 0.07-ev neutrons in the first order. The relationship of this energy to the known resonance levels of Sm^{149} is shown in Fig. 4. The results of a single run are shown in Fig. 5, in which time is plotted along the x axis. The counting rate C_1 is shown as the dotted line, and C_2 as the solid line. The figure illustrates how the over-all counting rate repeatedly increased by about 10 percent when the neutron polarization produced by the polarized Sm^{149} nuclei was destroyed by the iron foils. The statistical standard errors in the counting rates for the one run are shown on the graph. The observed changes in intensity are 3 or 4 times as great as the statistical error in each observation.

The over-all counting rate plotted in Fig. 5 includes not only the first-order 0.07 ev neutrons but also higher-order reflected neutrons. The counts due to the higher-order reflections constitute an appreciable fraction of the total counting rate for two reasons: the Sm resonance at 0.094 ev depletes the transmitted beam of first-order neutrons; the crystal structure factor of the 440 planes of magnetite is very much larger than that of the 220 planes. The shim effect is reduced by the presence of these higher-order neutrons.[10] For example, the 440 reflected neutrons should be polarized to about 10 percent in the direction opposite to that of the 220 reflection; the 660 reflection will have the same direction

[11] O. Halpern and M. H. Johnson, Phys. Rev. **55**, 898 (1939).

of polarization as 220, but will be much less because of the decrease in the magnetic form factor with increasing ($\sin\theta/\lambda$). The effect of the higher-order reflections upon the shim effect was studied quantitatively by means of appropriate filters, and corrections to G were made.

A summary of all the data is given in Table I. The results presented are the average of four experiments. The observations of all of these experiments were in good agreement.

The shim effect G, including all orders of reflection for all runs at the low temperature was 0.882 ± 0.007. This value is corrected to the value 0.787 ± 0.024, which should have been observed if first-order neutrons only were present in the beam. The polarization P_2 produced by reflection from the 220 planes of our magnetite crystal was known to be close to 90 percent.[10] Substituting the measured values of 0.787 for G, and 0.9 for P_2 into (8), the polarization P_1 produced by transmission through the Sm sample is calculated to have the value minus 0.24 (it is opposite in direction to the polarization produced by the magnetite).

The polarization of the neutron beam transmitted by the polarized Sm nuclei should be accompanied by an

TABLE I. Shim effect G.

Temperature	Shim effect G	Beam
(0.12°–0.15°K)	0.787 ± 0.024	Includes first-order neutrons only
(0.12°–0.15°K)	0.882 ± 0.007	Includes all orders
(1.2°K)	0.986 ± 0.007	Includes all orders

increase in the transmitted intensity. This increase is related to the polarization P_1 by the expression

$$P_1=[1-(C_3/C_2)^2]^{\frac{1}{2}}, \tag{9}$$

in which C_2 is the intensity transmitted by the sample, as defined in the foregoing, C_3 is the intensity transmitted with the Sm in zero field. Using the value $P_1=0.24$, given by the shim effect data, in (9), a value of C_3/C_2 of 0.97 should have been observed for first-order neutrons only, or a value of about 0.98 for all neutrons. A change in intensity of approximately this amount was observed, but this type of measurement was not pursued, since the shim effect is larger in size and simpler to measure reliably.

Table I shows also the results obtained for a series of runs in which the sample was maintained at 1.2°K in a field of 11 000 gauss. The shim effect in this case was 0.986 ± 0.007. This value of G corresponds to a neutron polarization and nuclear polarization from about (1/9) to (1/17) times that produced at the low temperature. This ratio, calculated using best estimates of the values of T and H in the two experiments, should be (1/34). Thus the polarization of the Sm^{149} nuclei decreases with temperature roughly in accordance with theory. Agreement can be obtained by assuming that

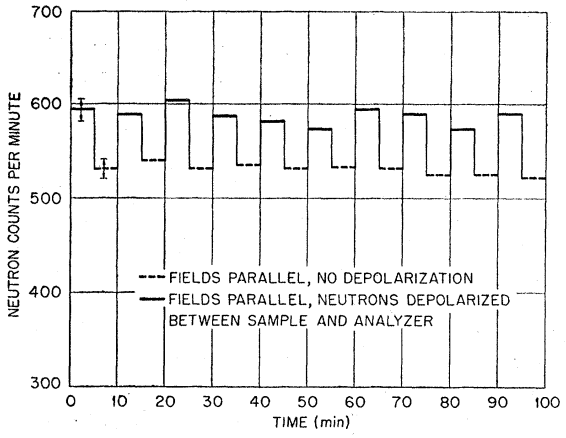

FIG. 5. Intensity of transmitted neutron beam *vs* time. The intensity increases when the neutron polarization produced by the polarized Sm^{149} is destroyed.

the experimental error in the value of $G=0.986$ for the high temperature is 1.5 times as large as the calculated statistical standard error shown in Table I.

IV. INTERPRETATION OF THE OBSERVATIONS

Consideration of the relative directions of the various vector quantities involved in the interpretation of the fact that the neutron polarization P_1 produced by transmission through the polarized Sm nuclei, is opposite to the neutron polarization P_2 produced by the magnetite leads to the conclusion that the capture cross section in the sample was greater when the nuclear spin and incident neutron spin are in the same direction. The directions of the relevant vectors are sketched in Fig. 6. The fields applied to the Sm sample and the magnetite crystal can be considered to be parallel, since nonadiabatic neutron transitions were not permitted to occur. The neutron spin direction corresponding to P_2, produced by the 220 reflection, is known from theory and experiment[12] to be antiparallel to the field applied to the crystal. The neutron spin direction predominant in the beam transmitted by the Sm sample is antiparallel to P_2, or parallel to the magnetic field applied to the Sm. The negative sign of the hfs coupling means that the most densely populated hyperfine structure level in samarium ethyl sulfate is the one which corre-

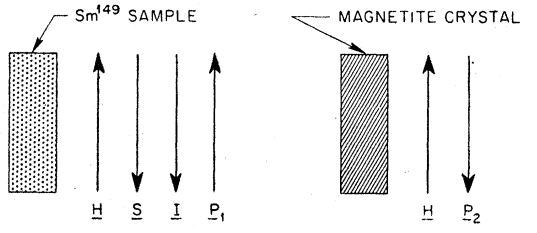

FIG. 6. Relative directions of relevant vector quantities leading to the conclusion that $J=I+\frac{1}{2}$ in 0.094-ev resonance in Sm^{149}.

[12] Sherwood, Stephenson, Stanford, and Bernstein, Bull. Am. Phys. Soc. **29**, No. 1, 54 (1954).

sponds to the nuclear spin I parallel to the electronic spin S. The Sm is more transparent to those neutrons whose spins are antiparallel to the spins of the Sm^{149} nuclei, and therefore captures preferentially those neutrons whose spins are parallel to the Sm nuclei. The neutron energy used, 0.07 ev, is sufficiently close to the resonance energy 0.094 ev so that it is reasonable to assume that this one resonance is predominantly responsible for the neutron capture at 0.07 ev. The results of our experiment are interpreted to mean that for the 0.094 ev resonance in Sm^{149}, $J=I+\frac{1}{2}$. This conclusion agrees with that of Brockhouse,[13] deduced from neutron scattering and transmission measurements.

From the number of grams per cm^2 of sample and the value for the Sm cross section at 0.07 ev, the factor $(N\sigma_0 d)$ for the Sm nuclei is calculated to be about 2.5, i.e., the intensity of 0.07-ev neutrons is diminished by the factor $e^{-2.5}$ by Sm capture. The value of the nuclear polarization f_N is calculated from (6a) and (7) to be about 0.12.

Inserting $f_N=0.12$ and $H=11\,000$ oersteds into (3), a sample temperature of 0.13°K is obtained. From the uncertainty in the exact value of $(N\sigma_0 d)$ at 0.07 ev, the sample temperature is estimated to have been between 0.12°K and 0.15°K. The difference between this temperature, and the temperature of the ferric ammonium sulfate coolant salt of 0.06°–0.07°K was somewhat larger than was expected based on the heat leak and on thermal conductivity considerations.[14]

[13] B. N. Brockhouse, Can. J. Phys. **31**, 432 (1953).

[14] E. Mendoza, "*Les Phenomènes Cryomagnetiques*" (College de France, 1948).

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Beta-Alpha Correlation in the Decay of Li^8†

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The beta-alpha directional correlation in the $Li^8(\beta)Be^{8*}(\alpha)He^4$ decay has been measured for various portions of the upper end of the beta spectrum, from about 90 percent to 10 percent of the total beta spectrum. No significant departure from isotropy was observed at the higher beta energies, as reported in earlier measurements. An average of the measurements gives a value of $A_2=0.01\pm0.03$ in the correlation function $1+A_2\cos^2\theta$.

THE beta decay of Li^8 leads primarily to the formation of the Be^8 nucleus in its first excited state, which then decays into two alpha particles.[1] The directional correlation between the beta and the alpha particles has been studied, and a small angular effect of the type $1+A_2\cos^2\theta$ has been reported.[2,3] We have continued the measurements made earlier in this laboratory.

Thin targets of natural lithium were bombarded with deuterons to produce Li^8 nuclei through the $Li^7(d,p)Li^8$ reaction. The deuteron beam of energy 0.66 Mev was interrupted periodically by means of a rotating shutter, to allow observation of the decay products only when the beam was not irradiating the target. The recording circuits were closed and opened by a switch in synchronization with the shutter which had a period of 4 sec, about equally divided between irradiation and eclipse of the target. The alpha particles were observed at a fixed angle, either 90° or 135° to the beam, by means of thin (approximately 10-mil) NaI or KI crystals. The crystal, mounted inside the target chamber, was coupled optically to an external photomultiplier tube through a light pipe. A NaI crystal, 2 inches long by 1.5 inches in diameter, which gave good resolution for gamma radiation, was used as the beta particle detector. The beta particles were admitted to the crystal through a 1-mil aluminum foil. The target chamber was constructed entirely of aluminum and Lucite. For observation of the beta particles, seven windows covered with 1-mil aluminum foil were provided at intervals from 45° to 270°, as measured from the alpha detector. After amplification, the pulses from each detector were discriminated with an integral bias and then presented to a coincidence detector. Accidental coincidences were recorded with a separate circuit counting delayed coincidences.

The beta detector was calibrated with the 4.43-Mev gamma ray from C^{12} (from a Po-Be source) and the 17.6-Mev gamma ray from the $Li^7(p,\gamma)Be^8$ reaction, using differential pulse-height analysis. The resolution of the alpha detector was tested with Po alpha particles, but the counter was not calibrated directly. Instead, the beta-alpha coincidence yield from the Li^8 decay was measured as a function of the bias (or the gain) of the alpha detector. A typical curve is shown in Fig. 1.

† Supported by a contract with the U. S. Atomic Energy Commission.

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[1] For additional information see the review article: F. Ajzenberg and T. Lauritsen, Revs. Modern Phys. **24**, 321 (1952).

[2] C. M. Class and S. S. Hanna, Phys. Rev. **89**, 877 (1953).

[3] D. St. P. Bunbury, Phys. Rev. **90**, 1121 (1953).