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 cm² 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.

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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).

On the plateau of this curve the observed coincidence yield per beta particle was 90–100 percent of the yield expected from a consideration of the solid angle subtended by the alpha detector.

The angular correlation was measured for various portions of the upper end of the beta spectrum. The results are shown in Fig. 2. In a typical run the average coincidence rate was of the order of 2 per sec and the accidental rate about 10 percent of the real rate. Because of the recoil velocity of the Be^{8*} nuclei following the beta decay, it is necessary to convert the observed yields from the laboratory to the center-of-mass system. This correction cannot be computed precisely, because of the continuous nature of the alpha and beta spectra and the lack of specific knowledge concerning the beta-neutrino correlation. As a result of the essential symmetry about 90° in the beta-alpha correlation, however, it is possible to obtain the correction experimentally by comparing the yields observed at θ and $\pi-\theta$. In each case, the estimated theoretical correction, having a maximum value between 5 and 10 percent, was compatible with the experimental value. As can be seen in the figure, no significant change in the correlation with beta energy is observed. An average of all the runs gives a value of $A_2=0.01\pm0.03$ in the expression $1+A_2\cos^2\theta$.

In our earlier work[2] the values of A_2 obtained when a major portion of the beta spectrum was observed are compatible with the present results. Larger values of A_2, obtained when the high end of the beta spectrum was recorded, resulted from a failure to achieve a sufficiently low bias on the alpha detector, completely below the low-energy limit of the alpha spectrum (~0.5 Mev). As discussed above, the use of thinner sources and improved resolution made it possible to include effectively the total alpha spectrum in the present investigation. The shift in the alpha energy resulting from the recoil of the Be^8 nucleus, when the beta particle is emitted parallel instead of perpendicular to the alpha particle, amounts to about 5 percent when averaged over the beta and alpha spectra. When the high end of the beta spectrum is selected, however, the shift is of the order of 15 percent at the low end of the alpha spectrum.

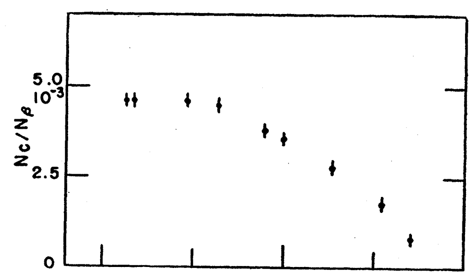

FIG. 1. Coincidence yield as a function of the integral bias on the alpha detector. The abscissa is in arbitrary units. The coincidences are normalized to the count in the beta detector, which had a fixed bias corresponding to a beta energy of 4.5 Mev.

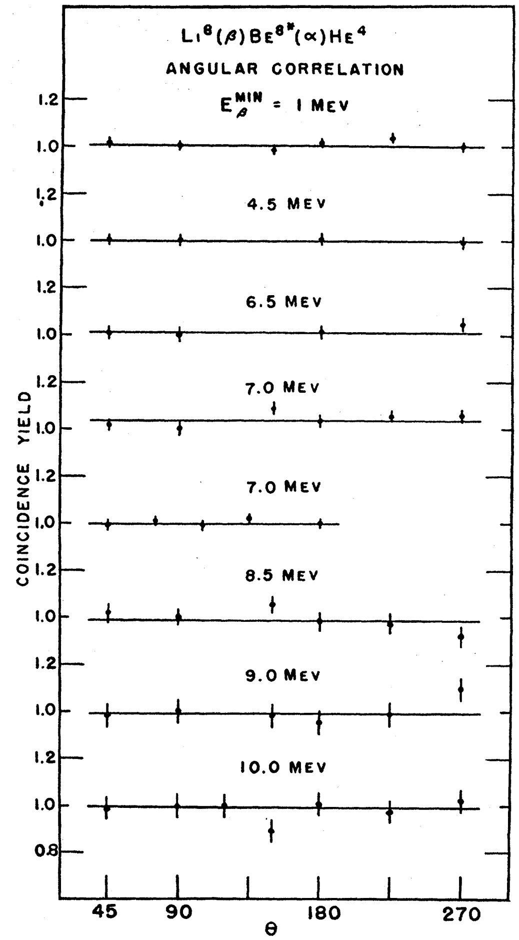

FIG. 2. Angular correlation in the $Li^8(\beta)Be^{8*}(\alpha)He^4$ decay. In all the curves, except the first, the total alpha spectrum was used. For the first curve the alpha bias corresponded to an alpha energy of about 2.5 Mev, and the data have been corrected for the change in alpha energy occurring in the laboratory system. For all the curves, except the fifth, the alpha counter was at an angle of 135° to the beam direction. For the fifth curve the angle was 90°. θ is the angle of the beta detector as measured from the fixed alpha detector. The bias on the beta detector is given for each curve in terms of the (approximately) equivalent beta energy.

As discussed by Gardner,[4] an isotropic result for the beta-alpha correlation does not serve to specify the spins of the particles, although it can be of help in eliminating certain possibilities. If the spin of Li^8 is assumed to be two, an isotropic correlation would result for either spin two or spin zero for the first excited state of Be^8.

We are greatly indebted to Mr. Richard Lee for his generous assistance in various phases of this investigation.

[4] J. W. Gardner, Phys. Rev. 82, 283 (1951).