Excited States of Ce^{140}†

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Scintillation and magnetic beta-ray spectrometry have been applied to the study of the more important levels of Ce^{140}. Coincidence experiments verify that successive levels are at 1.60, 2.09, 2.42, and 2.53 Mev above the ground state and correspond to gamma rays of energies 1.60, 0.815, 0.490, 0.438, and 0.328 Mev. The relative intensities of the gamma rays are found to be 2.50, 1.15, 1.25, 0.15, and 1.00, respectively. The energies and relative intensities of two weak high-energy transitions have been determined by means of a scintillation pair spectrometer. Values of 2.50 ± 0.05 and 3.00 ± 0.20 Mev are obtained with corresponding intensities of one percent and 0.04 percent of the 1.60-Mev gamma-ray. The beta-ray measurements substantiate the relative intensities and end-point energies of the beta-ray groups which have been reported by others. In addition, it has been possible to estimate the internal conversion coefficients and K/L ratios. The angular correlation of four cascade pairs of the above gamma rays has been studied. The results obtained, together with the beta-ray and internal conversion data, are most consistent with the assignment 0, 2+, 4+, 3+ for the ground state and first three excited states. The assignment 0, 2+, 4+, 4+ cannot be definitely excluded.

INTRODUCTION

THE complex radiations from the decay of 40-hour La^{140} have been studied by a number of investigators. Three somewhat different decay schemes have been suggested. The decay schemes proposed by Cork and co-workers[1] and Beach, Peacock, and Wilkinson[2] were based on the beta-spectra end points and gamma-ray energies. Recently, Peacock, Quinn, and Oser[3] have reinvestigated this decay more thoroughly and have proposed a decay scheme which is consistent with the coincidence studies of Bannerman, Lewis, and Curran.[4] The present work is concerned with the major features of this decay scheme which are shown in Fig. 1. The disintegration of La^{140} has been restudied with the help of scintillation counters and a 180° magnetic spectrometer with a view to checking the disintegration scheme and assigning spins and parities of the levels. The angular correlations between several pairs of gamma rays have been measured. The results of the angular correlation of four pairs of successive gamma rays and estimations of the K/L ratios, internal conversion coefficients, and intensity ratios for the gamma transitions are presented. Assignments of spins and parities of the first three excited states of Ce^{140} are proposed.

EXPERIMENTAL PROCEDURES

Cylindrical, canned thallium-activated NaI crystals, 1 inch×1 inch, mounted on Dumont 6292 photomultiplier tubes were used to detect the gamma radiations. Aluminum disks of one-eighth inch thickness were placed over the faces of the crystals to minimize pulses due to beta rays. Pulses from each of the detectors were fed into linear amplifiers whose outputs were analyzed in fast differential discriminators. A coincidence circuit ($2\tau=10^{-7}$ sec) was used to mix the pulses from the two channels.

Aqueous and acid solutions of lanthanam chloride were prepared by chemical extraction from an equilibrium $Ba^{140}-La^{140}$ sample obtained from the Oak Ridge National Laboratory. For the angular correlation measurements the source was contained in a thin-walled cylindrical teflon source holder and was placed 6 cm from the faces of both crystals. The crystals were provided with conical lead shields of sufficient thickness to eliminate crystal-to-crystal scattering in the gamma-ray energy range under consideration. Coincidences

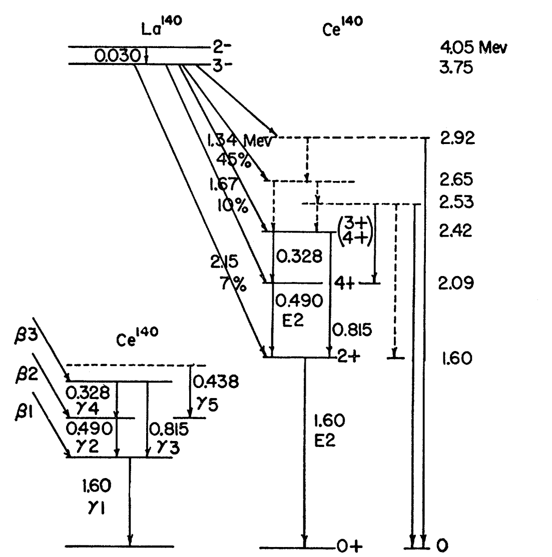

FIG. 1. Decay scheme of $La^{140}-Ce^{140}$. The relative intensities of the beta-ray groups and the energies of the gamma rays are those published by Peacock. The schematic of the decay at the lower left defines the notation used in this paper.

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1 Cork, LeBlanc, Stoddard, Martin, Branyan, and Childs, Phys. Rev. 83, 856 (1951).
2 Beach, Peacock, and Wilkinson, Phys. Rev. 76, 1624 (1949).
3 Peacock, Quinn, and Oser, Phys. Rev. 94, 372 (1954).
4 Bannerman, Lewis, and Curran, Phil. Mag. 42, 1097 (1951).

were recorded at angular intervals of 15° between 90° and 270°.

DECAY SCHEME

Although the various authors are essentially in accord as to the identification of the prominent radiations involved in the decay, the presence of a number of weaker gamma rays has lead to proposed decay schemes which are somewhat different. It seemed advisable, therefore, to check the more important features of the decay with the higher resolution scintillation equipment now available before undertaking directional correlation studies. The single crystal spectrum shown in Fig. 2 exhibits photopeaks due to the more intense gamma rays of energies 1.60, 0.815, 0.490, and 0.328 Mev (γ_1, γ_3, γ_2, and γ_4 respectively, as defined in Fig. 1). It is to be concluded that other gamma rays which have been reported in this energy region are considerably weaker, since most of the small irregularities in the singles curve can be ascribed to either Compton electrons or backscattering associated with the stronger radiations.

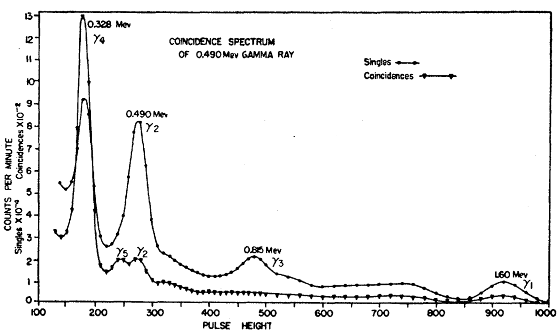

FIG. 2. Scintillation spectrum of Ce^{140} gamma rays. Circles represent the spectrum as registered by one counter. The lower curve is the coincidence spectrum obtained when the other counter is set to accept the photoelectron peak of the 0.490-Mev gamma ray.

The coincidence curve shown in Fig. 2 was obtained with one channel set to accept the full photopeak due to the 0.490-Mev gamma ray while the other channel surveyed the spectrum. The curve shown in Fig. 3 resulted when the fixed channel registered the 1.60-Mev gamma ray. These coincidence curves show that the 0.490-Mev gamma ray is coupled with the 0.328-Mev radiation. The small double coincidence peak (Fig. 2) is to be expected if a weak 0.438-Mev gamma ray (γ_5) is also in cascade with the 0.490-Mev gamma ray. Moreover, γ_1 is seen to be in coincidence with γ_2, γ_3, and γ_4. Further experiments show that γ_3 is in sequence only with the 1.60-Mev radiation. The coincidence data thus indicate that γ_1 either precedes or follows a $\gamma_2-\gamma_4$ cascade pair and its γ_3 crossover. Since a delayed coincidence experiment yielded only "prompt" coincidences, the lifetime of the intermediate level of γ_2 and γ_4 is estimated to be less than 10^{-8} sec. This configuration of the lower energy gamma rays receives strong support from the precise energy determinations of Hedgran and Lind.[5] They find that the sum of the energies of the cascade pair differs by only 0.20 kev from their measured value of 0.8151 Mev for γ_3. Finally, by using Bell's[6] absorption cross section curves for NaI, the relative intensities of the gamma rays have been estimated from the data shown in Figs. 2 and 3. These are listed in Table I.

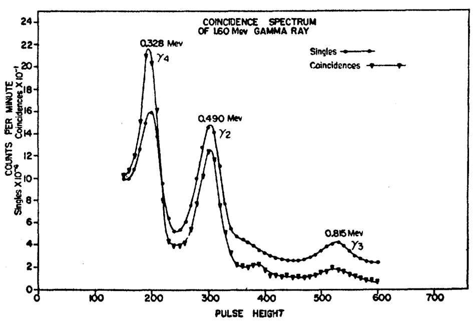

FIG. 3. Scintillation spectrum of Ce^{140} gamma rays. Triangles denote the coincidence spectrum obtained when the fixed channel was set to record the photopeak of the 1.60-Mev gamma ray.

Since accurate measurement of the energies and relative intensities of the weak high-energy gamma rays by usual spectrometer techniques is impracticable, a scintillation pair spectrometer was employed for this purpose. A similar three-crystal NaI(Tl) spectrometer has been described by Bair and Maienschein.[7] Pulses from the center crystal were analyzed with a differential pulse-height selector which was gated by pulses due to annihilation radiation from two side crystals. Figure 4 shows the spectrum obtained in this way. The three peaks, which appear at energies $2mc^2$ less than the gamma ray energies, are ascribed to radiations at 1.60, 2.50±0.05, and 3.0±0.2 Mev. The relative intensities calculated from the areas under the peaks and the pair

TABLE I. Gamma-ray intensities and internal-conversion data.

γ_i	γ_1: 1.60 Mev	γ_2: 0.49 Mev	γ_3: 0.815 Mev	γ_4: 0.328 Mev	γ_5: 0.438 Mev
Relative intensity of γ_i to γ_4: g_{i4}	2.5	1.25	1.15	1.00	0.15
Ratio of conversion of γ_i to total β disintegration: R_i	0.0008	0.0040	0.00168	0.0124	0
Total conversion coefficient: α_i	0.0008	0.00831	0.00412	0.0349	⋯
K-conversion coefficient: α_{Ki}	0.0008	0.00732	0.00412	0.0307	⋯
K/L ratio	large	7.4	large	7.4	⋯

[5] A. Hedgran and D. Lind, Arkiv. Fysik 5, 177 (1952).
[6] P. R. Bell, Oak Ridge National Laboratory (privately circulated tables).
[7] J. K. Bair and F. C. Maienschein, Rev. Sci. Instr. 22, 343 (1951).

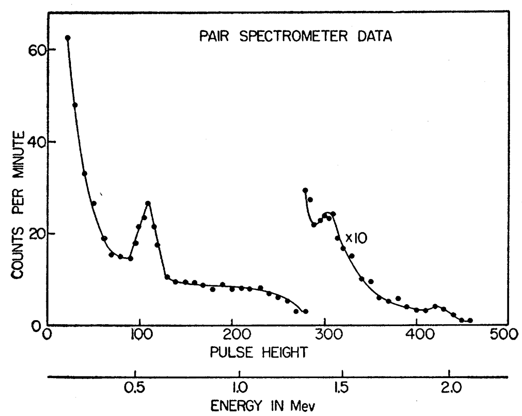

FIG. 4. Triple coincidence curve obtained with a scintillation pair spectrometer. The peaks which appear at about 0.60, 1.45, and 2.0 Mev are due to gamma rays of energies 1.60, 2.50, and 3.0 Mev. The 1.60-Mev radiation of Ce^{140} and the 2.62-Mev gamma ray of ThC′ were used for calibration.

production absorption probabilities, are 100, 1.0, and 0.04, respectively.

The beta-ray spectrum of La^{140} has been measured in a small 180° shaped field spectrometer and is in good agreement with the results of Peacock *et al.*[3] This spectrum has been resolved by Peacock into five groups having end-point energies of 2.15, 1.67, 1.34, 1.10, and 0.83 Mev. The relative intensities of these groups and the corresponding $\log ft$ values are listed in Table II. From these energy determinations it seems clear that the 0.328-Mev gamma ray precedes the 0.490-Mev transition. Also from the beta-ray energetics, the 1.60-Mev gamma ray must follow the 0.328−0.490 Mev cascade. The weak 0.438-Mev gamma ray (15 percent of the 0.328-Mev radiation) which is in coincidence with the 0.490-Mev gamma ray must precede it. It may be concluded that the decay scheme is substantially that of Fig. 1. Moreover, the relative intensities of the gamma rays to be expected on the basis of this scheme and the measured beta-ray intensities are in good accord with the scintillation results given in the first line of Table I.

The configuration 3− of the ground state of the La^{140}, indicated in Fig. 1, results from γ-γ and beta-gamma coincidence studies involving the radiations subsequent to the decay of Ba^{140}. Although many of the details of the $Ba^{140}-La^{140}$ decay are still uncertain, the position of the strong 30-kev gamma ray, as shown, seems definite.[1] This assignment is supported by coincidence experiments which show that this radiation is in sequence with all of the stronger gamma rays as well as all of the higher energy beta rays. In addition, the lifetime and the 30-kev transition cannot be long with respect to the 10^{-7} sec coincidence resolving time. Since the $(d_{5/2},f_{7/2})$ shell-model configuration of the La^{140} ground state requires negative parity, a spin of at least 3− is required to explain the absence of ground-state beta transitions for both the $Ba^{140}-La^{140}$ and $La^{140}-Ce^{140}$ decays. A higher spin than this would not be compatible with the relatively short lifetime of the 30-kev level and the $\log ft$ value of 8.0 for the beta rays to this level.

INTERNAL-CONVERSION COEFFICIENTS

Reasonable estimates of the internal-conversion coefficients of the stronger transitions $(\gamma_1, \gamma_2, \gamma_3, \gamma_4)$ can be made without detailed knowledge of the number, order, or intensities of the gamma rays which lie *above* the 2.42-Mev level. From the beta-ray spectrum the ratios R_i of the total number of conversion electrons of the particular gamma transitions γ_i to the total number of beta disintegrations have been measured (Table I). Reference to Fig. 1 shows that if the very weak 0.938, 2.5, and 3.0 Mev transitions are neglected, the *total* internal conversion coefficients of the respective gamma rays can be obtained by equating the number of conversion electrons and gamma rays arising from a given level to the number of beta rays that lead directly or indirectly to this level. These may be written as follows:

$$\alpha_1=R_1/(1-R_1),$$
$$\alpha_2=R_2(1+g_{32})/(1-f_2-R_3-R_2),$$
$$\alpha_3=R_3(1+g_{43}+g_{53})/(1-f_3-R_3-R_4),$$
$$\alpha_4=R_4(1+g_{34}+g_{54})/(1-f_4-R_3-R_4).$$

In these expressions, g_{ij} refers to the ratio of the gamma-ray intensity of γ_i to γ_j, and f_i denotes the fraction of the total beta-ray transitions which lead to levels which lie below that from which γ_i originates. From Fig. 1, it is seen that $f_2=0.07$ and $f_3=f_4=0.17$. The total internal conversion coefficients which result are listed in Table I. A check on the values of α_i may be obtained by noting that

$$\alpha_j=g_{ij}\alpha_i R_j/R_i.$$

Thus, in terms of α_4 as obtained above, the values of α_1 and α_2 agree within 10 percent of the values given in Table I.

Estimates of the K/L ratios for γ_2 and γ_4 have been made from the beta-ray spectrum. No conversion other than K conversion can be seen for γ_1 and γ_3. These values together with the corresponding values of α_K are also given in Table I.

ANGULAR CORRELATIONS

On the basis of the foregoing decay scheme, angular correlation measurements of the $\gamma_1-\gamma_3$, $\gamma_1-\gamma_2$, $\gamma_1-\gamma_4$

TABLE II. Beta-ray groups of La^{140}.

β group	$\beta 1$	$\beta 2$	$\beta 3$
Energy	2.15 Mev	1.67 Mev	1.34 Mev
Relative intensity	7%	10%	45%
Log ft	9.03	8.67	7.66

and $\gamma_2-\gamma_4$ cascades were undertaken. (The notation, as before, is described in Fig. 1.) Reference to Fig. 2 shows that the gamma rays in question are well resolved and that reliable results should be possible with the use of energy discrimination. In each correlation, singles were taken in both channels before and after the coincidence measurements to ascertain chance coincidence rates and to monitor drift in the equipment. A number of runs were taken for each correlation and a weighted average obtained after correction for decay, chance coincidences, and source asymmetry. The methods of analysis were essentially those described by Rose,[8] Klema and McGowan.[9] From the data, a least-squares fit was made of the function

$$W(\theta)=a+bP_2(\cos\theta)+cP_4(\cos\theta).$$

Finite size of the detectors necessitated correction for solid angle. These were made following the method outlined by Rose.[8]

0.815 − 1.60 Mev Correlation

The correlation between $\gamma_1-\gamma_3$ was measured with both channels set to accept the energy interval which included the γ_3 photopeak and the γ_1 photopeak. As can be seen in Fig. 2, this setting increased the coincidence efficiency without including any significant portion of the scintillation spectrum due to any other gamma rays. The analysis of the data resulted in the following function:

$$W(\theta)=1+0.0367P_2-0.025P_4,$$
$$[W(180°)-W(90°)]/W(90°)=+0.037\pm0.004.$$

1.60 − 0.490 Mev Correlation

The $\gamma_1-\gamma_2$ angular correlation was measured with one channel set to accept the γ_1 photopeak and a portion

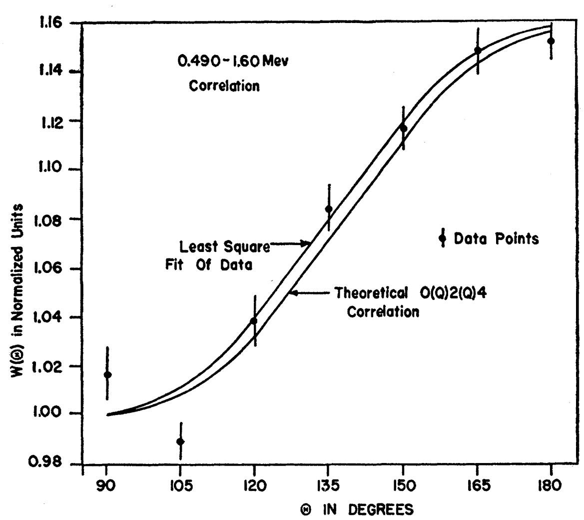

FIG. 5. Directional correlation of the 0.490- and 1.60-Mev radiations.

[8] M. E. Rose, Phys. Rev. **91**, 610 (1953).
[9] E. D. Klema and F. K. McGowan, Phys. Rev. **91**, 616 (1953).

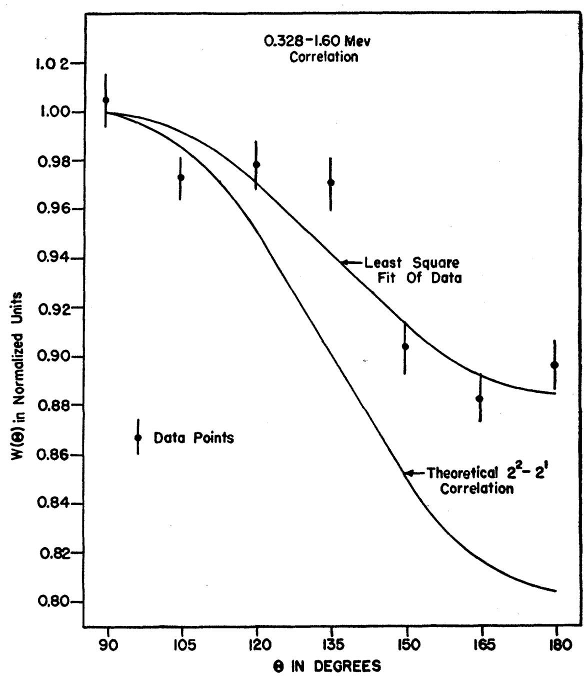

FIG. 6. Directional correlation of the 0.328- and 1.60-Mev radiations. A similar function was obtained for the angular correlation between 0.328- and the 0.490-Mev gamma rays.

of its Compton distribution, with the second channel accepting the higher side of the photopeak of γ_2. The latter setting was adopted to eliminate the effects of the weak 0.438-Mev gamma ray which was also in coincidence with γ_1. Allowance was made for the coincidences between the 1.60-Mev gamma ray and the Compton distribution of γ_3 lying under the γ_2 photopeak. The fractional number of such background coincidences was determined by extrapolation from the coincidence curve of Fig. 2 and subtracted from the data. The correction obtained in this way should be valid since the correlation described in the previous section is almost isotropic. The resulting correlation function for the $\gamma_1-\gamma_2$ cascade is

$$W(\theta)=1+0.106P_2-0.013P_4.$$

From the plot of this function shown in Fig. 5, it may be seen that the anisotropy is 0.167 ± 0.004.

0.328 − 1.60 Mev Correlation

With the channel width of one discriminator adjusted symmetrically over the photopeak of γ_4 and the other set to accept the photopeak of γ_1, as well as a portion of its Compton distribution, the angular correlation of this cascade was found to be of the form

$$W(\theta)=1-0.081P_2.$$

A plot of this function is shown in Fig. 6.

Measurements involving this cascade are not as clear-cut as the preceding ones, since the background

TABLE III. Experimental values of the coefficients of the directional correlation function $W(\vartheta)=1+A_2P_2(\cos\vartheta)+A_4P_4(\cos\vartheta)$.

Correlation (Mev)	A_2	A_4
0.815–1.60	0.00367±0.0054	−0.025±0.020
0.490–1.60	0.106±0.024	−0.0013±0.0019
0.328–1.60	−0.081±0.03	...
0.328–0.490	−0.092±0.020	...

coincidences arise from three sources. Reference to Fig. 2 shows that spurious coincidences result from Compton-scattered gamma rays of γ_3, γ_2, and γ_5 which lie under the γ_4 photopeak. A correction has been applied for the first of these effects in the manner described in the discussion of the 1.60−0.490 Mev correlation. It was not possible to correct for the coincidence background due to γ_2 and the weak γ_5 since the "Compton peaks" of γ_5 and γ_2 lie beneath the γ_4 photopeak. Such a correction would be further complicated by the fact that coincidences between the Compton scattered γ_2 and the 1.60-Mev gamma ray are angle-dependent. In spite of this difficulty, the sign and lower limit to the magnitude of the anisotropy which result from this experiment are thought to be reliable. Any further corrections, if they could be applied, would tend to make the measured anisotropy even more negative since the greatest contribution to the correction would come from the positive angle dependence of the $\gamma_1-\gamma_2$ coincidences.

Since a considerable number of Compton-scattered gamma rays accompanied these measurements, it might be argued that crystal-to-crystal scattering which would predominate at the 90° setting could account for the negative anisotropy. To check on this effect, a series of measurements of the well-known angular correlation of Co^{60} were made in such a way as to simulate the Compton scattering conditions which prevailed in the Ce^{140} experiment. The gamma rays of Co^{60} have energies which are in the range of the 1.60- and 0.815-Mev radiations of Ce^{140} and thus give rise to a scintillation Compton distribution which is similar to that of γ_1 and γ_3. With the differential discriminator set to accept only Compton-scattered gamma rays of Co^{60} in the 0.3–0.15 Mev region, i.e., in the range of γ_2, γ_4, and γ_5, the well established 0–2–4 correlation was obtained. It is believed, therefore, that crystal-to-crystal scattering was not present in any of the Ce^{140} experiments.

0.328−0.490 Mev Correlation

In measuring the $\gamma_2-\gamma_4$ correlation, the first and second discriminators were set on the photopeaks of the 0.328- and 0.490-Mev gamma rays, respectively. After analysis, the following correlation function was obtained:

$$W(\theta)=1-0.092P_2.$$

The same perturbations which were present in the preceding correlation are present in this case as well. Again, corrections for these effects tend to make the correlation function more negative. There is in addition, the effect of the presence of γ_1 comptons under γ_2 which together with γ_4 are rise to a negative correlation. Although correction for this effect would attenuate the observed negative anisotropy, it is felt that this perturbation is much smaller than those due to the other background contributions. As in the previous case, the experiment therefore yields the proper sign and lower limit to the magnitude of the correlation.

Table III summarizes the results of all of the directional correlation experiments. The errors indicated are statistical and do not take account of possible systematic or instrumental effects.

DISCUSSION

The experimental value of the angular correlation between the 1.60- and 0.490-Mev gamma rays is seen from Fig. 5 to agree with the theoretical 0–2–4 distribution to be expected for the first and second excited states of even-even nuclei. The estimates of α_K and the K/L ratio listed in Table IV support the $E2$ assignment for both gamma rays. Furthermore, the logft values (Table II) of the two beta groups leading to these levels from the decay of La^{140} are both in the first forbidden range, in accordance with these assignments and the spin and parity of the La^{140} ground state. The characterization of these radiations as listed in the last row of Table IV appears quite certain.

The 0.815−1.60 Mev correlation measurement is expected to be the most reliable since no correction for extraneous coincidences was necessary. The very small positive anisotropy cannot be interpreted as an attenuation of the correlation due to external field effects, since the $\gamma_1-\gamma_2$ correlation which involves the same intermediate state does not exhibit such "washing out." Therefore, the correlation cannot lead to a 0–2–4 sequence as Robinson and Madansky[10] have suggested. In fact, no theoretical correlation involving two pure multipole transitions results in such a small anisotropy. Since the 1.60-Mev gamma ray has been shown to be a pure $E2$ transition, the correlation can be interpreted if a mixed multipole assignment of the 0.815-Mev

TABLE IV. Summary of results.

	1.60 Mev	0.815 Mev	0.490 Mev	0.328 Mev
Spin change as obtained from angular correlation	2	2 or 1	2	0 or 1
α_K(exp.)	0.0008	0.0041	0.0073	0.031
α_K(theor.)	0.0007 ($E2$)	0.0028 ($E2$) 0.0044 ($M1$) 0.025 ($M3$)	0.010 ($E2$)	0.031 ($E2$) 0.044 ($M1$)
K/L(exp.)	high	high	7.4	7.4
K/L(emp.)	∼10 ($E2$)	∼8 ($M1$ or $E2$)	7.5 ($E2$)	8 ($M1$) 5 ($E2$)
Assignment	$E2$	$M1+E2$	$E2$	$M1$ or $M1+E2$

[10] B. L. Robinson and L. Madansky, Phys. Rev. 84, 1067 (1951).

transition is assumed. A mixing ratio of 1.8–3 percent for $E2/M1$ or 36 percent for $M3/E2$ fits the measured distribution according to assignments of 3+ or 4+, respectively, for the 2.42-Mev level.[11] Of the two possibilities, the estimated α_K listed in Table IV seems to favor the $E2-M1$ mixture. No assignment other than 3+ or 4+ is consistent with the experimental evidence. Assignment of 3+ or 4+ is in fair agreement with the $\log ft$ values of $\beta 3$ given in Table II.

The two angular correlations involving the 0.328−1.60 and the 0.328−0.490 Mev gamma-ray pairs, although subject to uncertainty in magnitude, serve to corroborate the foreoing interpretation. The theoretical anisotropies to be expected for these correlations, when the spins of the levels are successively 0–2–4–3, are *negative* for both and are both given by[11]

$$W(\theta)=1-0.140P_2.$$

For the case 0–2–4–4, *positive* anisotropies are expected with the following correlation applying to both pairs:

$$W(\theta)=1+0.197P_2.$$

[11] L. C. Biedenharn and M. E. Rose, Revs. Modern Phys. **25**, 729 (1953).

In the first case (0–2–4–3), an assignment of $M1$ or $E2+M1$ for the 0.328-Mev transition is possible from the experimental correlation. In the second case (0–2–4–4), the negative experimental anisotropies can only be obtained if this transition is of a mixed $E2-M1$ character. Rose's[12] theoretical K conversion coefficients for the $E2$ and $M1$ cases (Table IV) are too close in value for the estimated value of α_K to distinguish between the two possibilities. The K/L ratio would seem to favor the $M1$ assignment and the corresponding spin of 3+ for the 2.42-Mev level. It may be further mentioned that the measured intensities of the gamma rays originating from this level are in keeping with either a 3+ or 4+ configuration. Although the possibility of 4+ is not eliminated by these experiments, the configuration 3+ seems more in keeping with all of the data of Table IV.

ACKNOWLEDGMENTS

The authors wish to thank Dr. Milo B. Sampson and the cyclotron group for several bombardments during the initial stages of this work.

[12] Rose, Goertzel, Spinrad, Harr, and Strong, Phys. Rev. **83**, 79 (1951).

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Supermultiplets and Spin Dependent Forces*

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A tentative explanation for a group of favored negatron transitions from nuclei with $N-Z=3$ is proposed on the basis of a deviation from the supermultiplet formalism due to spin-dependent forces. The experimental evidence is exhibited and discussed.

1. INTRODUCTION

THE supermultiplet formalism[1–4] provides, thus far, the most natural theoretical explanation of the striking empirical difference between favored and unfavored allowed β transitions. The empirical fact that the unfavored decays have transition matrix elements (squared) that are, on the average, about a hundred times smaller than those of the favored decays is in qualitative accord with the supermultiplet formalism insofar as it predicts that the only nonvanishing matrix elements are for transitions between states in the same supermultiplet.

Exceptions to the theory can be put into two classes. First, there exist some transitions, such as $P^{30}\rightarrow Si^{30}$, that should, according to the theory, be favored but the empirical evidence indicates that they are not. Second, there exists a small class of β transitions that should be unfavored and yet show remarkably low comparative half-lives. In particular, the supermultiplet formalism in the approximation of spin independence for nuclear forces does not permit superallowed *negatron* decay for odd-A nuclei with $A>3$. There is considerable experimental evidence from the decay of nuclei with $T_z=\frac{3}{2}$ to excited states of nuclei with $T_z=\frac{1}{2}$ that is contrary to such a restriction. It is the purpose of this note to exhibit this evidence and to propose an explanation. The point of view adopted is that the spin dependence of nuclear forces is the most likely reason for a breakdown of the usual restrictions of the supermultiplet formalism. It is shown that the experimental observations of fast negatron decay to excited states of stable odd-A nuclei with $A\lesssim 25$ can be qualitatively

* Supported by the U. S. Atomic Energy Commission.
[1] E. P. Wigner, Phys. Rev. **51**, 106 (1937).
[2] E. P. Wigner, Phys. Rev. **51**, 947 (1937).
[3] F. Hund, Z. Physik **105**, 202 (1937).
[4] E. P. Wigner, Phys. Rev. **56**, 519 (1939).