unaffected by a previous loss of electrons is perhaps less well founded. Our attempts at an analysis of this kind failed because the shake-off probabilities cannot be sufficiently precisely determined in the present work; if an independent shake-off spectrum can be accurately measured in the future, the analysis might be worth attempting anew.

The best explanation for the dip at charges 12, 13, and 14 in both Xe^{133}-Cs^{133} and Xe^{131m}-Xe^{131} would seem to be that it is an indication of structure such as one would expect to be associated with the individual electron shells in which the vacancy cascades are initiated, and that the main strength of the spectrum at the high-charge end derives from initial vacancies which have appeared in the K shell. This K-shell distribution then merges into a weaker mixture of different distributions, mostly at lower charge states, which derive from vacancy cascades which have started from other shells. This kind of structure would be illuminated by an experiment in which the charged ions are extracted from xenon gas under irradiation with x-rays, the energy of the x-rays being adjusted first at one side and then at the other side of an absorption edge. We understand that experiments of this kind are being contemplated in one or two other laboratories, and we shall await their outcome with interest.

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Disintegration of La^{135} and Confirmatory Experiments on Nd^{147}†

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The disintegrations of La^{135}, Ba^{135m}, and Nd^{147} have been studied with the help of magnetic spectrometers and scintillation counters. La^{135} decays almost entirely by electron capture. The half-life has been found to be 19.8±0.2 hr. Electron capture to the ground state takes place in 95–97% of all disintegrations. Gamma-rays of energies 104, 218, 265, 295, 367, 481, 588, 642, 862 kev have been found. There is a very weak positron spectrum. The internal-conversion coefficient of the line at 481 kev has been measured. The value $\alpha_K=0.0130$ indicates an $M1$ transition. The line at 862 kev has $\alpha_K=2.5\times10^{-3}$. The disintegration scheme is discussed. The internal-conversion coefficient of the line at 265 kev from Ba^{135m} has been found to be $\alpha_K=3.82\pm0.2$. The spectrum of Nd^{147} has been reinvestigated, confirming the scheme of Hans, Saraf, and Mandeville. The internal-conversion coefficient for the line at 92 kev has been found to be 1.52±0.05.

I. DISINTEGRATION OF LANTHANUM-135

1. Introduction

The disintegration of La^{135} has been studied by various authors over the last fifteen years, but the information on the disintegration scheme has, so far, been quite incomplete. Weimer, Pool, and Kurbatov[1] irradiated barium with deuterons and found a substance in the lanthanum fraction having a half-life of 17.5 hr, decaying predominantly by electron capture and having a gamma ray, measured by absorption, whose energy was 880 kev. Chubbuck and Perlman[2] investigated the lanthanum fraction produced from the alpha-particle bombardment of cesium and found an activity decaying by electron capture with a half-life of 19.5 hr which they ascribed to La^{135}. Wapstra[3] prepared La^{135} by deuteron bombardment of barium and measured two gamma rays, using scintillation counter techniques, having energies of 485 and 660 kev, whose intensity ratio was 6:1. In addition, barium x-rays were found, which were about fifty times as strong as the gamma rays, indicating that approximately 98% of the disintegrations occurred by electron capture to the ground state of Ba^{135}. No indication of a gamma ray of energy 269 kev was found, indicating that the 29-hr metastable state[4,5] of Ba^{135} is not excited in the decay of La^{135}. Wapstra interpreted this to mean that the ground state of La^{135} probably has the configuration $d_{5/2}$ rather than $g_{7/2}$. Finally, Fagg[6] has found a state at 218 kev arising as a result of the Coulomb excitation of separated Ba^{135} by alpha particles.

The present work was undertaken to make a more detailed study of the radiations from La^{135} with the help of a magnetic spectrometer and scintillation counters. In addition, the radiations from the 29-hr Ba^{135} were reinvestigated.

2. Source Preparation

Electromagnetically separated Ba^{134} (50.8%), in the form of $BaCO_3$, was bombarded by deuterons in the Indiana University Cyclotron. Iron carrier was added as a gathering agent for lanthanum, and the trivalent hydroxides were precipitated with ammonia leaving the

† Supported by the joint program of the Office of Naval Research and the U. S. Atomic Energy Commission.

1 Weimer, Pool, and Kurbatov, Phys. Rev. **63**, 67 (1943).
2 J. B. Chubbuck and I. Perlman, Phys. Rev. **74**, 982 (1948).
3 A. H. Wapstra, Physica **19**, 671 (1953).
4 R. D. Hill and F. R. Metzger, Phys. Rev. **83**, 455 (1951).
5 W. H. Cuffey and R. Canada, Phys. Rev. **83**, 654 (1951).
6 L. W. Fagg, Phys. Rev. **109**, 100 (1958).

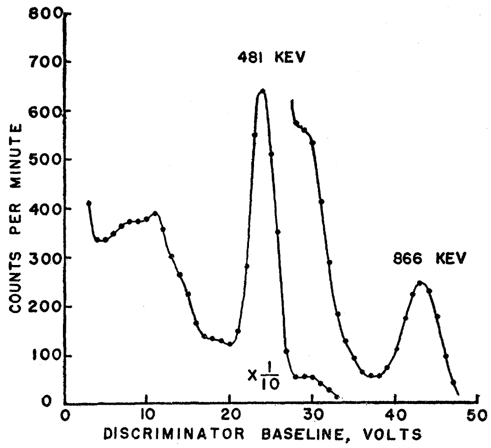

FIG. 1. Gamma-ray spectrum of La^{135} observed with a scintillation spectrometer.

barium in solution. The hydroxides were redissolved and precipitated a second time to remove any occluded barium salts. The lanthanum was separated carrier free from the iron by dissolving the hydroxides in hydrochloric acid and passing the solution through a Dowex-50 ion exchange column and washing with HCl at suitable acid concentrations. This process was, likewise, repeated twice.

The barium, on which certain experiments were performed, was precipitated as carbonate from the ammoniacal solution.

The sources of either lanthanum or barium were laid down as chlorides on a thin Zapon backing and measured either with a scintillation spectrometer or a magnetic lens spectrometer.

3. Measurements on La^{135}

The half-life of La^{135} was measured on several sources and was found to be 19.8 ± 0.2 hr.

The gamma-ray spectrum was measured with the help of a NaI(Tl) scintillation spectrometer using either a 100-channel analyzer or a single-channel analyzer for measurement. It was apparent at once that barium x-rays, emitted by the source, were exceedingly strong compared to any gamma-ray emission. A typical spectrum is shown in Figs. 1 and 2. Lines will be seen at 862, 588, and 481 kev. There are also lower energy lines, resolved in coincidence and also seen as internal-conversion lines in a magnetic lens spectrometer (see below), but these are obscured in the Compton background.

The strongest line is that at 481 kev. The intensity of this line was compared to that of the x-rays. This was accomplished by measuring the area under the photopeak of the 481-kev line and that under the x-ray, using a set of "peak to total" curves for various gamma-ray energies taken with the same geometry and crystal, and using the efficiency curves of Wolicki, Jastrow, and Brooks.[7] Corrections were also made for absorption of the x-rays in the aluminum housing of the crystal. The intensity of the 481-kev gamma ray is approximately 2.6% of the intensity of the x-rays. It follows that the main mode of decay of the La^{135} is by electron capture to the ground state, in agreement with the earlier work.[2,3] The relative intensities of the lines at 481, 588, and 862 kev, measured in the same manner, stand in the ratio 1.00:0.11:0.17 within an estimated error of approximately 10%. Thus, electron capture to the ground state takes place in 95–97% of all disintegrations.

The particle spectrum of La^{135} was measured in a magnetic lens spectrometer using a carrier-free source and is shown in Fig. 3. The spectrometer contained no spiral baffle to separate positrons from electrons. It is immediately evident from Fig. 3 that positrons, if

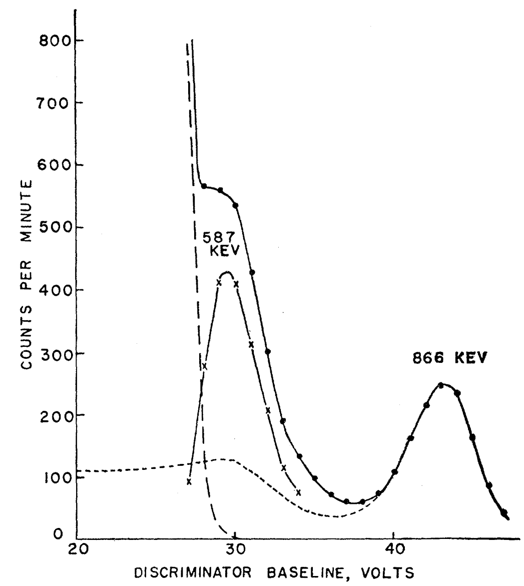

FIG. 2. Scintillation spectrum of La^{135} showing detail of line at 587 kev.

present, are of very low abundance. In order to make a further search for positrons, a source was investigated with the help of a 180°-type magnetic spectrometer. An extremely weak positron distribution was indeed found, but it was so weak that it was impossible to make a Fermi plot or determine the end point.

The energies of the gamma rays associated with the several internal-conversion lines are given in Table I. The line marked 2*a* comes at the energy to be expected for the line at 265 kev from Ba^{135m}. This line is very weak and may arise in part from an imperfect separation of lanthanum from barium. Its relative intensity was much less when the chemical separation was carried through twice rather than only once. Nevertheless, the

[7] Wolicki, Jastrow, and Brooks, Naval Research Laboratory Report NRL-4833, 1956 (unpublished).

line is always present, and it is felt that it probably arises from a transition from the level at 481 kev to that at 218 kev. The line at 218 kev is, presumably, the same as that observed by Fagg at 218 kev arising from Coulomb excitation. Figure 4 shows an N/I *vs* I plot of the line at 481 kev. The ratio of $K/(L+M)$ for this line, determined from several experiments, was found to be 7.2.

In order to obtain more information on the nature of the disintegration scheme, gamma-gamma coincidence measurements were made using two scintillation counters. One photomultiplier assembly was fed to a single-channel analyzer and could be set on any desired region of the spectrum. The other was fed to a 20-channel pulse-height analyzer. A fast-slow coincidence set was used to open a gate on the 20-channel pulse-height analyzer. Thus, if the single-channel pulse-height analyzer were set on some particular line, the 20-channel analyzer displayed pulses arising from all gamma rays in coincidence with the gamma ray in question.

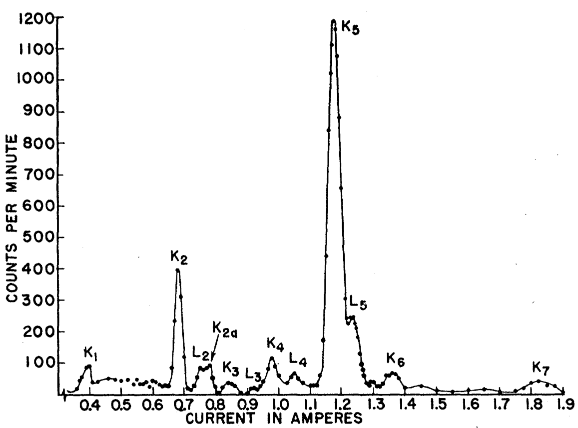

FIG. 3. Internal-conversion lines of La^{135}.

In one experiment, the single-channel analyzer was set at the position of the 218-kev line, and the 20-channel analyzer was set to display all lines whose energies lay between 200 and 800 kev. In this case, strong coincidences were obtained at 642, 360, and 220 kev. Thus, a new line was discovered at 642 kev, for which a place exists on the disintegration scheme. On the other hand, with the single-channel analyzer set on the line at 367 kev, strong coincidences are obtained with the line at 218 kev. From these experiments, it is seen that the line at 218 kev is in coincidence with a line at 642 kev and one at 360–370 kev. The line at 218–220 kev, which appears when the single-channel analyzer is set at the 218-kev position, can be accounted for by assuming that it arises from coincidences between Compton electrons from higher-energy lines, detected in the single-channel analyzer, and the 218-kev line.

Using the measured energies of the gamma rays, the disintegration scheme shown in Fig. 5 was constructed. Coincidences between the stronger lines, *viz.* the 642–218 kev and the 367–218 kev, have been verified by experiment. The weak line at 263 kev, shown dotted in the diagram, is assumed to arise from a transition between the 481-kev and 218-kev states. The very weak line at 104 kev is likewise assumed to be a transition between the 588-kev and the 481-kev states. A very weak positron emission has been measured but its end-point energy has not been determined. It is assumed that it takes place to the ground state of Ba^{135}. The total disintegration energy of La^{135} is predicted to be 1.3 Mev from the curves of Way and Wood[8] which would leave an energy of 300 kev available for positrons to the ground state, and this was roughly what was found.

TABLE I. Energies of gamma rays determined from internal-conversion lines.

Line No.	Energy of gamma ray (kev)	Line No.	Energy of gamma ray (kev)
1	104	4	367
2	218	5	481
2*a*	265	6	588
3	295	7	862

The internal-conversion coefficient of the line at 481 kev was measured by a comparison method in the following manner. The internal-conversion electrons for the 481-kev line were measured either in the magnetic lens spectrometer or in the 180° spectrometer. The number of K internal-conversion electrons for the 481-kev line was thereby determined. A source of Cs^{137} was then placed in the same instrument and the number of K internal-conversion electrons for the 661-kev gamma

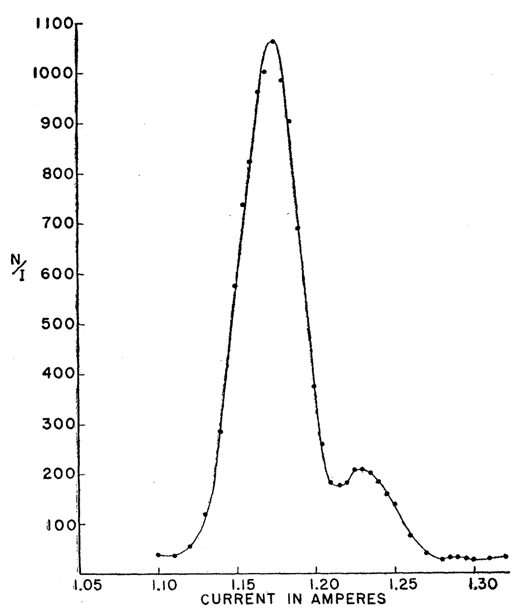

FIG. 4. The internal-conversion line of the 481-kev gamma ray.

[8] K. Way and M. Wood, Phys. Rev. 94, 119 (1954).

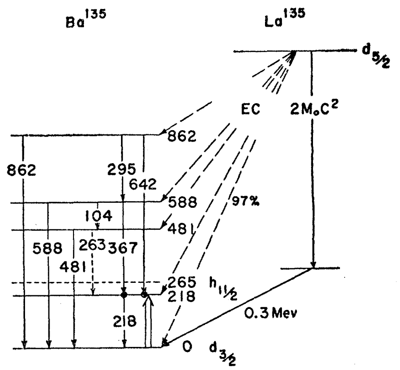

FIG. 5. Disintegration scheme of La^{135}.

ray were determined from this source. The intensities of the 661-kev gamma ray from Cs^{137} and the 481-kev gamma ray from La^{135} were then measured in a standard position with a calibrated scintillation spectrometer. In the case of the 481-kev line of La^{135}, corrections were applied for the contributions from higher energy lines, for the overlap of the 588-kev line with the 481-kev line, and for the decay of the source. One therefore determines $(\alpha_K{}^{481}/\alpha_K{}^{Cs})$ from the relation

$$(\alpha_K{}^{481}/\alpha_K{}^{Cs}) = (N_e{}^{481}/N_e{}^{Cs}) \times (N_\gamma{}^{Cs}/N_\gamma{}^{481}).$$

The result, using two different cesium sources, was $\alpha_K{}^{481}/\alpha_K{}^{Cs} = 0.136 \pm 0.004$. Using the theoretical value of Sliv and Band[9] for α_K for cesium of 0.096, the value of $\alpha_K{}^{481}$ is found to be 0.0130. This agrees with the Sliv and Band value for an $M1$ transition of 481 kev and barium ($Z=56$), the product nucleus. Their calculated value is 0.0130. From this measurement, it is to be inferred that the 481-kev transition is an $M1$ transition with very little mixing of $E2$. The $K/(L+M)$ ratio of 7.2 is also in agreement with this conclusion. The total conversion coefficient of the line at 862 kev was determined by comparing the area under the (unresolved) conversion line with the area under the K-conversion line for the gamma ray at 481 kev. Using these values, the relative intensities of the 862-kev and 481-kev lines given above, and the value of α_K for the 481-kev line determined by these experiments, a value of $\alpha_{tot} = 2.8 \times 10^{-3}$ was obtained for the 862-kev line. In this region, the coefficients for $M1$ and $E2$ transitions lie close together. Correcting for the K/L ratio, using the tables of Rose[10] corrected for finite size of the nucleus, one obtains $\alpha_K{}^{862} = 2.5 \times 10^{-3}$. The theoretical values are $\alpha_2 = 2.25 \times 10^{-3}$, $\beta_1 = 3.0 \times 10^{-3}$. It is not felt that these measurements are good enough to distinguish between the two, but there is a slight preference toward $E2$.

From the information obtained in these experiments, it is possible to draw some conclusions concerning the spins and parities of some of the levels of Ba^{135} and the ground state of La^{135}. Table II summarizes the values of the decay energy, energy of the positrons (if any), branching ratio (relative probability of reaching a given state), logft, and f_K/f_+ for the ground, 481-kev and 862-kev states, respectively. In the one case (transition to the ground state) in which positron emission is possible, $f = f_K + f_+$; otherwise $f = f_K$.

The ground state of $_{56}Ba_{77}{}^{135}$ is known to have a spin of $\frac{3}{2}$ and corresponds to the configuration $(d_{3/2}{}^3)_{3/2}$. The magnetic moment is $+0.832293$ nm.[11] The value of logft for the transition from La^{135} to the ground state of Ba^{135} is 5.7. The configuration of the ground state of La^{135}, therefore, cannot be $g_{7/2}$, since such a configuration would require a logft of $\sim$13. Since the $g_{7/2}$ and $d_{5/2}$ levels have approximately the same energy in this region but, according to Nilsson,[12] the $d_{5/2}$ level lies lower, the configuration $d_{5/2}$ is ascribed to the ground state of La^{135}. This is in agreement with the measured value of logft and also accounts for the absence of transitions to the $h_{11/2}$ state, as has been found in these experiments.

The level order in Ba^{135}, according to Nilsson, should be $(d_{3/2}{}^3)_{3/2}$, $(d_{3/2}{}^2)_0 s_{1/2}$, $(d_{3/2}{}^2)_0 h_{11/2}$. These would correspond to the ground state and first two excited states, respectively. The state at 218 kev has been found by Fagg in Coulomb excitation and he attributes to it the character $\frac{1}{2}+$. This corresponds, of course, to the configuration $(d_{3/2}{}^2)_0 s_{1/2}$. The state at 265 kev has the configuration $(d_{3/2}{}^2)_0 h_{11/2}$.

The configurations of the higher states—481 kev, 588 kev, and 862 kev—are more difficult to predict from theory owing to configuration mixing or collective effects. The shell model predicts[13] states of even parity and spins from $\frac{1}{2}$ to $\frac{7}{2}$ for states starting around 0.5 Mev. These experiments give values for logft for transitions to, and internal-conversion coefficients for transitions from, the states at 481 kev and 862 kev. For the state at 481 kev, the logft value is 7.1 which implies that the transition is l-forbidden or that it is slowed up owing to configuration mixing. The value of the internal-conversion coefficient shows that the 481-kev transition to the ground state is of an $M1$ character. These con-

TABLE II. Characteristics of the decay of La^{135}.

	Decay energy Mev	Positron energy Mev	Branching ratio	Logft	f_K/f_+
Ground state	1.3	$\sim$0.3	97%	5.7	$\sim$1000
481-kev state	0.82	···	3%	7.1	···
862-kev state	0.44	···	0.3%	7.4	···

[9] L. A. Sliv and I. M. Band, Leningrad Physics-Technical Institute Report, 1956 [translation: Report 57 ICCK 1, issued by Physics Department, University of Illinois, Urbana, Illinois (unpublished)].

[10] M. E. Rose, "Internal-Conversion Coefficients," No. 14 Oak Ridge National Laboratory (privately circulated).

[11] H. E. Walchli and T. J. Rowland, Phys. Rev. **102**, 1334 (1956).

[12] S. G. Nilsson, Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd. **29**, No. 16 (1955).

[13] The authors are indebted to Professor K. W. Ford for these suggestions.

siderations would suggest that the character of the 481-kev state is $\frac{1}{2}+$ or $\frac{3}{2}+$. For the state at 862 kev, the internal-conversion coefficient of the 862-kev gamma ray is consistent with an $E2$ transition. This would imply that the character of this state is $\frac{7}{2}+$, which would also be consistent with the value of logft if the transition is assumed to be l-forbidden.

II. EXPERIMENTS ON Ba^{135m}

Since these experiments also produced Ba^{135m} from the $Ba^{134}(d,p)Ba^{135m}$ reaction, the barium fraction was used to investigate the internal-conversion coefficient of the 265-kev line from Ba^{135m}. As in the case of the lanthanum, the internal-conversion electrons from Ba^{135m} were measured in the magnetic lens spectrometer as were also the conversion electrons from a source of Cs^{137}. Both sources were then measured with a calibrated scintillation spectrometer. From those measurements, the value $\alpha_K^{Ba}/\alpha_K^{Cs}=39.8\pm2.0$. As before, using $\alpha_K^{Cs}=0.096$, one obtains $\alpha_K^{Ba}=3.82\pm0.2$ for the internal-conversion coefficient of the 265-kev line of Ba^{135}. This line is known to have an $M4$ character. The value of the internal-conversion coefficient for the line (β_4) given by Sliv and Band is 4.0 which agrees with the experiment within the errors.

III. EXPERIMENTS ON Nd^{147}

Experiments were commenced on Nd^{147} since there existed a discrepancy between the results of Rutledge, Cork, and Burson[14] on the one hand and Hans, Saraf, and Mandeville[15] on the other. The former authors published a very complicated scheme, based mostly on the energies of internal-conversion lines observed with the help of a permanent-field photographic spectrograph, while the latter published a much simpler scheme based mostly on the measurement of gamma rays with the help of a scintillation spectrometer and coincidence counting. While this experiment was in progress, Lindqvist and Karlsson[16] verified certain features of the scheme proposed by Hans, Saraf, and Mandeville and, in addition, Cork, Brice, Helmer, and Woods[17] repeated the experiments of Rutledge *et al.*, finding many fewer internal-conversion lines. The present experiments essentially confirm the findings of Hans *et al.* and will be reported briefly, mostly in the form of tables.

Sources of Nd^{147} were obtained from the Oak Ridge National Laboratory. The sources, which were carrier free and appeared to be free from impurities except for the Pm^{147} daughter, were passed through an ion exchange column as a further precaution. The beta-ray spectrum and the internal-conversion line at 91 kev were measured with the help of a magnetic lens spectrometer. The low-energy internal-conversion lines were measured in a permanent-field photographic recording magnetic spectrometer. Gamma rays were also measured with the help of a scintillation spectrometer. In addition, gamma-gamma coincidences were measured by setting on a given line with a single-channel analyzer and displaying those lines in coincidence with the gamma ray on a 20-channel pulse-height analyzer.

The low-energy internal-conversion lines seen with the permanent-field spectrograph are given in Table III. Lines corresponding to a gamma ray of 198.2 kev were not found. The instrument used in this investigation could not measure the internal-conversion lines of higher energy. The higher energy gamma rays observed by all three groups of investigators are essentially in agreement, as shown in Table IV. The gamma-gamma coincidence experiments, reported by Hans *et al.*, were repeated by the present writers. No curves are given since the results, also shown in Table IV, are in agreement with Hans *et al.*

The beta-ray spectrum was measured in a magnetic

TABLE III. Low-energy conversion lines from Nd^{147}.

Electron energy (kev)	Line designation	Energy sum (kev)
31.63	Auger $-L_I$	
32.11	Auger $-M$	
46.05	K^1	91.25
74.00	K^2	119.2
83.74	$L_I{}^1$	91.17
84.05	$L_{II}{}^1$	91.07
84.70	$L_{III}{}^1$	91.16
85.29	Weak, not Nd^{147}	...
89.53	$M_I{}^1$	91.18
90.84	N^1	91.18
113.26	$L_I{}^2$	120.64
114.22	$L_{II}{}^2$	121.08
117.34	$M_I{}^2$	118.99

TABLE IV. Gamma-rays of Pm^{147} (from Nd^{147}). Energies in kev.

Observed gamma rays: CBHW[a]	HSM[b]	This work: Internal conversion	This work: Crystal	This work: Coincidence
91.3	92	91.2	92	92
120.6	120	119.2		110
198.2	...		...	...
277.0	280		272	
321	320		312	310
400	410		396	420
441	440		440	
533	530		525	
597	600		...	595
688	690		684	

Gamma-gamma coincidences: HSM[b]	This work
320 (92, 120, 280)	320 (92, 120, 280)
92 (120, 280, 320, 440, 600)	92 (120, 320, 420, 595)
280 (410)	280 (320, 420)

[a] See reference 17.
[b] See reference 15.

[14] Rutledge, Cork, and Burson, Phys. Rev. **86**, 775 (1952).
[15] Hans, Saraf, and Mandeville, Phys. Rev. **97**, 1267 (1955).
[16] T. Lindqvist and E. Karlsson, Arkiv Fysik **12**, 519 (1957).
[17] Cork, Brice, Helmer, and Woods, Bull. Am. Phys. Soc. Ser. II, **3**, 64 (1958).

lens spectrometer. The Fermi plot shows groups with end-point energies of 0.801, 0.472, 0.347 Mev, together with the beta-rays from the Pm^{147} daughter with an end point at 0.225 Mev. Lower-energy groups may be hidden under the Pm^{147} beta rays. The energies agree with those originally determined by Kondaiah[18] and fit well into the scheme proposed by Hans *et al.*

The internal-conversion coefficient of the 92-kev gamma ray was measured in two ways. The first method consisted in measuring the intensities of the 92-kev gamma ray and the x-ray with the help of the calibrated scintillation counter described above. In these measurements, corrections were made for the absorption of the gamma ray and x-ray in the housing of the crystal and for the escape peak. The fluorescent yield was also properly taken into account in converting from x-ray intensity to the number of K-conversion electrons. The result of four measurements gave $\alpha_K^{Nd}=1.53\pm0.08$. This is to be compared with the value obtained by Hans *et al.* of 1.6 ± 0.2.

In the second method, the internal-conversion coefficient was determined by a comparison method using Hg^{203}. The internal-conversion line of Nd^{147} and that of Hg^{203} at 279 kev were both measured in a magnetic lens spectrometer. The gamma-ray intensities of the 92-kev line of Nd^{147} and the 279-kev line of Hg^{203} were determined for the two sources, from which the internal-conversion electrons had been measured, with the help of the calibrated scintillation spectrometer. Using the value of $\alpha_K^{Hg}=0.159$, as determined by Nordling, Siegbahn, and Sokolowski,[19] the results of the determination gave $\alpha_K^{Nd}=1.50\pm0.07$. This result together with the one determined from comparison of the x-ray and gamma ray gives $\alpha_K^{Nd}=1.52\pm0.05$. This value is somewhat lower than the theoretical value, $\alpha_K=1.68$, which one would calculate using 94% $M1$ and 6% $E2$ (from the result of Lindqvist and Karlsson[16]) and the tables of conversion coefficients of Sliv and Band.[9]

ACKNOWLEDGMENTS

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[18] E. Kondaiah, Phys. Rev. **71**, 1056 (1951).

[19] Nordling, Siegbahn, and Sokolowski, Nuclear Phys. **1**, 326 (1956).

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Levels of Be^{10} and B^{10}†

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The gamma rays produced in the bombardment of Be^9 (thick target) with 2.8-Mev deuterons were measured with a three-crystal pair spectrometer. The gamma rays are assigned in a consistent manner to decay from known levels of Be^{10} and B^{10}. Using information from stripping reactions it can then be inferred that the spins of the 5.96- and 6.26-Mev levels of Be^{10} are 1^- and 2^-, respectively. Furthermore it is shown that the gamma-ray and stripping information is consistent with spins 2^- and 2^+ for the 5.11- and 5.16-Mev levels of B^{10}, respectively, and that the 5.16-Mev level of B^{10} must have a very small alpha-particle reduced width, in accordance with a proposal of Wilkinson and Jones. Reduced widths of many levels of Be^{10} and B^{10} are summarized and analog levels in the two nuclei are searched for and compared.

I. INTRODUCTION

As part of a survey of gamma rays produced in deuteron-induced reactions,[1] the gamma rays from the Be^9+d reaction at 2.8 Mev were studied. Since recently certain discrepancies have been noted[2] in the spin assignments of the 5.11- and 5.16-Mev levels of B^{10} and in the energy dependence of the gamma-ray excitation in the Be^9+d reaction,[3] we wish to present our results ahead of a more detailed publication[1] in the hope that a certain amount of clarification will result. We also believe that our work, in conjunction with that of others (references given below) will give some clue

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* Alfred P. Sloan Foundation Fellow, 1957–1958. On leave from Stanford University, 1957–1958.

[1] L. F. Chase, Jr., Ph.D. thesis, Stanford University, 1958 (unpublished); L. F. Chase, Jr. (to be published).

[2] L. Meyer-Schützmeister and S. S. Hanna, Phys. Rev. **108**, 1506 (1957). We are very grateful to Dr. Hanna for sending us unpublished revisions for some of the level widths in the $Li^6(\alpha,\gamma)$ reaction. These revised widths have been incorporated in our paper (see footnote 27 and Table III).

[3] McCrary, Bonner, and Ranken, Phys. Rev. **108**, 392 (1957). We are very grateful to Professor Bonner for sending us some original data of this work.