PHYSICAL REVIEW VOLUME 161, NUMBER 4 20 SEPTEMBER 1967

Lifetimes of the 91- and 531-keV States in Promethium-147

M. T. Rama Rao, V. V. Ramamurty, and V. Lakshminarayana
Laboratories for Nuclear Research, Andhra University, Waltair, India

(Received 28 Februray 1967)

The lifetimes of the 91- and 531-keV states in Pm^{147}, populated in the β decay of Nd^{147}, are determined employing a time-to-pulse-height converter arrangement similar to that of Green and Bell. The half-life of the 91-keV state, determined by the slope method, yielded a value 2.46 ± 0.07 nsec. The mean-life of the 531-keV state, determined by the centroid-shift method, yielded a value $(1.2\pm0.22)\times10^{-10}$ sec. These values are employed to determine the $M1$ and $E2$ transition probabilities, and are compared with the values obtained from the single-particle estimates and the values estimated by employing the Kisslinger-Sorensen-type wave functions and also those of Choudhury and O'Dwyer for the ground and the 91-keV states of Pm^{147}. From the experimental transition probabilities the 531-keV state is inferred to contain sizable parts of the $\frac{7}{2}+$ phonon and the $\frac{5}{2}+$ phonon contributions.

I. INTRODUCTION

The decay scheme of Nd^{147} to Pm^{147} is well established,[1-4] and the main features of the scheme are shown in Fig. 1. The two $\frac{5}{2}+$ states at 91 and 531 keV, which are of present interest, are shown in heavy lines. The two levels are fed by intense β groups with end-point energies 819 and 377 keV. The spins and parities of the ground states of Nd^{147} and Pm^{147} are established[5] to be $\frac{5}{2}-$ and $\frac{7}{2}+$, respectively. The characters of the excited states at 91 and 531 keV in Pm^{147} being fixed[3,6] as $\frac{5}{2}+$, the nature of the two β transitions feeding these states may be assumed to be similar. Studies on β-γ directional correlations are being made in our laboratories with a view to inferring the structure of these states. Recently, Kisslinger and Sorensen[7] furnished wave functions for the $\frac{7}{2}$ and $\frac{5}{2}$ states in Pm^{147}. In order to study the applicability of these wave functions to the ground and the two $\frac{5}{2}$ states in Pm^{147}, the lifetimes of these states are determined and analyzed on the basis of these wave functions.

II. EXPERIMENTAL DETAILS

A. Apparatus

The experimental arrangement is shown in Fig. 2. It is a conventional slow-fast coincidence arrangement incorporating a time-to-amplitude converter similar to that of Green and Bell.[8] The two individual channels are assembled using RCA 6810A photomultipliers and NE102 plastic scintillators. For β detection, a conical well-type scintillator, 1 in. in diam and 2 mm in effective thickness, is used, while for the detection of conversion electrons a similar crystal with an effective thickness of 1 mm is used. On the other hand, a 1 in.×1 in. plastic crystal is used for γ detection. The photomultipliers are operated at 2000 V. The slow channels receive pulses from the eight dynodes, while the fast pulses are derived from the anodes. The latter pulses are limited by using E88CC tubes, and clipped with RG-63/U cables, to obtain pulses of height 1 V and duration 30 nsec. These pulses are applied by using delay lines of suitable lengths to facilitate the desired overlap times. The 6BN6 converter is operated conventionally at reduced potentials in order to achieve a sensitivity of 1 V. The output of the converter after amplification is fed to a 100-channel analyzer, gated by the slow-coincidence output, as shown in Fig. 2. The time calibration is carried out by observing the shift in the centroid position of the time spectrum obtained with a prompt photon source (Na^{22}). The time spectrum observed with a Co^{60} source, after correction for the chance coincidences, is shown in Fig. 3. It shows a full width at half-maximum of 7.6×10^{-10} sec, and the slopes of the curves decrease by a factor of 2 in 8.02×10^{-11} sec.

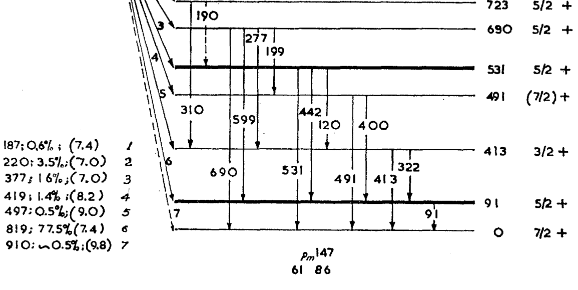

FIG. 1. Main features of the decay scheme of Nd^{147}. The 91- and 531-keV states of present interest are shown in heavy lines.

---

[1] G. T. Ewan, R. L. Graham, and J. S. Geiger, Bull. Am. Phys. Soc. **6**, 238 (1961).

[2] M. R. Gunye, R. Jambunathan, and B. Saraf, Phys. Rev. **124**, 172 (1961).

[3] E. Spring, Phys. Letters **7**, 218 (1963).

[4] N. Ranakumar, Ph.D. thesis, Andhra University, Waltair, India (unpublished).

[5] A. Cabezas, I. Lindgren, E. Lipworth, R. Marrus, and M. Rubinstein, Nucl. Phys. **20**, 509 (1960).

[6] B. Saraf, R. Jambunathan, and M. R. Gunye, Phys. Rev. **124**, 178 (1961).

[7] L. S. Kisslinger and R. A. Sorensen, Rev. Mod. Phys. **35**, 853 (1963).

[8] R. E. Green and R. E. Bell, Nucl. Instr. Methods **3**, 127 (1958).

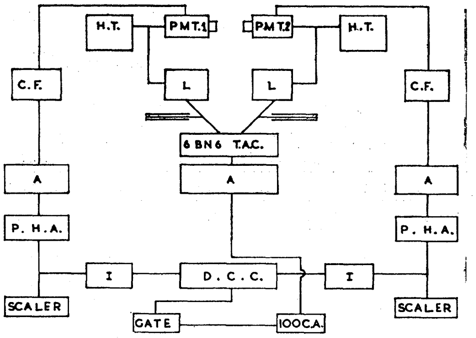

FIG. 2. A block diagram of the experimental arrangement. P. M. T., photomultiplier tube; H. T., high tension; L, limiter; T. A. C., time-to-amplitude converter; C. F., cathode follower; A, linear amplifier; P. H. A., single-channel pulse-height analyzer; I, inverter; D. C. C., double coincidence circuit; 100 C. A., 100-channel analyzer.

B. Measurements

The source Nd^{147} is produced by neutron irradiation of a spectroscopically pure sample of natural neodymium oxide in the Apsara reactor (Bombay) for a period of 15 days, and is obtained in liquid form as neodymium chloride in dilute HCl. The source is allowed to decay for a period of about three weeks before observations are made, to avoid interference from short-lived impurities. A few drops of the source are evaporated on a thin Mylar foil and used in the present investigation.

To determine the half-life of the 91-keV state, a β-conversion-electron coincidence method is employed. The β channel is integrally set to accept energies greater than 500 keV, while the other channel is gated differentially on the K-conversion line of the 91-keV transition. The delays in both the channels are adjusted so as to obtain the slope of the time spectrum on the right side of the curve to represent the half-life of the 91-keV state. The time spectrum is recorded, and after subtracting the chance coincidences, the different count rates are least-squares-fitted. The results are shown in Fig. 4. The half-life of the 91-keV state, obtained as an average of four independent determinations, yielded a value 2.46±0.07 nsec. Because the energies involved in this study are rather small, auxiliary experiments are conducted to study the energy dependence of the prompt-curve parameters. From the results obtained in such studies, it is concluded that this effect is not considerable for the present case.

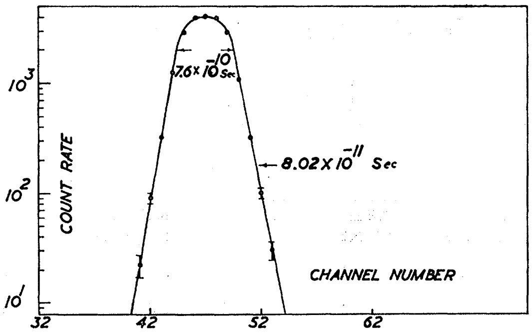

FIG. 3. Prompt-coincidence curve. This curve is obtained with a Co^{60} source with the early channel set integrally on the β spectrum at 225 keV and the late channel set on the Compton edge of the γ rays.

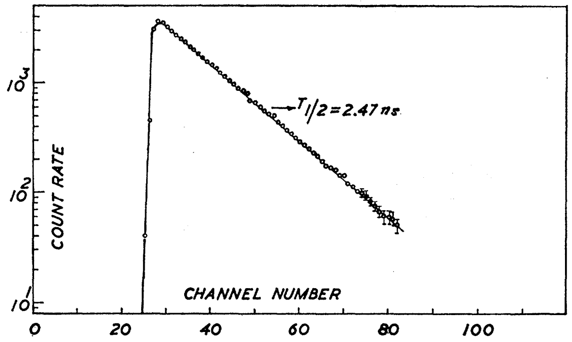

FIG. 4. Time spectrum obtained with Nd^{147} source. The slope represents a $T_{1/2}=2.47$ nsec for the 91-keV state. The spectrum is obtained by accepting the β ray above 500 keV in the early channel and the K-conversion line of the 91-keV transition in the late channel.

The centroid-shift method is employed for the measurement of the lifetime of the 531-keV state, the prompt source being Co^{60}. In the actual experiment, the β spectrum feeding the 531-keV state is accepted in the energy interval 225–300 keV in the early channel, and the Compton edge of the 531-keV γ ray is accepted in the late channel. In the comparison experiment, the time spectrum is obtained with the prompt source Co^{60}, the β and γ channels being set as in the actual experiment. The two resulting spectra are shown in Fig. 5, after the usual area normalization. The shift between the two centroids in time, corresponding to the mean life τ of the state, is obtained from these spectra. The average of five such determinations yielded a value $\tau=(1.2\pm0.22)\times10^{-10}$ sec. The rather large error is a result of the integration processes involved, as well as poor statistics.

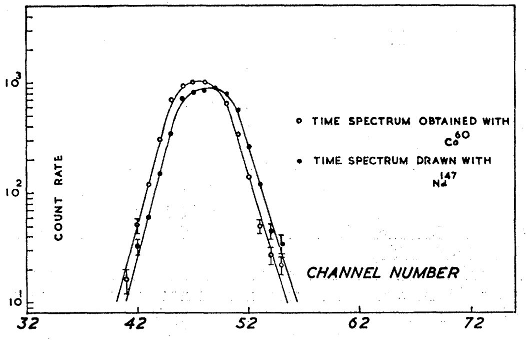

FIG. 5. Time spectrum obtained with a Nd^{147} source, with the early channel accepting 225–300-keV β and the late channel set on the Compton edge of the 531-keV γ. The comparison spectrum is obtained with a Co^{60} source under identical conditions. The centroid shift $(1.2\times10^{-10}$ sec) corresponds to the mean life of the 531-keV state.

TABLE I. Values of lifetimes for the 91-keV state.

$T_{1/2}$ (nsec)	Reference
2.44±0.08	9
2.44	10
3.4	11
2.45±0.2	12
2.50±0.06	13
2.59±0.02	14
2.46±0.07	Present work

III. RESULTS AND DISCUSSION

The half-life of the 91-keV state has been measured by several investigators, and the values are summarized in Table I.[9–14]

It can be seen from Table I that the value of $T_{1/2}$ in the present work agrees fairly well with those of the other investigations. The experimental magnetic dipole and electric quadrupole transition probabilities $T(M1)$ and $T(E2)$ are estimated from the value of $T_{1/2}$ given in Table I using the relations

$$T(M1)=[R/T_{1/2}\times 1.44(1+\alpha_{\text{tot}})]\times 1/(1+\delta^2)\,, \tag{1}$$

$$T(E2)=[R/T_{1/2}\times 1.44(1+\alpha_{\text{tot}})]\times \delta^2/(1+\delta^2)\,, \tag{2}$$

where α_{tot} is the total conversion coefficient, δ^2 $(=E2/M1)$ is the mixing ratio, and R is the branching ratio. Using the values $R=1$, $\alpha_{\text{tot}}=1.79^{15,16}\pm0.08$, and $\delta^2=8.07^{17}\times10^{-3}$, the values of the transition probabilities are obtained; they are given in Table II together with the corresponding single-particle estimates. The latter values are obtained using the relations[18]

$$T(M1)=2.9\times10^{13}E_\gamma{}^3S\,, \tag{3}$$

$$T(E2)=7.4\times10^{7}A^{4/3}E_\gamma{}^5S\,, \tag{4}$$

where E_γ is the transition energy in MeV, A is the mass number of the isotope, and S is the statistical factor. The statistical factors are estimated using the relation

$$S(J_i,L,J_f)=(2L+1)\{C(J_iJ_fL,\tfrac{1}{2}-\tfrac{1}{2}0)\}^2\,, \tag{5}$$

where J_i and J_f are the initial and final spin values, L is the multipolarity of the transition, and C is the Clebsch-Gordan coefficient. The corresponding $M1$ hindrance and $E2$ enhancement are also included in the table. The large hindrance in $M1$ has been hitherto attributed to l-forbiddenness. Alternatively, it may be possible to estimate the values of $T(M1)$ and $T(E2)$ from the wave functions furnished by Kisslinger and Sorensen. Their wave functions for the $\frac{7}{2}$ and $\frac{5}{2}$ are assumed to represent the ground and the 91-keV states, respectively.

$$|\tfrac{7}{2}\rangle=0.71|0\tfrac{7}{2}\tfrac{7}{2}\rangle+0.63|2\tfrac{7}{2}\tfrac{7}{2}\rangle-0.08|2\tfrac{5}{2}\tfrac{7}{2}\rangle-0.08|2\tfrac{3}{2}\tfrac{7}{2}\rangle\,,$$

$$|\tfrac{5}{2}\rangle=0.90|0\tfrac{5}{2}\tfrac{5}{2}\rangle+0.12|2\tfrac{7}{2}\tfrac{5}{2}\rangle+0.10|2\tfrac{5}{2}\tfrac{5}{2}\rangle-0.15|2\tfrac{3}{2}\tfrac{5}{2}\rangle-0.30|2\tfrac{1}{2}\tfrac{5}{2}\rangle.$$

The value of $T(M1)$ is estimated from these wave functions by considering the transition amplitudes for the $\frac{7}{2}+$ phonon, $\frac{5}{2}+$ phonon and $\frac{3}{2}+$ phonon parts of the wave functions separately, adding, and squaring the resultant amplitude. The single-particle contribution is neglected because of l forbiddenness. The transition amplitudes are the square roots of the reduced transition probabilities and are obtained from the formula[19]

$$B(M1)=T(M1)/\alpha^2E_\gamma{}^3=(2J_f+1)j(j+1)(2j+1)\times\begin{Bmatrix}J_i & J_f & 1\\ j & j & J_c\end{Bmatrix}^2(g_c-g_p)^2\,, \tag{6}$$

where j is the spin of the particle state ($\frac{7}{2}$, $\frac{5}{2}$, or $\frac{3}{2}$ in the present case), $\alpha^2=4.2\times10^{12}$, the factor in the curly brackets is a $6j$ symbol, and g_c and g_p are the core and particle g factors, respectively. The value of g_c is assumed to be Z/A $(=0.411)$, and g_p is obtained from the ground-state magnetic dipole moment using the relations

$$\mu(\tfrac{7}{2})=(0.71)^2\langle0\tfrac{7}{2}\tfrac{7}{2}|T^1|0\tfrac{7}{2}\tfrac{7}{2}\rangle+(0.63)^2\langle2\tfrac{7}{2}\tfrac{7}{2}|T^1|2\tfrac{7}{2}\tfrac{7}{2}\rangle+(0.08)^2\langle2\tfrac{5}{2}\tfrac{7}{2}|T^1|2\tfrac{5}{2}\tfrac{7}{2}\rangle+(0.08)^2\langle2\tfrac{3}{2}\tfrac{7}{2}|T^1|2\tfrac{3}{2}\tfrac{7}{2}\rangle\,, \tag{7}$$

TABLE II. Values of transition probabilities for the 91-keV transition.

Description	$T(M1)$ (sec^{-1})	$M1$ hindrance	$T(E2)$ (sec^{-1})	$E2$ enhancement
Experimental	$(1.008\pm0.047)\times10^8$	...	$(8.13\pm0.44)\times10^5$	...
Single-particle estimates	3.62×10^{10}	359	6.94×10^4	11.7
Wave functions of Ref. 7	2.03×10^6	49.6[a]	2.90×10^5	2.8
Wave functions of Ref. 23	1.4×10^8	1.39	6.86×10^5	1.2

[a] $M1$ enhancement instead of hindrance.

---

[9] R. L. Graham and R. E. Bell, Can. J. Phys. **31**, 377 (1953).

[10] E. Bodenstedt, E. Matthias, H. J. Korner, and R. H. Siemssen, Z. Naturforsch. **13a**, 425 (1958).

[11] G. Manning and J. D. Rogers, Nucl. Phys. **15**, 166 (1960).

[12] Hans-Dietrich Wendt and Peter Kleinheinz, Nucl. Phys. **20**, 169 (1960).

[13] E. Bodenstedt, H. J. Korner, F. Friesius, D. Hovestadt, and E. Gerdan, Z. Physik, **160**, 33, (1960).

[14] H. Beekhuis, Physica **28**, 1199 (1962).

[15] The value of α_{tot} is obtained by adding the theoretical coefficients corresponding to L and M shells from Sliv and Band's tables $(\alpha_{L+M}=0.26)$ to the experimental value (Ref. 16) $\alpha_K=1.53\pm0.08$.

[16] A. C. G. Mitchell, C. B. Creager, and C. W. Kocher, Phys. Rev. **111**, 1343 (1958).

[17] The mixing ratio δ^2 is assumed from the abstract by Ewan *et al.* (Ref. 1), in which the error in δ^2 is not specified. The value was inferred from the L-subshell intensity ratios. Consequently the error in its estimation is assumed to be smaller than that in, the estimation of α_{tot}. Thus, the over-all error in the estimated values of $T(M1)$ and $T(E2)$ is approximately represented by the compounded error in $T_{1/2}$ and α_{tot}.

[18] S. A. Moszkowski, in *Alpha-, Beta-, and Gamma-Ray Spectroscopy*, edited by K. Siegbahn (North-Holland Publishing Company, Amsterdam, 1965), Chap. 15.

[19] A. De-Shalit, Phys. Rev. **122**, 1530 (1961).

TABLE III. Values of transition probabilities for the 531-keV transition.

Description	$T(M1)$ (sec^{-1})	$M1$ hindrance	$T(E2)$ (sec^{-1})	$E2$ enhancement
Experimental	$(3.6\pm1.4)\times10^{9}$	$\cdots$	$(3.2\pm1.3)\times10^{9}$	$\cdots$
Single-particle estimates	2.7×10^{12}	750	4.7×10^{8}	7

where

$$\langle J_cjJ|T^1|J_cjJ\rangle=\frac{J(J+1)+J_c(J_c+1)-j(j+1)}{2(J+1)}g_c+\frac{J(J+1)-J_c(J_c+1)+j(j+1)}{2(J+1)}g_p. \tag{8}$$

J_c, j, and J being the core, particle, and resultant angular momenta, respectively. Employing these relations together with the measured[20] μ value 2.58 nm, the value of g_p is obtained as

$$g_p=0.845.$$

The value of $T(E2)$ is likewise obtained by considering separately the transition amplitudes from the $\frac{7}{2}+$ phonon part in $|\frac{5}{2}\rangle$ to the $|0\frac{7}{2}\frac{7}{2}\rangle$ part in $|\frac{7}{2}\rangle$, and from the $\frac{5}{2}+$ phonon part in $|\frac{7}{2}\rangle$ to the $|0\frac{5}{2}\frac{5}{2}\rangle$ part in $|\frac{5}{2}\rangle$. The corresponding single-particle value is also obtained between $|0\frac{5}{2}\frac{5}{2}\rangle$ and $|0\frac{7}{2}\frac{7}{2}\rangle$. All these transition amplitudes are added and squared to yield the reduced transition probability $B(E2)$. The final expression employed[21] is given by

$$\frac{T(E2)}{\beta^2E_\gamma{}^5}=B(E2)=(2J_f+1)\left[\frac{(0.9\times0.71)}{\sqrt{8}}[B(E2)_{\mathrm{sp}}]^{1/2}+[B(E2)_{\mathrm{core}}]^{1/2}\left(\frac{(0.12\times0.71)}{\sqrt{8}}+\frac{(0.08\times0.9)}{\sqrt{6}}\right)\right]^2. \tag{9}$$

where $\beta^2=1.23\times10^{13}$, $B(E2)_{\mathrm{sp}}$ is the single-particle reduced transition probability, and $B(E2)_{\mathrm{core}}$ is the reduced transition probability of the core, which is assumed[22] to be $0.114e^2\times10^{-48}$ cm^4. This value is the average of $B(E2)$ for Nd^{146} and Sm^{148}. The values of $T(M1)$ and $T(E2)$ obtained from Kisslinger and Sorensen's wave functions are also included in Table II. It can be seen from these values that the $E2$ enhancement is reduced to 2.8; but an $M1$ enhancement of about 50 is noticed. It thus appears that some adjustment is needed for the amplitudes of the different parts in the wave functions to obtain a better fit.

Recently, Choudhury and O'Dwyer[23] investigated the properties of the low-lying states in odd-mass Pm nuclei within the framework of the intermediate-coupling approach. It is assumed that the last odd proton has the orbits $1g_{7/2}$ and $2d_{5/2}$ available to it and is coupled to the surface vibrations of the core. The resulting Hamiltonian of the coupled system was diagonalized, including all states with up to three phonons of the quadrupole vibrations. They furnished the wave functions of some low-energy states in Pm^{147}. The amplitudes of the particle parts and the $\frac{7}{2}+$ one-phonon and $\frac{5}{2}+$ one-phonon parts of the ground and the 91-keV states of Pm^{147} furnished by them are given below:

$$|\tfrac{7}{2}\rangle=-0.7745|0\tfrac{7}{2}\tfrac{7}{2}\rangle+0.5524|2\tfrac{7}{2}\tfrac{7}{2}\rangle+0.1515|2\tfrac{5}{2}\tfrac{7}{2}\rangle,$$

$$|\tfrac{5}{2}\rangle=+0.7671|0\tfrac{5}{2}\tfrac{5}{2}\rangle+0.2423|2\tfrac{7}{2}\tfrac{5}{2}\rangle-0.5282|2\tfrac{5}{2}\tfrac{5}{2}\rangle.$$

It may be noted from these wave functions that the $\frac{5}{2}+$ phonon and the $\frac{7}{2}+$ phonon amplitudes in $|\frac{5}{2}\rangle$ are larger than the corresponding values in the Kisslinger-Sorensen wave function. Consequently, the transition probabilities will assume higher values and may provide a better fit. The $T(M1)$ and $T(E2)$ values estimated[24] from Choudhury and O'Dwyer's wave functions are also included in Table II. It can be seen that the estimates of $T(M1)$ and $T(E2)$ from these wave functions do yield the best fit for the present experimental results.

The lifetime of the 531-keV state has not previously been determined accurately. Wendt and Kleinheinz,[12] however, estimated an upper limit for the lifetime of this state as 0.6 nsec. The present value of the mean life $T=(1.2\pm0.22)\times10^{-10}$ sec is employed to estimate the values of $T(M1)$ and $T(E2)$ as in the previous case using the known mixing[25] and branching[3] ratios. The mixing ratio $\delta^2(=E2/M1)$ is assumed to be 0.90 ± 0.3, and the branching ratio is taken to be 0.83 ± 0.08. The conversion coefficient for this transition is small, and is not taken into account, in view of the large errors in the mean life as well as in the mixing ratio. The transition probabilities thus estimated are given in Table III together with the corresponding single-particle estimates. In this case, the $M1$ hindrance and the $E2$ enhancement are about 750 and 7, respectively. If the 531-keV state is assumed to be due to single-particle excitation, the $M1$ hindrance is associated with l forbiddenness, as in the previous case. Alternatively, the 531-keV state may be viewed as resulting from a configuration $[(g_{7/2})^8{}_0(d_{5/2})^3{}_{5/2}]_{5/2}$ for the 11 protons in excess of 50. On this basis, the ground- and the 91-keV-state configurations correspond to $[(g_{7/2})^7{}_{7/2}(d_{5/2})^4{}_0]_{7/2}$ and $[(g_{7/2})^6{}_0(d_{5/2})^5{}_{5/2}]_{5/2}$, which are to be viewed as holes in $g_{7/2}$ and $d_{5/2}$, respectively. With this description, the $M1$ transition between the 531 keV and the ground states is forbidden, and the $T(E2)$ is reduced. It can be shown that the value of

---

[20] J. Reader, Phys. Rev. **141**, 1123 (1966).

[21] R. A. Sorensen, Phys. Rev. **133**, 281 (1964).

[22] J. Lindskog, T. Sundstrom, and P. Sparrman, *Alpha-, Beta-, and Gamma-Ray Spectroscopy*, edited by K. Siegbahn (North-Holland Publishing Company, Amsterdam, 1965), Vol. 2., App. 3.

[23] D. C. Choudhury and T. F. O'Dwyer, Nucl. Phys. **A93**, 2 300 (1967).

[24] Taken from the tabulated values of the paper.

[25] G. A. Westernbarger and D. A. Shirley, Phys. Rev. **123**, 1812 (1961).

$T(E2)$ for this case is equal to $\frac{2}{3}T(E2)$ for a single-particle transition. In view of the fact that an $E2$ enhancement is noticed in the present experiment, the description of the 531-keV state as a $(d_{5/2})^3$ configuration does not appear to be correct. The nature of the 531-keV state is therefore assumed to be similar to that of the 91-keV state, and to be given by

$$|\tfrac{5}{2}\rangle_{531}=A|0\tfrac{5}{2}\tfrac{5}{2}\rangle+B|2\tfrac{7}{2}\tfrac{5}{2}\rangle+(1-A^2-B^2)^{1/2}|2\tfrac{5}{2}\tfrac{5}{2}\rangle,$$

where A and B are constants which can be determined from the present experimental values of $T(M1)$ and $T(E2)$. The values of $T(M1)$ and $T(E2)$ for the 531-keV transition occurring from a state of the above description to the ground state (assumed to be described by a Kisslinger-Sorensen wave function) are obtained in a manner similar to that of the 91-keV transition described earlier. Thus, the $M1$ transition probability is neglected between the particle parts and is estimated from the $\frac{7}{2}+$ phonon and $\frac{5}{2}+$ phonon parts. $T(E2)$ is obtained using the particle as well as the $\frac{7}{2}+$ phonon and $\frac{5}{2}+$ phonon parts. The final equations obtained using the experimental values of $T(M1)$ and $T(E2)$ in terms of A and B are given below

$$0.01853A+0.08478B=0.02794$$
$$-0.02271\ (1-A^2-B^2)^{1/2}+0.2108B=0.07635.$$

On solving these equations the following sets of values are obtained:

	Set I	Set II
A	-0.51 ± 0.18	0.30 ± 0.11
B	0.44 ± 0.15	0.26 ± 0.09
$(1-A^2-B^2)^{1/2}$	0.74 ± 0.25	$-0.91\pm0.31.$

The large errors are essentially due to the large uncertainty in δ^2. A more accurate determination of this factor, together with a better accuracy in the determination of the lifetime, will be useful in reducing these errors. It is interesting to note that the wave function for the 531-keV state thus deduced contains sizable parts of $\frac{7}{2}+$ phonon and $\frac{5}{2}+$ phonon contributions. This is suggestive of the fact that the intermediate-coupling calculations by Choudhury and O'Dwyer can be extended to this case. In fact, a 532-keV state was considered by them in Pm^{147}; but its spin was assumed to be $11/2+$. If it is assumed to be $\frac{5}{2}+$, the resulting wave function may yield amplitudes for comparison with the present experimental results.

ACKNOWLEDGMENTS

One of the authors (M.T.R.R.) would like to thank P. Jagam for his help with the instrumentation and is grateful to the Council of Scientific and Industrial Research, Government of India, for awarding a research fellowship to him during the course of the work.

Erratum

Dynamic Penetration Effects in the Internal Conversion of Electric Dipole Transitions in Lu^{175}, G. T. Emery and M. L. Perlman [Phys. Rev. **151**, 984 (1966)]. In Eq. (A4) the phase factor, given as $\exp(i3.345)$, should instead be $\exp[i(3.345+\varphi-\varphi_0)]$, where $\varphi=\arg[\mathfrak{M}_{+1}(X,Y)]$ and $\varphi_0=\varphi(X=0,\ Y=0)$. We thank Dr. L. Holmberg and Dr. B.-G. Pettersson for pointing out this error, which affects the results for the 282.5-keV transition. With the matrix elements and weighting factors adopted, $\mathfrak{M}_{+1}(X,Y) =-0.0050+i(-0.0287-0.550X+7.20Y)$.

This correction and the use of the new value for b_K [either that of Thun, mentioned in our note added in proof and now published—J. E. Thun, Nuclear Phys. **A91**, 653 (1967)—or a more recent value in agreement—L. Holmberg, L. Gidefeldt, M. Gunnerhed, and B.-G. Pettersson, Nuclear Phys. **A96**, 305 (1967)] do not eliminate the ambiguity, noted on p. 989 of our paper, in the determination of the penetration parameters and mixing ratio for the 282.5-keV transition. Some model-dependent assumption is still required to obtain definite values. Holmberg and collaborators introduce the assumption, different from the two considered by us, that $G(M2)_{282.5}=G(M2)_{396.3}$. They then derive the mixing ratios from the nuclear-alignment results of M. A. Grace, C. E. Johnson, R. G. Scurlock, and R. T. Taylor [Phil. Mag. **2**, 1079 (1957)]. If we adopt this assumption and also require $X=0$, the corrected Eq. (A4) with a new average value $b_K=0.265\pm0.047$, together with Eqs. (A1) and our experimental conversion coefficients, gives the result $Y_{282.5}=0.0131\pm0.0010$. This makes $|H(E1,282.5)|=0.98\pm0.09$, and $H(E1,396.3)/H(E1,282.5)=1.00\pm0.09$, in perfect agreement with the zero-order rotational branching rules. Holmberg, Gidefeldt, Gunnerhed, and Pettersson point out that the values of the mixing ratios they derive, when combined with the internal conversion data, require that $g_s(\text{eff}, M2)$ be somewhat larger than $g_s(\text{eff}, E1)$. We thank these authors for informing us of their results.