and thank the authors of reference 1 for making their material available.

[1] Buniatov, Vrublevskii, Kopylova, Korolevich, Petukhova, Sidorov, Skzhipchak, and Filipkovskii, J. Exptl. Theoret. Phys. (U.S.S.R.) **34**, 1028 (1958), Soviet Phys. JETP **7**, 711 (1958).

[2] Fay, Gottstein, and Hain, Nuovo cimento Suppl. **11**, 234 (1954).

[3] W. F. Fry and G. R. White, Phys. Rev. **90**, 207 (1953).

[4] W. H. Barkas, UCRL 3769 (1957).

[5] Friedlander, Keefe, Menon, and Merlin, Phil. Mag. **45**, 533 (1954).

[6] E. Segre, editor, Experimental Nuclear Physics (Russ. Transl.), vol. 1, M. 1955 [Wiley, N.Y., 1953].

Translated by A. M. Bincer
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INVESTIGATION OF CONVERSION ELECTRON SPECTRA OF NEUTRON-DEFICIENT ISOTOPES OF LUTECIUM

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THE study of the radiations from highly deformed nuclei provides material for further development of the collective model of the nucleus. The isotopes of lutecium are very interesting from this point of view. Recently a series of papers have appeared[1-4] concerning the neutron-deficient isotopes of Lu, but these data do not give a clear picture of the decay of these isotopes. Further investigations are necessary for this purpose.

We have studied the conversion spectrum of the isotopes of the lutecium fraction separated from a tantalum target irradiated with fast protons (660 Mev). The separation method was described earlier.[5] The measurements were made with a prism β spectrometer having an instrumental halfwidth of $\sim 0.1\%$ and with a double-focusing spectrometer with an instrumental halfwidth ~ 0.25 to 0.30%. The spectrum of conversion electrons contains a large number of lines belonging to Lu^{169} (half-life ~ 1.5 days), Lu^{170} (~ 2 days), Lu^{171} (~ 8 days), Lu^{172} (~ 6.7 days), and Lu^{173} (~ 200 days).[1,4,6] The assignment of the lines to the various isotopes was made on the basis of the half-life. Because of the small difference in lifetime, the separation of the lines of Lu^{169} and Lu^{170} is very difficult and was not completely achieved. It could be established from the measurements that the lines associated with Lu^{170} (84.19 kev, 193.3 kev) decay with a period of ~ 2 days. Lines having a lifetime less than that of the Lu^{170} lines were assigned to Lu^{169}. The comparatively small difference in the half-lives of Lu^{171} and Lu^{172} also prevented a unique assignment of transitions to one or the other of these two isotopes.

Table I gives the energies of γ transitions whose conversion lines decay with a period of $\sim$ 1.5 or 2 days. Table II gives the energies of the γ transitions with period 6.7 to 8 days. The energy of the transitions was determined from the energy of the K and L conversion lines. The accuracy of the energy determination if $\sim 0.1\%$. In those cases where only the K line or the L line was observed, the energy of the transition is given in parentheses.

[1] Bobrov, Gromov, Dzhelepov, and Preobrazhenskii, Izv. Akad. Nauk SSSR, Ser. Fiz. **21**, 940 (1957) [Columbia Techn. Transl. **21**, 942 (1957)].

[2] Gromov, Dzhelepov, Dmitriev, and Preobrazhenskii, Izv. Akad. Nauk SSSR, Ser. Fiz. **21**, 1573

TABLE I. Energies of γ transitions in the spectra of Lu^{169}, Lu^{170}

No.	Energy of γ transition in kev	No.	Energy of γ transition in kev	No.	Energy of γ transition in kev	No.	Energy of γ transition in kev
1	24.23	7	110.9	13	(286.5)	19	(543.8)
2	62.65	8	156.8	14	(290.9)	20	(755.1)
3	70.54	9	165.0	15	(369.2)	21	(937.7)
4	84.19	10	191.2	16	378.4	22	(1453)
5	87.30	11	193.3	17	(419.8)	23	(1481)
6	(91.83)	12	283.0	18	(457.2)		

Half-life for Nos. 1, 2, 5, 7, 8, 9, 10: < 2 days; for Nos. 4, 11: ~ 2 days.

TABLE II. Energies of γ transitions in the spectra of Lu^{171}, Lu^{172}

No.	Energy of γ transition in kev	Identification, A	No.	Energy of γ transition in kev	Identification, A
1	(55.71)		25	(594.0)	
2	66.70	171	26	625.7	
3	72.33		27	629.6	172
4	75.85	171	28	666.9	(171)
5	78.70	172	29	(688.6)	
6	(85.55)		30	697.2	
7	90.55	172	31	712.2	171
8	91.30	171	32	739.1	171
9	112.7		33	766.7	
10	181.4	172	34	780.2	
11	203.3	172	35	809.2	172
12	269.9	172	36	838.9	171
13	279.8	172	37	(853.1)	
14	323.7	(172)	38	899.8	(172)
15	372.3		39	911.0	172
16	399.7	172	40	(927.6)	
17	410.1		41	(985.7)	
18	485.9	(171)	42	1002	172
19	490.1		43	(1020)	
20	(498.6)		44	(1071)	
21	(517.7)		45	1094	172
22	527.9	(172)	46	(1103)	
23	(535.6)		47	(1139)	
24	539.5	172			

(1957) [Columbia Techn. Transl. **21**, 1562 (1957)].
[3] Gorodinskii, Murin, Pokrovskii, and Preobrazhenskii, Izv. Akad. Nauk SSSR Ser. Fiz. **21**, 1004 (1957) [Columbia Techn. Transl. **21**, 1005 (1957)].
[4] Mihelich, Harmatz, and Handley, Phys. Rev. **108**, 989 (1957).
[5] Preobrazhenskii, Lilova, Dobronravova, and Teterin, Журн. неорг. хим. (J. of Inorg. Chem.) **1**, 2294 (1956). Preobrazhenskii, Kaliamin, and Lilova, Журн. неорг. хим. (J. of Inorg. Chem.) **2**, 1164 (1957).
[6] G. Wilkinson and H. G. Hicks, Phys. Rev. **81**, 540 (1951).

Translated by M. Hamermesh
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ON THE PENETRATING COMPONENT IN EXTENSIVE AIR SHOWERS

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In reference 1 Kazarov and Andronikashvili describe their experimental apparatus and the results obtained from their investigation of the energy spectrum of the penetrating component of extensive air showers. We give here certain additional data which, together with the results given in references 1 and 2, provide the basis for a number of conclusions.

We investigated the penetrating component at a depth of 127 m water equivalent (m.w.e.) using two detectors identical with that described in reference 1. One of the detectors was placed directly under the selecting system while the other, which had been placed at our disposal by M. F. Bibilashvili, was located 45 m from the first. The apparatus was directed in such a way that coincidences were registered between the master pulse and either of the detectors.

The data showed that out of 302 registered showers with a mean number of particles $\overline{N} = 2.85 \times 10^5$, there were 23 showers accompanied by triggering of the detector located at 45 m. We used these data to calculate the penetrating particle density ρ_μ from the formula given in reference 1. The result was $\rho_\mu = 0.077 \pm 0.018\ m^{-2}$. This density refers approximately to the distance 45 to 50 m from the shower axis. Calculations yielded only a small correction to the effective distance mainly because of the angular distribution of extensive shower axes.

In their investigation of the lateral distribution of the penetrating component at 61 m.w.e. for a shower with $\overline{N} = 3 \times 10^5$ Andronikashvili and