Letters to the Editor

γ TRANSITIONS IN THE Sm^{146} NUCLEUS

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We investigated γ radiation of Sm^{146} resulting from electron capture in Eu^{146}. The source consisted of a gadolinium fraction separated by a chromatographical method from a tantalum target bombarded by 660-Mev protons from the synchrocyclotron of the Joint Institute for Nuclear Research. After the decay of the short-lived Gd^{147} (29 hr) and Gd^{149} (9.3 days), the basic activity was due to Gd^{146} (60 days) and its daughter nucleus Eu^{146} (5 days). According to our estimate, the contribution from the relatively soft radiation of Eu^{146} in the region of the Sm^{146} lines was insignificant. The sources used by us had been stored for 40 and 180 days.

The measurements were made on a double scintillation coincidence spectrometer. The investigated lines were separated by means of a single-channel amplitude analyzer and the entire pulse spectrum picked up by the other branch was fed to a coincidence circuit with a resolving time of $2\tau = 10^{-7}$ sec. The coincidence pulses were used to trigger a 100-channel analyzer of type AI-100. The spectrum was fed to this analyzer with a suitable delay.

The Eu^{146} decay has been studied previously,[1,2] and γ transitions of energies 0.64 and 0.74 Mev have been discovered. Moreover, transitions have been found[3] with energies of 0.66 and 0.89 Mev.

We discovered a number of γ transitions arising during the decay of Eu^{146}. The energies and relative intensities of these transitions are shown in the table. As there are a number of lines in the γ spectrum with close-lying energies, we have indicated the total intensity for such groups of lines, and we list the mean energy of such a group; the energies of the lines forming the group are shown in the parentheses. The intensities were determined by resolution into the standard

E_γ, Mev	I_γ
0.64	~1
0.74	1.00
0.91	0.10
1.1 (1.07+1.17)	0.14
1.3 (1.26+1.31)	0.10
1.5 (1.45+1.56)	0.13
1.8	0.02
2.1 (1.94+2.06+2.19)	0.04
2.4	0.01

line shape. The intensity of the 0.74-Mev transition was taken as unity. The 0.64-Mev transition was not single transition; according to our estimate, its intensity is approximately equal to the intensity of the 0.74-Mev transition. The errors in the intensity determination were ~ 30%.

The region of the spectrum above 0.9 Mev was investigated with a lead filter 28 g/cm^2 thick to eliminate the effect of the summation of the most intensive quanta of 0.64 and 0.74 Mev which were emitted in coincidence.

Our experiments confirmed the presence of coincidences (see reference 1) between the 0.74- and 0.64-Mev quanta. Figure 1 shows the spectrum of coincidences with each of these two quanta (in both cases lead filters 6 g/cm^2 thick were used).

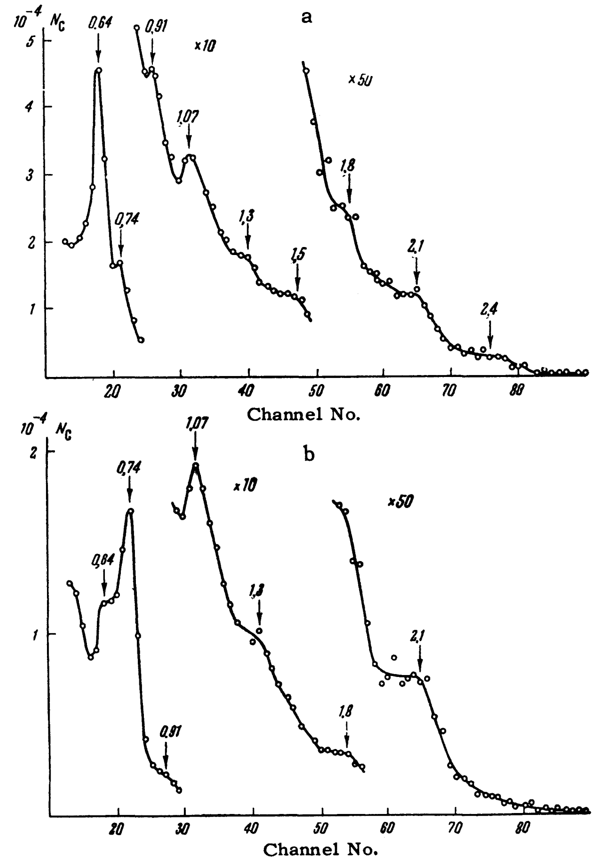

FIG. 1

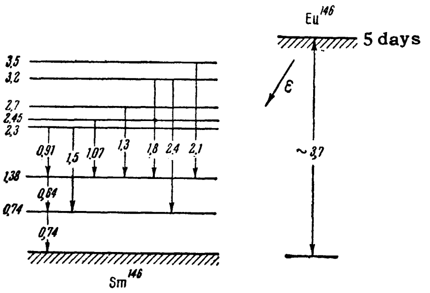

FIG. 2

We found coincidences of 0.74-Mev quanta (Fig. 1a) with quanta of 0.64, 0.91, 1.07, 1.3, 1.5, 1.8, 2.1, and 2.4 Mev. We also observed coincidences of 0.64-Mev quanta (Fig. 1b) with all the quanta enumerated above, except for 1.5 and 2.4 Mev; we also found self coincidences of the 6.4-Mev quanta, which compells us to assume that there is still one more quantum with energy close to 0.64 Mev. Moreover, we investigated coincidences with various parts of the hard region of the spectrum in the range of 2.4, 2.1, 1.8, 1.5, 1.3, 1.1, and 0.9 Mev.

In the spectrum of coincidences with 0.24-Mev quanta the peak at 0.74 Mev is plainly visible, while the 0.64-Mev peak is absent, which is in agreement with the data of the spectrum of 0.64-Mev coincidences. In the case of the coincidences with 2.1-Mev quanta, both peaks are absent. Coincidences with parts of the spectrum in the regions of 0.9, 1.1, and 1.3 Mev give peaks at 0.64 and 0.74 Mev of approximately the same intensity. However, while investigating the coincidences with the part in the region of 1.5 Mev, we observed a sharp increase in the intensity of the 0.74-Mev peak, which is in agreement with the results of experiments on coincidences with 0.64-Mev quanta and gives a basis to assume that the 1.5- and 0.64-Mev transitions are not in cascade. It thus follows that the 0.74-Mev transition is the lower one in the 0.64-0.74 Mev cascade, since the 1.5- and 2.4-Mev transitions proceed directly to the 0.74 level. As regards the remaining transitions, it can be said that they go to the 1.38-Mev level.

In neither the singles spectrum nor in the coincidence spectrum was there observed a direct transition from the 1.38-Mev level of intensity greater than 5% of the 0.74-Mev lines.

In conclusion, we propose a variant of the decay scheme of the Eu^{146} nucleus which is in agreement with the results of the present work (Fig. 2). The energy of the Eu^{148} decay into Sm^{146} is 3350 kev according to Cameron's formula and 3700 kev according to Levi's formula,[4] which allows the existence of the levels introduced by us up to 3.5 Mev.

Some of the transitions occurring in coincidence are probably individual components of the groups shown in the table (for example, the 1.07-Mev line from the group of 1.1-Mev lines.

We noted a γ line of energy 280 kev which was in coincidence with quanta of 115 — 120 kev; they are apparently associated with the decay of Gd^{146} or Eu^{147}.

[1] Gorodinskiĭ, Murin, Pokrovskiĭ, and Preobrazhenskiĭ, Izv. Akad. Nauk SSSR, Ser. Fiz. **21**, 1624 (1957), Columbia Tech. Transl. p. 1611.

[2] Anton'eva, Bashilov, Dzhelepov, and Preobrazhenskiĭ, JETP **36**, 28 (1959), Soviet Phys. JETP **9**, 20 (1959).

[3] Gorodinskiĭ, Murin, Pokrovskiĭ, Preobrazhenskiĭ, and Titov, Dokl. Akad. Nauk SSSR **112**, 405 (1957), Soviet Phys.-Doklady

[4] B. S. Dzhelepov and G. F. Dranitsina, Систематика энергий β-распада (Systematics of the β-Decay Energy), Press of the Acad. Sci. U.S.S.R., 1960.

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ON THE THEORY OF PARAMAGNETIC RESONANCE OF Ti *AND* Co *IONS IN CORUNDUM*

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As a result of recent experimental investigations of paramagnetic resonance in Al_2O_3 crystals containing different paramagnetic impurities it has been found that the magnetic properties of Ti ions[1] and of Co ions[2,3] differ appreciably from the properties of these ions in other crystals studied previously. If we make certain natural assumptions then, as our calculations have shown, the whole set of experimental facts relating to the paramagnetic resonance spectra and the spin-lattice relaxation times can be simply explained.