ON THE LEVEL SCHEME OF Ta^{181}

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It is shown by the $\beta\gamma$-coincidence technique that a 137-kev transition between the 619- and 482-kev levels ($T_{1/2} = 10^{-8}$ sec) does not exist, whereas some new γ transitions at 619, 480, and 345 kev have been detected. The period of the 619-kev level is less than 10^{-9} sec.

THE decay of Hf^{181}, which has a half-life of 46 days, has been investigated by many authors (see reference 1). Measurements carried out on β and γ spectrometers lead to the decay scheme shown in the work of Boehm and Marmier[2] and Snyder and Frankel.[3]

We measured the decay scheme of Hf^{181} by the $\beta\gamma$-coincidence technique, in order to determine the lifetime of the 619-kev level, which has been previously found to be smaller than 10^{-8} sec.[3]

The β radiation was detected by anthracene of thickness 2 mm and the γ quanta by a NaI(Tl) crystal of size 30 × 25 mm. The fast — slow coincidence circuit consisted of (2 or 3) energy-discrimination channels a slow-coincidence circuit (2×10^{-6} sec), and a fast-coincidence circuit with a resolving time of 5×10^{-9} to 2×10^{-8} sec.[4]

Without the absorber in the β channel (according to the cited decay scheme[2,3]) the curve of the delayed coincidences of β particles and 482-kev γ rays should show a half-life of 10^{-8} sec for the 482 kev level. Curve a in Fig. 1 shows that we have coincidences with a period less than 10^{-8} sec. In order to explain this, we examined, by means of an aluminum absorber (30 mg/cm^2), conversion electrons from the K and L shells due to the 133-kev γ transition (which contributes to the 10^{-8} period of the 482 kev level). We thus obtained curve b of Fig. 1. Repetition of the same experiment with 345-kev γ quanta gave analogous curves; β radiation with an upper cut-off of 404 kev is in coincidence with 480- and 345-kev γ rays. It thus follows that, in contrast to the Ta^{181} decay scheme, there is no 137-kev γ transition from the 619-kev level to the 482-kev level.

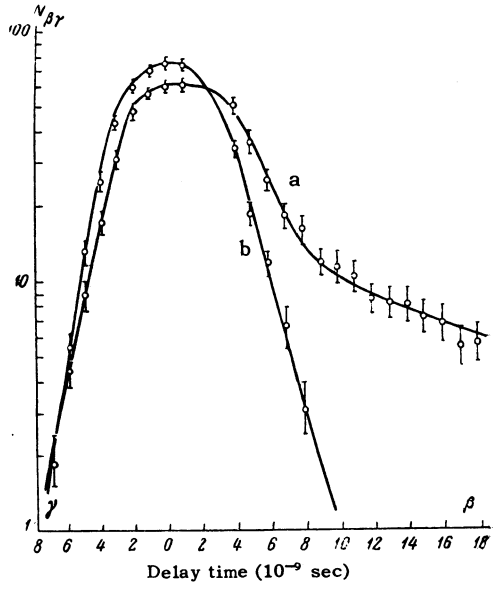

FIG. 1. a – curve of coincidences $e^-_{133} + \beta - \gamma$, 480 kev; b – curve of $\beta\gamma$ coincidences, 480 kev.

Moreover, the measurements show that there still exists a 619-kev γ transition in coincidence with 404-kev β radiation. From a study of the slope of the delayed-coincidence curve we find that the period of this transition is less than 10^{-9} sec.

In its intensity, the spectrum of γ rays in coincidence with conversion electrons from the 133-kev γ transition (the γ-spectrum coincidences were obtained introducing a delay of 1.7×10^{-8} sec in the β channel) corresponds to the direct γ spectrum of Hf^{181}, which is obtained from the β transition with an upper cut-off of 408 kev (93.5%).

The curve of Fig. 2 shows the γ spectrum in coincidence with β rays for which E_{max} = 404 kev. [An aluminum filter (30 mg/cm^2) which absorbs the conversion electrons from the 133-kev γ rays was placed in the β channel.] In this case we obtained a new ratio for the intensities of the 480-kev and 345-kev γ quanta. These new photons of energy close to 480 and 345 kev are in coincidence with 136-kev photons. This confirms the results of the triple coincidences $\beta_{404} - \gamma_{136} - \gamma_{480}$ and $\beta_{404} - \gamma_{136} - \gamma_{345}$.

Thus, the measurements lead to the following conclusions:

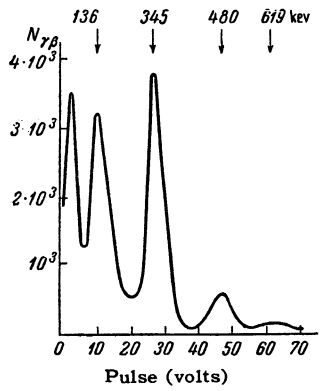

FIG. 2

1) There is no 137-kev γ transition from the 619-kev level to the 482-kev level ($T_{1/2} = 10^{-8}$ sec).

2) There exists a 619-kev γ transition, in agreement with reference 5, and two new γ transitions of energy close to 480 and 345 kev; the latter two transitions are in coincidence with 136-kev γ rays.

3) The period of the 619-kev level is less than 10^{-9} sec. On the basis of the preliminary data, it can be concluded that the 619-kev level is not the first rotational level of the family which belongs to the 615-kev level ($K = \frac{1}{2}^+[411]$).

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[2] F. Boehm and P. Marmier, Phys. Rev. 103, 342 (1956).

[3] E. Snyder and S. Frankel, Phys. Rev. 106, 755 (1957).

[4] H. Vartapetian, Ann. phys. 3, 569 (1958).

[5] Borovikov, Gvozdev, Kondurov, and Khazov, Izv. Akad. Nauk SSSR, Ser. Fiz. 23, 1448 (1959), Columbia Tech. Transl. (in press).

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