The β-Ray Spectrum of $_{91}$Ekatantalum^{233} *

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THE investigations of A. V. Grosse, E. T. Booth and J. R. Dunning[1] definitely established the existence of a β-emitting isotope of ekatantalum produced by irradiating thorium with slow neutrons. They found the half-life of this product to be 27.4 ± 0.3 days. It was assumed that the $_{91}Et^{233}$ decayed with the emission of a β-particle into $_{91}U^{233}$ and to test this hypothesis the β-ray spectrum of this substance was examined. It was found to consist mainly of conversion lines, some of the most intense of which were very close to those of $_{91}Pa^{231}$. To dispel any doubts as to the purity of the Et^{233} two separate curves were taken 27 days apart. Similar runs were made on a source of protactinium prepared by A. V. Grosse. The intensity of all the lines in the spectrum of Et^{233} decay at the same rate of approximately 27 days while the protactinium remained the same. Furthermore, closer examination revealed definite differences in the energies and structure of the lines of the spectra of ekatantalum and protactinium.

Because of the complex structure of the β-ray spectrum of $_{91}Et^{233}$, it is difficult to distinguish the nuclear disintegration electrons from the conversion electrons due to gamma-radiation. A very large fraction of the β-activity is due to conversion lines of which at least four can be distinguished at 63, 77, 192 and 293 kev. From Fig. 1 it appears that these lines are superposed on a continuous spectrum of relatively small intensity whose maximum energy end-point is masked by the line at 192 kev. By subtracting this line from the continuous background the end-point appears to lie in the neighborhood of 230 kev. Above 230 kev the spectrum consists most probably of a single conversion line at 293 kev.

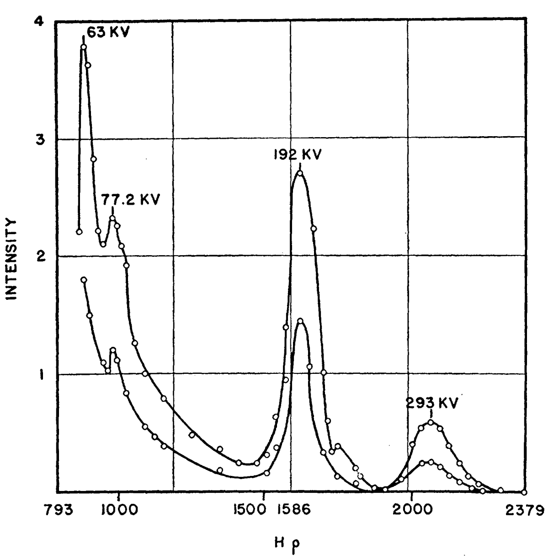

FIG. 1. Beta-ray spectrum of $_{91}$ekatantalum^{233}.

Because of the complexity of the spectrum it is planned to re-examine Et^{233} with greater resolving power (the present resolving power, i.e., half-width of line divided by $H\rho$ at maximum intensity, is 5 percent). The energies involved are in the region where corrections for absorption in the counter window (0.5-mil Cellophane) must be applied. A more detailed study with greater resolving power and thinner window is in progress which should yield more significant values of the end-point of the continuous spectrum and the energies of the gamma-rays.

[1] A. V. Grosse, E. T. Booth and J. R. Dunning, Phys. Rev. 59, 322 (1941).
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The Fourth $(4n+1)$ Radioactive Series*

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SINCE the discovery by Fermi and his co-workers[1] of $_{90}Th^{233}$, a type $4n+1$ radioactive product, numerous attempts[2,3] have been made to determine its successive disintegration products. The discovery of fission by Hahn and Strassmann has generally cast doubt upon the interpretation of previous work in this field, and quite recently Hahn and Strassmann[4] themselves questioned their original interpretation in regard to this series. We began work more than a year ago to renew these investigations.

Measurements were first made on the half-life of the thorium capture product, Th^{233}, and the thickness of aluminum required to reduce the ionization-chamber readings to one-half. These were found, respectively, to be 23.0 minutes and 0.020 cm. Similar experiments with U^{239} yielded 23.5 minutes and 0.018 cm for the equivalent values. To dispel any doubts that these two decaying products might be the same, uranium surrounded by cadmium was irradiated with neutrons in a paraffin geometry near the cyclotron. To this irradiated sample a small amount of thorium was added as a carrier and precipitated as a fluoride. This thorium precipitate contained less than one percent of the uranium activity, thus proving definitely that the two products are not identical.

It has been found that the thorium captures neutrons by a strong resonance process similar to uranium. Three identical samples of thorium (50 mg ThO_2) painted on nickel sheets were exposed to neutrons from the cyclotron in a paraffin geometry. One sample was surrounded by no absorbers, the second by 0.40 g/cm^2 of cadmium, and the third by 1.4 g/cm^2 of boron. The initial activities of the 23-minute periods were in the ratio of 100 : 55 : 11. This is interpreted as evidence that thorium has a strong resonance capture above the cadmium cut off at an energy less than 25 ev.

A search was made for "$_{91}A^{233}$" reported by I. Curie[2] to be the first disintegration product and to have a period of from 2 to 3 minutes. Thorium was irradiated with neutrons in a paraffin geometry, and element 91 separated with zirconium phosphate, the precipitate being placed upon an ion chamber in less than five minutes after the end of the irradiations. No short period was found in any of a number