Penetrating Beta-Particles from Uranium Activated by Neutrons

We have looked for penetrating beta-rays and hard gamma-rays coming from U after irradiation by fast neutrons ($\sim$3 Mev) from a D−D source, using two counters with a circuit for recording coincidences. The two glass-walled counters were placed horizontally side by side with a 2-mm layer of uranium oxide beside each counter, all as close to the target as possible ($\sim$5 cm from target to center of U). A beam of D^+ ions of 40 μA at 350 kv was run onto a target of frozen D_2O. This is known to give about $1.4 \cdot 10^8$ neutrons per sec. ($\sim$7 g Ra-Be equivalent). The geometry of the arrangement did not permit the effective use of paraffin.

The number of coincidences was reducible to practically zero by the introduction of 5.2 mm of Al between the U and the counters, showing the activity observed to be attributable to primary beta-rays rather than to secondary particles ejected by hard gamma-rays. Some coincidences were found with 3.9 mm of Al between the U and the counters, the particles having had to penetrate 3.9 mm of Al, 3.6 mm of glass, and 0.12 mm of Cu, thus having had an energy greater than 4.2 Mev. The following measurements of half-lives were made with 1.3 mm of Al between the U and the counters (for keeping out UX_2 beta-rays) and are attributable to particles of energy above 2.9 Mev. Check experiments of two sorts showed the coincidences to be genuine ones, not chance ones resulting from high initial counting rates.

The coincidences were photographically recorded by an oscillograph after stopping the bombardment. Only about 100 counts were found in each run, so it was necessary to repeat the experiment many times. From the record was found the count for each interval of 4 cm (1.93 sec.). The totalled results of 47 such experiments for which the time of bombardment was 5 sec. are shown at A in the accompanying figure. The straight line A', giving the best fit to the later points (averages of 3) corresponds to a half-life of 12.8 sec. The points at B give the differences between the original points and A', the line at B giving a half-life of 3.5 sec. The high value for the first point suggested the presence of an activity of still shorter half-life. Accordingly, the films were re-studied, and the number of counts for each 1-cm interval (0.48 sec.) tabulated. The results are plotted at C after taking off the 13-sec. activity, the line having the slope determined at B (changed scale of abscissae). The circled points show the averages of the neighboring four points. Again taking differences one gets the points at D. The line drawn here corresponds to a half-life of 0.6 sec. It is impossible, of course, to determine accurate values of half-lives from such meager data. Nevertheless, it is fairly certain that at least three must be present, and that the values obtained are of the right order of magnitude. The three half-lives may be given as 11–15 sec., 3.0–4.0 sec., 0.3–0.9 sec. The calculated values of the activities for equilibrium are roughly equal for all three half-lives.

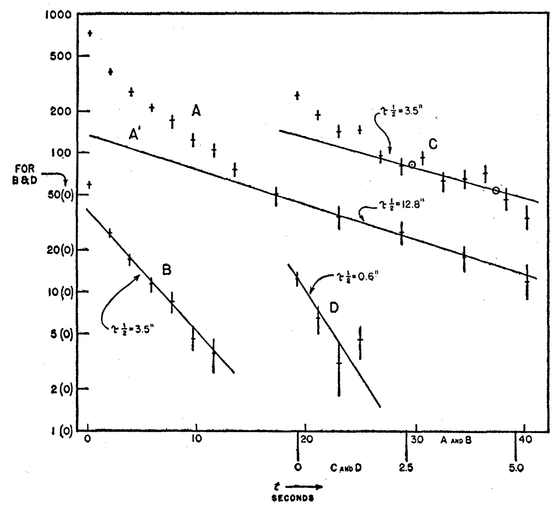

FIG. 1.

Runs made with bombardments of 30 sec. show an increase of the initial activity of the longer period consistent with the above half-lives. With bombardments of 90 sec. a larger apparent value for the longer half-life was obtained, indicating the presence of another activity of still longer half-life, making it probable that the value of 11–15 sec. is too large. It is of interest that our two longer half-lives are nearly the same as those reported for the delayed emission of neutrons.

We also looked for coincidences while the beam was running. Coincidences from beta-rays having an energy >3.3 Mev were found, but the introduction of more Al cut the number down to one inappreciably different from a high background. This result merely shows the absence of very penetrating beta-rays in any quantity comparable with that of these slower ones.

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