Radioactive Barium and Strontium from Photo-Fission of Uranium

It is of interest to learn whether photo-fission[1] produces the same radioactive elements and with similar relative yields as neutron fission. We have irradiated uranium with slow neutrons, fast neutrons, and γ-rays (separately) and have investigated the alkaline earth radioactivities produced.

In each run about one pound of uranium nitrate dissolved in nitric acid was placed close to the target of the Westinghouse electrostatic generator. To produce the γ-rays, a CaF_2 target was bombarded with one microampere of 3-Mev protons. For fast neutrons, a lithium hydride target was bombarded with three microamperes of 3-Mev unresolved hydrogen ions. For slow neutrons, a beryllium metal target was bombarded with six microamperes of 3-Mev hydrogen ions and the target surrounded with water. After irradiation for one hour, barium and strontium were chemically separated out of the uranium solution. The carrier method as described by Hahn and Strassman[2] and Lieber[3] was used. A solution of barium and strontium nitrate ($\frac{1}{2}$ gram) was added and reprecipitated with fuming nitric acid. The barium and strontium were separated from an acetic acid sodium acetate solution with ammonium chromate. The barium chromate precipitate was dissolved in dilute hydrochloric acid and barium chloride precipitated by adding concentrated hydrochloric acid. The barium chloride precipitate was dissolved in a known amount of water and put into a "water jacket" type of counter. To the strontium containing chromate filtrate was added yttrium nitrate and the yttrium precipitated with pure ammonium hydroxide. From the filtrate, strontium was precipitated with ammonium carbonate. The strontium carbonate was dissolved in a known amount of dilute hydrochloric acid and the activity determined as before. Samples of the decay curves obtained are shown in Figs. 1 and 2. It is evident from the figures that an 86-minute barium[2] and a 6-hour strontium[3] are produced, both by neutron and photo-fission. A 14-minute barium[4] is present, and the build-up of the 35-hour yttrium[3] is also shown. The ratio of the initial activity of the 6-hour strontium to the 86-minute barium is approximately the same for both slow and fast neutron fission as for γ-fission.

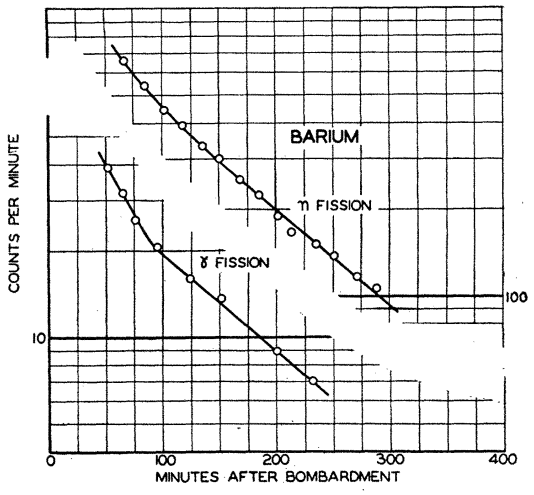

FIG. 1. Decay curves of active barium from neutron and γ-ray fission of uranium.

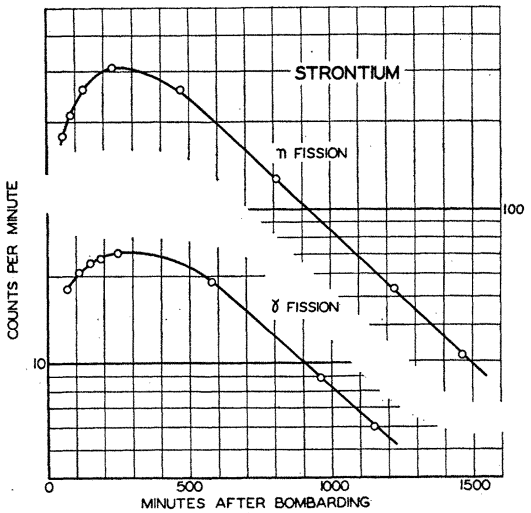

FIG. 2. Decay curves of active strontium from neutron and γ-ray fission of uranium.

To make sure that only γ-rays were causing fissions when uranium was irradiated by bombarding CaF_2 with protons, we made a check run with a calcium metal target. No activity was found in the barium and strontium fractions.

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[1] Haxby, Shoupp, Stephens and Wells, Phys. Rev. **58**, 78 (1940).
[2] O. Hahn and F. Strassman, Naturwiss **27**, 89 (1939).
[3] C. Lieber, Naturwiss **27**, 421 (1939).
[4] O. Hahn and F. Strassman, Naturwiss **27**, 11 (1939).