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Californium Isotopes from Bombardment of Uranium with Carbon Ions

A. Ghiorso, S. G. Thompson, K. Street, Jr., and G. T. Seaborg

September 6, 1950

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CALIFORNIUM ISOTOPES FROM BOMBARDMENT OF URANIUM WITH CARBON IONS

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University of California, Berkeley, California

September 6, 1950

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The recent production and identification[1] of isotopes of elements with atomic numbers up to six higher than the target element through bombardment with hexapositive 120-Mev carbon ions made it seem worthwhile to apply this technique to the transuranium region.

Accordingly, small pieces of natural uranium metal (about 0.5 mil thick and 2.5 cm by 0.6 cm area) were irradiated in the internal carbon ion beam in the Berkeley 60-inch cyclotron. Following the irradiations, the uranium was dissolved in dilute hydrochloric acid containing hydrogen peroxide and a transplutonium fraction was isolated through the use of lanthanum fluoride, and lanthanum hydroxide precipitation steps followed by the ion exchange adsorption column procedure in which concentrated hydrochloric acid is used to separate the tripositive actinide elements from the rare earth elements.[2]

The transplutonium fractions in hydrochloric acid were evaporated as weightless films on platinum plates which were placed in the ionization chamber of the 48 channel pulse analyzer apparatus in order to measure the yield and energies of any alpha-particles which might be present. In the best experiment at about one hour after the end of the 90-minute bombardment, some 50 disintegrations per minute of the distinctive 7.1-Mev alpha-particles[3] of Cf^{244} were observed to be present and to decay with the 45-minute half-life. The Cf^{244} was presumably formed by the reaction $U^{238}(C^{12},6n)$.

After the decay of the alpha-particles due to Cf^{244}, about five disintegrations per minute of alpha-particles with 6.8-Mev energy was observed and

this alpha-radioactivity decayed with a half-life of about 35 hours. A consideration of the systematics of alpha-radioactivity[4] leads us to the view that this activity is due to the new isotope Cf^{246} formed by the reaction $U^{238}(C^{12},4n)$. The measured half-life agrees with the expected alpha half-life for the observed energy for an even-even isotope of the element with atomic number 98.

It is not possible at this time to obtain a good estimate of the intensity of the carbon ion beam. Therefore, the cross sections for the reactions given above cannot be calculated. However, it is interesting to note that the indicated yields for the (C,6n) and (C,4n) reactions are comparable.

If the isotopic assignment of the new 35-hour activity to Cf^{246} is correct, these new data give a better idea as to the slope of the alpha-energy vs. mass number line for californium, which in turn makes it possible to make better predictions of the radioactive properties of the nuclides in this region.

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[1] Miller, Hamilton, Putnam, Haymond, and Rossi, Phys. Rev. (in press).

[2] K. Street, Jr. and G. T. Seaborg, J. Am. Chem. Soc. 72, 2790 (1950).

[3] Thompson, Street, Jr., Ghiorso, and Seaborg, Phys. Rev. 78, 298 (1950).

[4] Perlman, Ghiorso, and Seaborg, Phys. Rev. 77, 26 (1950).

[redacted]