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A new isotope of californium has been produced in the bombardments of ^{233}U, ^{234}U, ^{235}U, and ^{236}U with ^{12}C ions from the Hilac. It decays with a half-life of 3.4 ± 0.2 min by the emission of α particles with an energy of 7.39 ± 0.02 MeV. From an analysis of the excitation functions, it is concluded that the isotope has the mass number 242.

The uranium targets were made by molecular plating, from an isopropyl alcohol solution of uranyl nitrate onto 5-mg/cm^2 Be foils to a thickness of about 0.5 mg/cm^2. The nitrate was converted to the oxide by careful heating.

Beams of 124-MeV ^{12}C from the Hilac were, after magnetic deflection through 30 deg, degraded to the desired energy by the use of weighed Be foils. The range-energy curve of ^{12}C in Be as measured by Walton was used to estimate the energy.[1] The degraded energy spectrum was also measured by the use of a Li-diffused Si detector.

The collimator in front of the target had a diameter of 0.6 cm. The average beam current was about 1.5 x 10^{-6} A. At these intensities the degrader foils had to be water cooled.

The recoil atoms produced in the reaction were slowed down in helium at a pressure of about 700-mm Hg contained inside a cylindrical chamber of diameter 2.5 cm and length 4.4 cm. A Faraday cup for beam-intensity measurement was located at the end of the chamber. In the middle of the

chamber wall and vertical to the beam axis was a 0.2-mm orifice through which the helium gas with the recoils was pumped into a target chamber. The recoils were collected on a platinum disk[2] placed in front of the orifice at a distance of about 1 cm. After the end of bombardment, the foil was flamed to remove β and α activities of volatile elements produced from the Be foils, and Pb and Bi impurities. The remaining activities were analyzed by the use of an α grid chamber in connection with a 1600-channel pulse-height analyzer. The decay of the various α groups was followed through seven preset time intervals, during each of which 200 channels of the analyzer were used for analysis of the energy spectrum. As calibration standards, the 5.80-MeV and 7.68-MeV α groups from ^{244}Cm and ^{214}Po, respectively, were used.

The time between end of bombardment and start of analysis was about 1 minute.

Figure 1 shows a typical α spectrum obtained in the bombardment of ^{235}U with 80 MeV ^{12}C. The α groups in the spectra obtained with this and the other targets were identified as follows:

1. A group at 7.05 ± 0.02 MeV decayed with a half-life of about 10 minutes and was tentatively assigned to the previously unobserved nuclide ^{243}Cf. For further details and discussion of this α group, see the following Letter.

2. A group at 7.14 MeV and half-life of 44 min, observed with ^{236}U and ^{238}U as targets, was from the excitation functions assigned to the known[3] isotope ^{245}Cf.

3. A group at 7.21 ± 0.02 MeV decayed with a half-life of 20 min. This emitter was produced in a 3n, 4n, and 6n reaction with the targets

^{235}U, ^{236}U, and ^{238}U, respectively, and was attributed to ^{244}Cf that previously has been reported[3] to decay with a half-life of 25 ± 3 min by the emission of α particles with an energy of 7.17 ± 0.01 MeV.

4. A least-square-fit analysis of the decay for the α group at 7.39 ± 0.02 MeV in which about 500 events were used gave a half-life of 3.4 ± 0.2 min. The shapes and positions of the maxima of excitation functions for the production of this α emitter corresponded to a (^{12}C, 3n), (^{12}C, 4n), (^{12}C, 5n), (^{12}C, 6n), and (^{12}C, 8n) reaction with the targets ^{233}U, ^{234}U, ^{235}U, ^{236}U, and ^{238}U, respectively,[4] and is thus the nuclide ^{242}Cf. Especially the functions of ^{234}U (^{12}C, 4n) and ^{235}U(^{12}C, 5n) were conclusive. At the peaks of these functions about 70 events of ^{242}Cf were observed per experiment.

A more complete quantitative analysis of the functions shall be given in a later report.

The possibility that ^{242}Cf also decays by electron capture was not investigated. The half-life-energy relationship fits well the general trend for even-even Cf isotopes, indicating the dominant mode of decay for ^{242}Cf to be by α emission. The α energy of 7.39 MeV corresponds to a Q_α of 7.54 MeV that is in excellent agreement with the value predicted by Foreman and Seaborg.[5]

We would like to thank Donald F. Lebeck for help in the analysis of the data. We also wish to thank Charles A. Corum for the design of the equipment, Thomas E. Bowman for the preparation of the targets, and the Hilac crew for excellent accelerator operations.

*This work was done under the auspices of the U. S. Atomic Energy Commission.

1. John R. Walton (LRL, Berkeley) unpublished results, 1960.

2. This technique was first developed by one of the authors (Albert Ghiorso) in 1959 and later applied by R. MacFarlane and R. D. Griffioen, then at the Lawrence Radiation Laboratory, who published a similar version of the experimental arrangement in Nucl. Instr. Methods 24, 461 (1963).

3. A. Chetham-Strode, Jr., G. R. Choppin, and B. G. Harvey, Phys. Rev. 102, 747 (1956).

4. T. Sikkeland, S. G. Thompson, and A. Ghiorso, Phys. Rev. 112, 543, (1958).

5. B. M. Foreman, Jr., and G. T. Seaborg, J. Inorg. Nucl. Chem. 7, 305 (1958).

Fig. 1. Alpha spectrum from five 10-min bombardments of 500 $\mu g/cm^2$ of ^{235}U with about 80 MeV ^{12}C of intensity 6 $\mu A/cm^2$ (+6 ions).

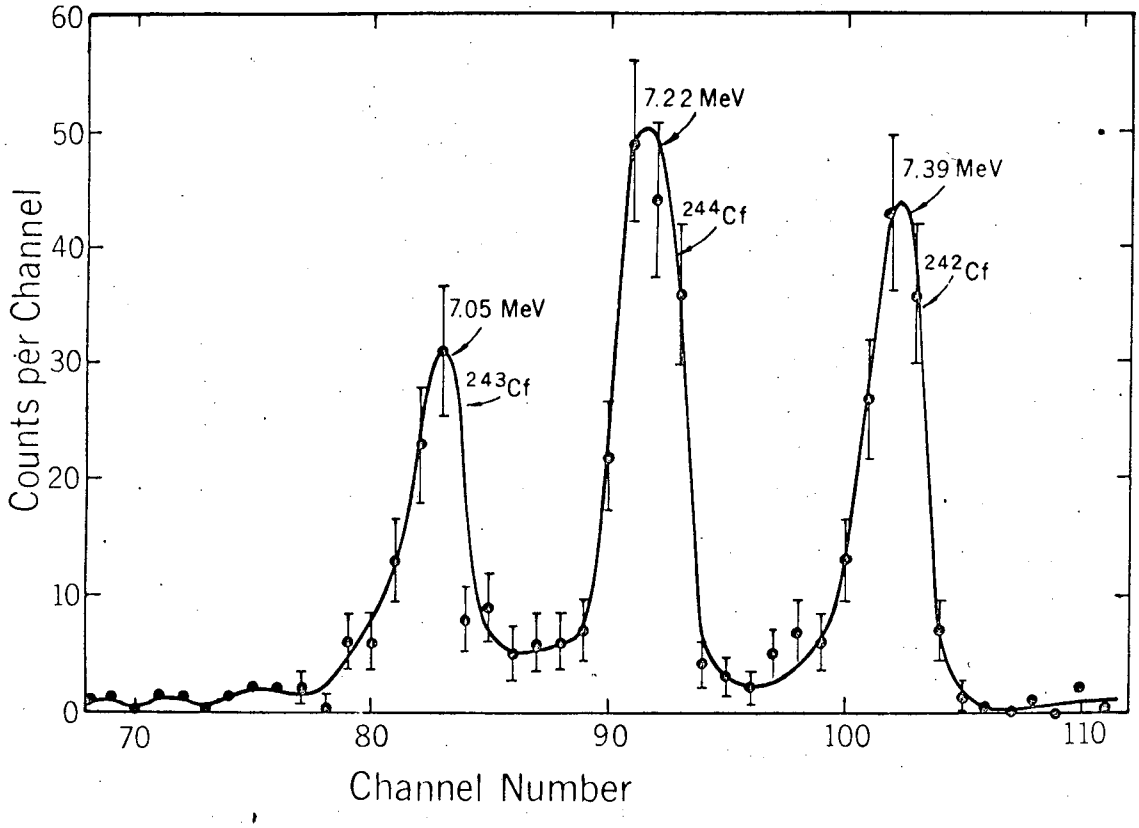

Fig. 1

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