Fission Fragment Kinetic Energies of Cf^{246}, Cf^{248}, and Cf^{254}†

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Fission fragment kinetic energy spectra of Cf^{246}, Cf^{248}, and Cf^{254} were measured by comparison to Cf^{252}. The most probable fragment energies were (in MeV): Cf^{246}, 84.8±1.3 and 110.8±1.5; Cf^{248}, 81.6±0.9 and 107.1±0.8; Cf^{254}, 83.0±2 and 103.1±2.

A SURVEY of the kinetic energy of fission fragments from spontaneous fission or neutron-induced fission shows an increasing amount of kinetic energy in the fragments as the fission parameter Z^2/A increases.[1] It appeared interesting to determine how the fission kinetic energy varied as the mass number varied for a given Z. A convenient series for this study was the californium isotopes Cf^{246}, Cf^{248}, Cf^{252}, and Cf^{254}. Cf^{252} had already been studied[1,2] and recently data on the fission kinetics of Cf^{254} has been reported.[3] In this paper the fission kinetic energy of Cf^{246}, Cf^{248}, and Cf^{254} are reported and compared with Cf^{252}.

Cf^{246} and Cf^{248} were prepared simultaneously by irradiating curium containing 98% Cm^{244} and 2% Cm^{246} with 41-MeV helium ions in the 60 in. Argonne cyclotron. The californium was isolated from the curium by a series of ionic exchange columns. The californium was prepared in a form suitable for measuring the kinetic energies of the fission fragments by volatilizing the oxide onto a quartz plate in a special vacuum evaporator. At the time the source was prepared 99.5% of the spontaneous fission events of the source was due to the 35-h Cf^{246}; after about 30 days essentially all the spontaneous fissions observed were due to the longer lived Cf^{248}.

A highly enriched sample of Cf^{254} was prepared by utilizing the small electron-capture branching ratio (~0.1%) of the 38-h isomer of Es^{254}. Es^{254} was prepared by irradiating a sample of Cf^{252} for 6 months in the Materials Testing Reactor. The Es^{254} was chemically separated from the californium and fission products and allowed to decay. The products Cf^{250}, formed from the α decay of accompanying Fm^{254}, and Cf^{254} from the electron capture decay of Es^{254} were isolated. The mass ratio of Cf^{250} to Cf^{254} was about 1000 to 1. These isotopes were then separated in the Argonne isotope separator. In the final product the Cf^{250} made a negligible contribution to the total fissions. The separated Cf^{254} was collected on aluminum and contained 1 spontaneous fission per min; this was used directly for energy measurements.

The fission fragment kinetic energy spectrum of each sample was measured with silicon diffuse junction detectors and compared to a Cf^{252} standard at frequent intervals during each run. Due to the small amounts of activity it was only feasible to measure single-sided noncoincident spectra.

Table I lists the most probable kinetic energies found for the high- and low-energy peaks in each sample. The values used for the Cf^{252} standard were 104.7±1 and 79.8±1 MeV.[2] A Gaussian analysis was used to determine the energies. The energies were normalized to the data taken by the time-of-flight measurements.[2] More accurate values would have been obtained by correcting the measured energies for the kinetic energies carried off by the neutrons; however, this was not done since ν is unknown for the isotopes involved.

TABLE I. Most probable fission fragment kinetic energies (in MeV).

Isotope	E heavy	E light	E total	Mass ratio
Cf^{246}	84.8±1.3	110.8±1.5	195.6±2.0	1.31±0.03
Cf^{248}	81.6±0.9	107.1±0.8	188.7±1.3	1.31±0.02
Cf^{252} [a]	79.8±1	104.7±1	184.5±1.4	1.31±0.03
Cf^{254}	83.0±2	103.1±2	186.1±2.8	1.24±0.05

[a] Standard; see Ref. 2.

* Based on work performed under the auspices of the U. S. Atomic Energy Commission.

[1] A. B. Smith, P. Fields, A. Friedman, S. Cox, and R. Sjoblom, in *Proceedings of the Second International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958* (United Nations, New York 1958).
[2] J. C. Milton and J. S. Frazer, Phys. Rev. **111**, 877 (1958).
[3] R. Brandt, Lawrence Radiation Laboratory Report UCRL-10481, 1962 (unpublished).