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Alpha Decay of Cf^{246}†

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A sample of Cf^{246} was prepared by intensive alpha bombardment of Cm^{244}. The alpha spectrum was studied by use of silicon surface barrier detectors having a resolution of 18 keV at 6.7-MeV alpha energy. The alpha energies and intensities found for the transitions were: 6.753 MeV, 77.9±0.2%; 6.714±0.0007 MeV, 21.9±0.2%; 6.621±0.001 MeV, 0.18±0.02%; and 6.465±0.003 MeV, undetermined intensity. The energies can be fitted by the expression

$$E=6.46I(I+1)+0.0074I^2(I+1)^2\ \text{keV}$$

and the relative intensities by $C_0:C_2:C_4=1:0.42:0.080$, where the C's are the reciprocals for the hindrance factors of the various L waves.

TEN milligrams of Cm^{244} containing 2% Cm^{246} by mass were bombarded for 100 h in the Argonne 60-in. cyclotron. After the bombardment the resulting products were chemically purified and samples of the californium fraction were volatilized onto backing disks for alpha and fission counting. For the first two weeks essentially all the californium activity was due to Cf^{246}. The singles alpha spectrum was obtained by use of a silicon surface barrier detector and a 400-channel pulse-height analyzer. The fissions were counted in a small fast ion chamber using pulse-height discrimination to sort out the alpha pulses. The alpha to fission ratio so found gave a fission half-life of 1340±160 yr in reasonable agreement with the value of 2100 yr of Hulet, Thompson, and Ghiorso[1] for an alpha half-life of 36 h.

The alpha singles spectrum is shown in Fig. 1. The

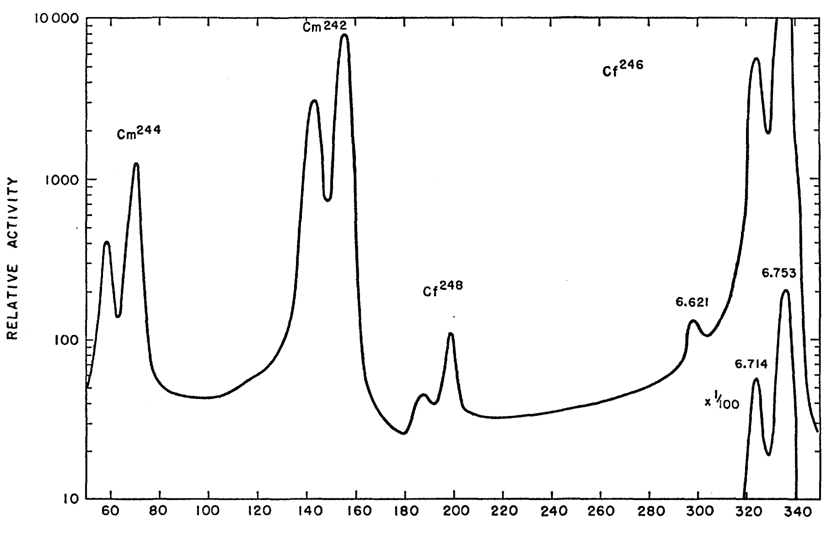

FIG. 1. Alpha singles spectrum of Cf^{246}.

† Based on work performed under the auspices of the U. S. Atomic Energy Commission.
[1] E. K. Hulet, S. G. Thompson, and A. Ghiorso, Phys. Rev. 89, 878 (1953).

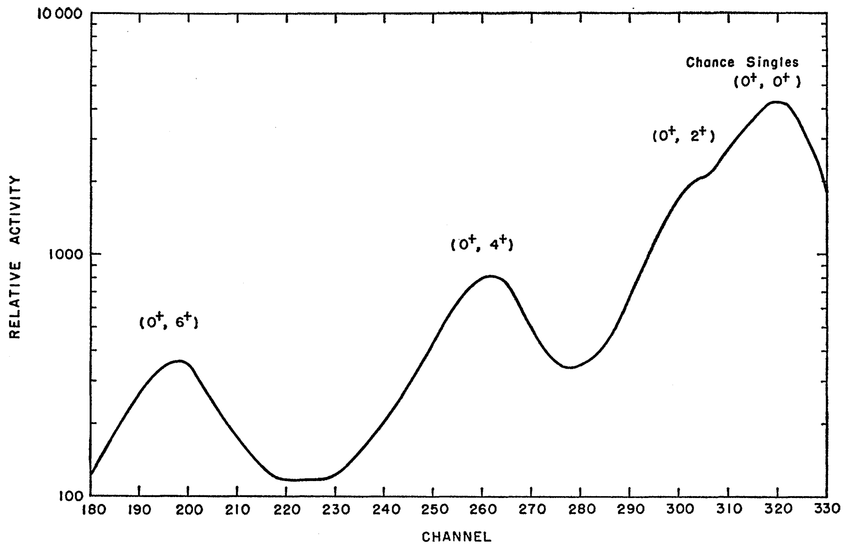

FIG. 2. Gamma-alpha coincidence spectrum of Cf^{246}.

circuits and detectors used gave a full width at half-maximum of 17.9 keV for the Cf^{246} $(0^+,0^+)$ transition at 6.753 MeV. The symbol $(I_1^{\pi_1},I_2^{\pi_2})$ is used to represent conveniently an alpha transition from a state of spin I_1 and parity π_1 to a state of spin I_2 and parity π_2. The energies of the peaks were calculated by use of a Gaussian fitting computer program, the intensities of the transitions were obtained by graphical integration. The analyzer was calibrated by using Cm^{242} and Pu^{238} standards.

The spectrum obtained by use of silicon detectors has a low-energy linear component added to the main Gaussian peaks. This linear component tends to obscure lower energy low-intensity peaks. To eliminate this the analyzer was gated by demanding coincidences between alpha pulses and gamma pulses corresponding to Cm K x-ray energies or higher. The alpha spectrum would then tend to emphasize those transitions that went to states which de-excited by K conversion or by γ emission with an energy greater than 105 keV. Figure 2 shows the spectrum so obtained. To obtain a reasonable coincidence rate a larger detector was used which gave only 50-keV resolution.

TABLE I. Alpha spectrum of Cf^{246}.

Transition	Energy (MeV)	Intensity (%)	Energy[a] (MeV)	Intensity[a] (%)
$(0^+,0^+)$	6.753	77.9	6.753	78
$(0^+,2^+)$	6.714±0.0007	21.9	6.711	22
$(0^+,4^+)$	6.621±0.001	0.18	...	...
$(0^+,6^+)$	6.465±0.005	...	...	...

[a] See Ref. 3.

The energies and intensities of the alpha transitions are tabulated in Table I.

The alpha-energy standards used were Pu^{238}, Cm^{244}, Cm^{242}, and the Cf^{246} ground-state transition determined by Hummel *et al.*[2]

It was found that the data in Table I could be fitted by

$$E_I=\alpha I(I+1)+\beta I^2(I+1)^2$$

with $\alpha=6.46$ keV, $\beta=0.0074$ keV, and the intensities could be expressed by $C_0:C_2:C_4=1:0.42:0.088$, where the C's are the reciprocals for the hindrance factors of the various L waves.[3] We would like to express our thanks to the cyclotron crew, especially G. Parker and M. Oselka, for their aid in the bombardment and in design of the curium target holder.

[2] J. P. Hummel, F. S. Stephens, Jr., F. Asaro, A. Chetham-Strode, Jr., and I. Perlman, Phys. Rev. **98**, 22 (1955).

[3] F. Asaro, S. G. Thompson, F. S. Stephens, and I. Perlman, in *Proceedings of the International Conference on Nuclear Structure, Kingston, Canada, 1960*, edited by D. A. Bromley and E. Vogt (University of Toronto Press, Toronto, 1960), pp. 581–3.