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UCRL-2947

The New Element Fermium, Atomic Number 100

A. Ghiorso, S.G. Thompson, G.H. Higgins and G.T. Seaborg
Radiation Laboratory and Department of Chemistry
University of California, Berkeley, California

April 7, 1955

This communication is a description of the results of experiments performed in January 1953 and the following months which represent the discovery of the element with atomic number 100.

Upon learning[1] that the isotope Pu^{244} was present in the plutonium fraction from uranium furnished by the University of California Los Alamos Scientific Laboratory, which had been subjected to a very high instantaneous neutron flux, and following the observation[2] that this material contained a 6.6-Mev alpha emitter due to element 99 it was decided to look for isotopes of element 100 in material from the same source. After dissolution of the sample and preliminary chemistry designed to isolate a tripositive lanthanide and actinide (transplutonium) fluoride fraction, followed by separation of the actinides by the ion exchange adsorption-concentrated HCl elution method,[3] the mixture of tripositive actinides was adsorbed on the cation-exchange resin Dowex-50 and eluted at 87° C with ammonium citrate solution.[4] The completion of the alpha pulse analyses of the various fractions from such elution experiments resulted in the positive identification (i.e., elution in the eka-erbium position just ahead of the 6.6-Mev element 99 alpha activity) of a 7.1-Mev alpha activity as due to an isotope of element 100. The intensity of this new alpha particle activity, which had been independently and previously observed[5] at Los Alamos without chemical identification beyond proving that it was due to a

[redacted]

transplutonium element, was about 4 percent of that of the 6.6-Mev alpha activity. The amount of activity was so small (0.06 alpha count per minute) and its half-life so short (approximately a day) that it was not possible in the first experiment (January 16, 1953) to deduce its exact elution position (see Fig. 1). It was clear that the short-lived 7.1-Mev activity was sustained by a 99 parent; subsequent elution and pulse analysis experiments showed half-lives of about 16 hours for the 100 activity and about 30 days for its 99 parent. The exact elution position of this new element as eluted with ammonium citrate at 87° C from a Dowex-50 cation-exchange resin column was determined in a later experiment (March 1, 1953) utilizing more material and is shown in Fig. 2.

A rather definite isotopic assignment could be made for this element 100 activity, both from a consideration of the energy surface and pattern of radioactivity in this region,[6] and on the basis of subsequent results from the intense neutron irradiation[7-10] of Pu^{239}. These suggested the mass number 255 for the 7.1-Mev 100 alpha activity, corresponding to the decay sequence $99^{255} \xrightarrow[\sim 30\ d]{\beta^-} 100^{255}$ (~16-hour, 7.1-Mev alpha particle), the 99^{255} originating from the beta decay of U^{255} and daughters.

We suggest for the name for the element with atomic number 100, fermium (symbol Fm), after Enrico Fermi.

ACKNOWLEDGMENTS

We wish to thank R. W. Spence of the University of California Los Alamos Scientific Laboratory and K. Street, Jr., of the University of California Livermore Laboratory, and their groups, for their aid in

providing source material for this work and for their active interest and cooperation. The aid of L. Zumwalt, L. B. Werner, N. E. Ballou, and I. J. Russell is also gratefully acknowledged. The active assistance of N. B. Garden and his Health Chemistry Group, and of R. A. Glass was indispensable to the success of this investigation.

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

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1. Inghram, Fried and co-workers, private communication (December 1952).
2. Forthcoming publication from our laboratory and the Argonne Laboratory will describe the discovery of element 99.
3. K. Street, Jr. and G. T. Seaborg, J. Am. Chem. Soc. 72, 2790 (1950).
4. See, e.g., Thompson, Street, Ghiorso, and Seaborg, Phys. Rev. 80, 790 (1950).
5. R. W. Spence and C. I. Browne, private communication (January 1953).
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7. Thompson, Ghiorso, Harvey, and Choppin, Phys. Rev. 93, 908 (1954).
8. Harvey, Thompson, Ghiorso, and Choppin, Phys. Rev. 93, 1129 (1954).
9. Studier, Fields, Diamond, Mech, Friedman, Sellers, Pyle, Stevens, Magnusson, and Huizenga, Phys. Rev. 93, 1428 (1954).
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FIGURE CAPTIONS

Fig. 1. First elution of element 100 in relation to elements 99 and 98 with ammonium citrate.

Fig. 2. Elution of elements 95-100 with ammonium citrate.

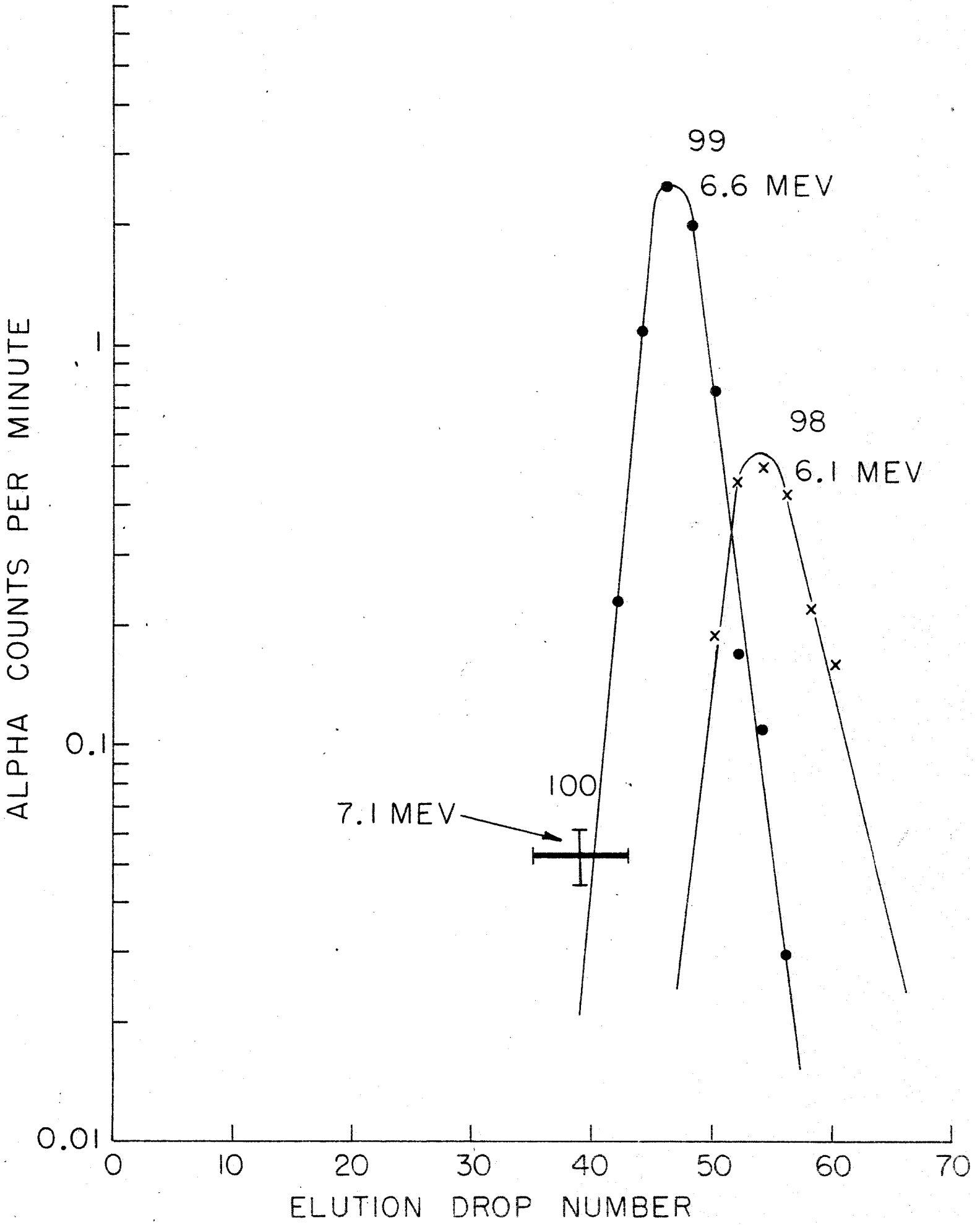
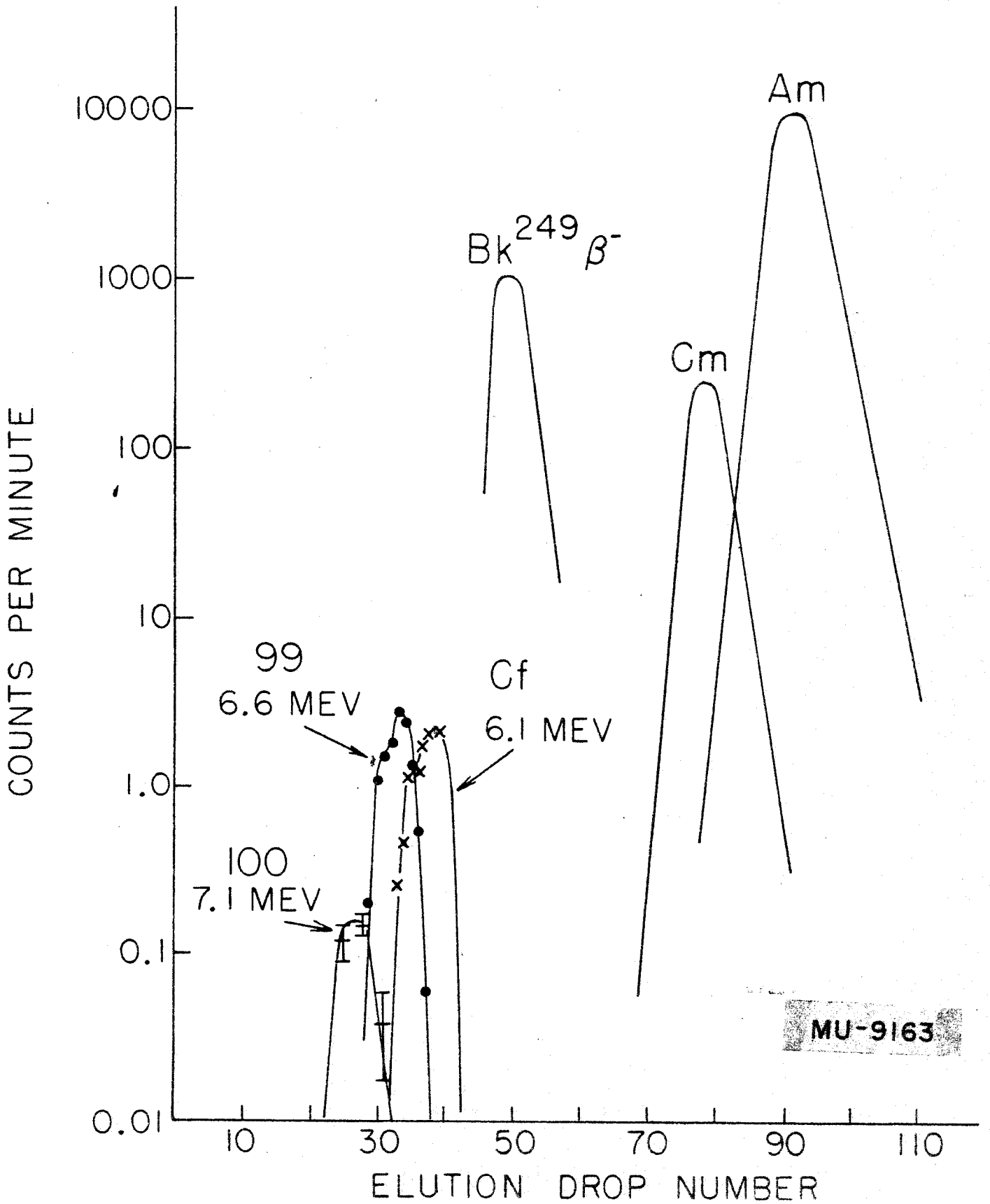

99
6.6 MEV
98
6.1 MEV
100
7.1 MEV
ALPHA COUNTS PER MINUTE
1
0.1
0.01
0
10
20
30
40
50
60
70
ELUTION DROP NUMBER

Fig. 23375-1


COUNTS PER MINUTE
10000
1000
100
10
1.0
0.1
0.01
Bk249 β-
Am
Cm
99
6.6 MEV
Cf
6.1 MEV
100
7.1 MEV
MU-9163
10
30
50
70
90
110
ELUTION DROP NUMBER