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THE NEW ELEMENT LOSALIUM, ATOMIC NUMBER 99

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THE NEW ELEMENT LOSALIUM, ATOMIC NUMBER 99

A. Ghiorso, S. G. Thompson, G. H. Higgins, and G. T. Seaborg

May 5, 1955

Printed for the U. S. Atomic Energy Commission

[redacted]

The New Element Lawrencium, Atomic Number 103

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University of California, Berkeley, California

May 5, 1955

This communication is a description of the results of experiments performed in December 1952 and the following months which represent the discovery of the element with atomic number 103.

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, it was decided to look for isotopes of transcalifornium elements 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,[2] the mixture of tripositive actinides was adsorbed on the cation-exchange resin Dowex-50 and eluted at 87° C with ammonium citrate solution.[3] Upon completion of the alpha pulse analyses of the various fractions from this first elution experiment the measurements showed the presence of what appeared to be transcalifornium activity consisting of 6.6-Mev alpha particles (see Fig. 1) and spontaneous fission.

In order to prove that a new element had been found, part of the first sample was redissolved, tracer Cf^{246} (36-hour, 6.75-Mev alpha particle[4]) was added to it and combined with another sample of the same source material and another elution and alpha

pulse analysis experiment was immediately performed. Despite the very small amount of activity (about 1 count per minute) this second experiment showed that the 6.6-Mev alpha activity eluted ahead of the Cf^{246} alpha activity and hence proved[5] conclusively that a new (transcalifornium) element had been found. Figure 2 shows the pulse analysis data for two successive elution fractions, of which the first (Fig. 2a) shows clearly the 6.6-Mev alpha particle component while the second (Fig. 2b) shows essentially no 6.6-Mev alpha component but only the 6.75-Mev alpha particle of Cf^{246}. Obviously the assignment of atomic number could not be made on the basis of these data. On the erroneous assumption that the spontaneous fission was due to a transcalifornium nuclide a tentative assignment to "100^{254}" was made which was changed immediately upon completion of the next elution experiment a couple of days later as described below.

In order to complete the atomic number identification for the newly discovered element (i.e., make the correct choice between atomic numbers 99 and 100), the elution samples were immediately redissolved and a third elution and pulse analysis experiment was performed. The results of this experiment, shown in Fig. 3, showed conclusively that the 6.6-Mev alpha activity is due to an isotope of element 99, with elution clearly in the eka-holmium position. Thus the atomic number identification for this new element was completed on December 20, 1952. Measurements on the elution fractions from this third experiment showed that the spontaneous fission was due largely to a californium isotope. Measurements

during the next few weeks showed a half-life for the 6.6-Mev 99 alpha activity of about 20 days and that it was sustained by a californium parent whose half-life was established somewhat later, as also about 20 days.

A rather definite isotopic assignment could be made, 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 253 for the 6.6-Mev 99 alpha activity, corresponding to the decay sequence $Cf^{253} \xrightarrow[\sim 20\ d]{\beta^-} 99^{253}$ (~20 day, 6.6-Mev alpha particle), the Cf^{253} originating from the beta decay of U^{253} and daughters.

The above observations were confirmed a short time later by Studier, Fields, Diamond, Mech, Hirsch, Pyle, and Fried of the Argonne National Laboratory.

We suggest for the name for the element with atomic number 99, losalium (symbol Lo), after the University of California Los Alamos Scientific Laboratory.

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.

REFERENCES

[1] Inghram, Fried and co-workers, private communication (December 1952).

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

[3] See, e. g., Thompson, Street, Ghiorso, and Seaborg, Phys. Rev. 80, 790 (1950).

[4] Ghiorso, Thompson, Street, Seaborg, Phys. Rev. 81, 154 (1951).

[5] The information that a new element had been discovered was immediately communicated, before the completion of the atomic number identification, to the AEC Los Alamos and Argonne Laboratories; in these communications the 6.6-Mev alpha particles were tentatively assigned to "100^{254}" on the tentative assumption that this alpha activity and the spontaneous fission might be due to the same nuclide, as spontaneous fission systematics indicated that such a degree of spontaneous fission, if due to a transcalifornium nuclide, should be associated with an even-even isotope of element 100.

[6] G. T. Seaborg, University of California Radiation Laboratory Unclassified Report UCRL-1942 (March 1952). (Ohio State University Third Annual Phi Lambda Upsilon Lecture Series.)

[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).

[10] Fields, Studier, Mech, Diamond, Friedman, Magnusson, and Huizenga, Phys. Rev. 94, 209 (1954).

FIGURE CAPTIONS

Fig. 1. First elution experiment (citrate eluant).

Fig. 2. Alpha pulse analyses of fractions from second elution experiment.

Fig. 3. Third elution experiment (citrate eluant).

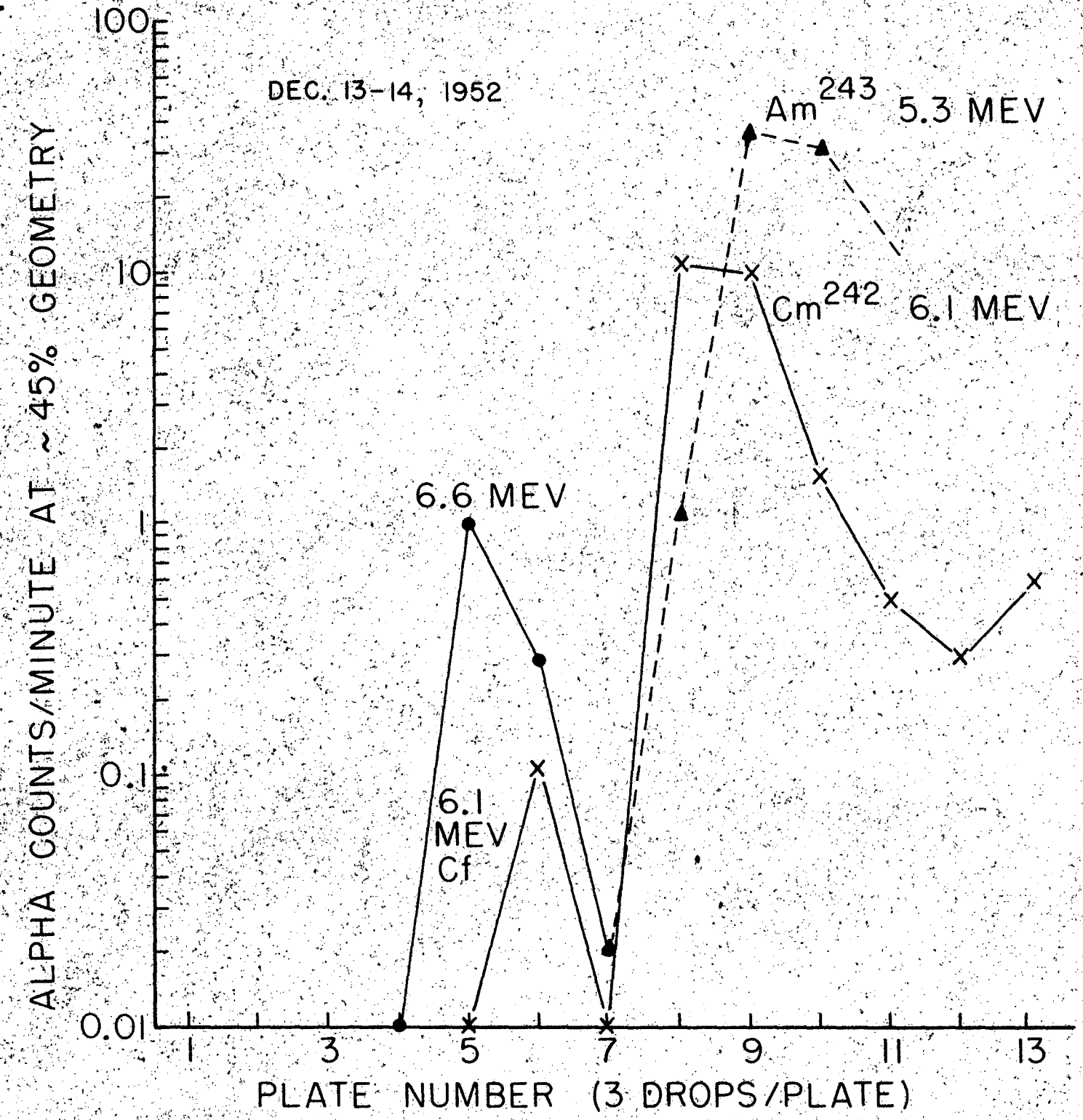
DEC. 13-14, 1952
Am 243 5.3 MEV
Cm 242 6.1 MEV
6.6 MEV
6.1 MEV Cf
ALPHA COUNTS/MINUTE AT ~45% GEOMETRY
100
10
1
0.1
0.01
1
3
5
7
9
11
13
PLATE NUMBER (3 DROPS/PLATE)

Fig. 1

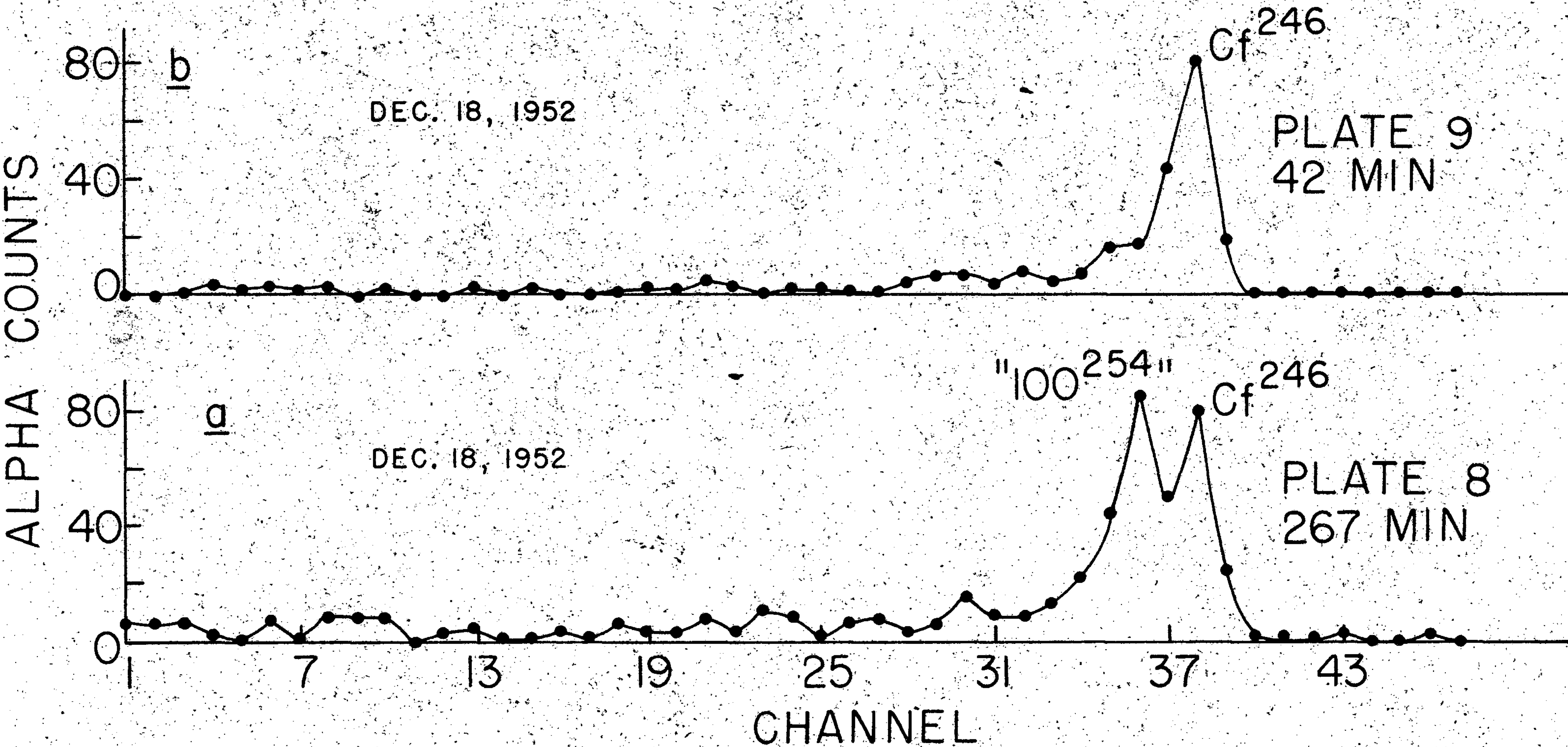
ALPHA COUNTS
80
40
0
b
DEC. 18, 1952
Cf^{246}
PLATE 9
42 MIN
a
DEC. 18, 1952
"100^{254}"
Cf^{246}
PLATE 8
267 MIN
1
7
13
19
25
31
37
43
CHANNEL

Fig. 2

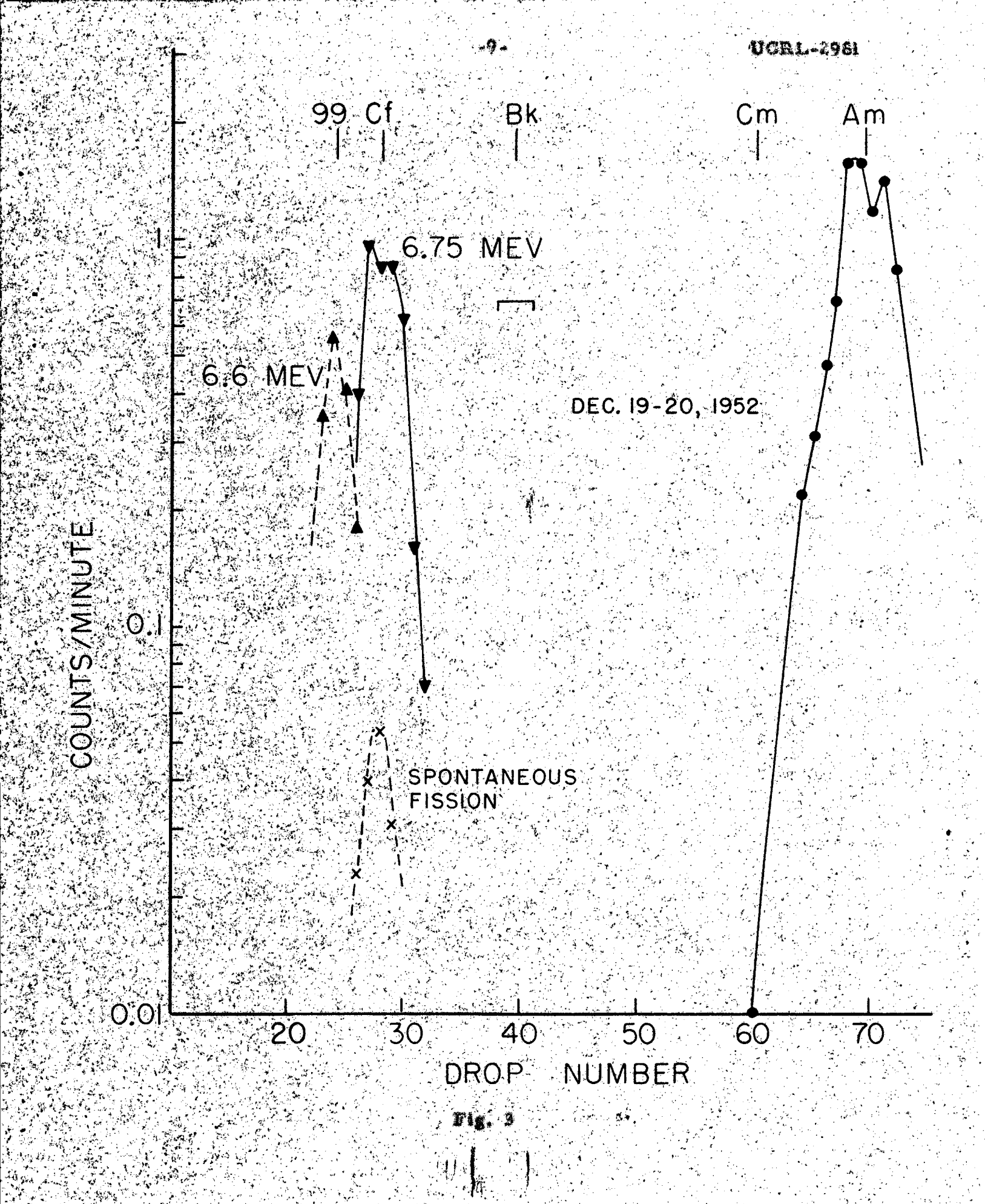
99 Cf
Bk
Cm
Am
6.75 MEV
6.6 MEV
DEC. 19-20, 1952
SPONTANEOUS FISSION
COUNTS/MINUTE
1
0.1
0.01
20
30
40
50
60
70
DROP NUMBER

Fig. 3

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