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DISCOVERY OF A NEW MENDELEVIUM ISOTOPE

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DISCOVERY OF A NEW MENDELEVIUM ISOTOPE

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August 1958

Helium ion bombardments of E^{253} have resulted in the identification of a new isotope of mendelevium (element 101) with mass number 255. The isotope decays by orbital electron capture to Fm^{255}, with a half life of approximately 1/2 hour. The daughter isotope was identified by its alpha energy (7.08 Mev) and half-life (21.5 hours).[1] Mendelevium-255 may also decay by alpha branching with an energy of 7.34 Mev, but the evidence for this is not conclusive.

Bombardments were carried out at the 60-inch cyclotron at Crocker Laboratory using a modified version of the target probe previously described.[2] Helium ion energies of 24, 29, 36, and 42 Mev were obtained with intensities of the order of 5 microamperes on a target area of 0.07 cm^2. Approximately 2×10^{12} atoms of E^{253} were electroplated on the target area of a 1.0 mil gold foil. During the course of the experiments, the amount of einsteinium decayed to a value of 3×10^{11} atoms. The transmuted nuclei were caught on a catcher foil adjacent to the target area using standard recoil techniques.[3] To determine the recoil and chemical yield, a known amount of Cm^{244} was included in the target so that the Cf^{246} and Cf^{245} produced by the helium ion beam would serve as a monitor.[4]

The earliest experiments were confined to a search for short-lived alpha emitting isotopes of mendelevium. Two methods were used to obtain the actinide fraction. In the first method, a gold catcher foil (0.2 mg/cm^2) was dissolved in aqua regia, and the gold was removed by passing the solution (in

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* French Atomic Energy Commission – C.E.N. Fontenay-aux-Roses, FRANCE.

2 M HCl) through a Dowex-1 anion resin column. In the second method, the recoil nuclei were caught on a thin Mylar film (0.5 mg/cm^2) which subsequently was placed on a platinum plate and ignited to destroy the organic matter. The sample was transferred to a 50-channel alpha pulse height analyzer for observation of the alpha groups.

In the investigation for longer lived isotopes, the gold catcher foil was dissolved and the gold removed as described above. The actinide fraction was evaporated to dryness, redissolved in 0.05 M HCl and sorbed on a Dowex-50 (12% cross-linked) cation resin column. The actinides were then eluted in sequence with 0.25 M ammonium alpha-hydroxy isobutyrate solution (pH = 4.68). The mendelevium and fermium elution positions were internally calibrated by adding thulium and yttrium tracers. A 7.08 Mev alpha group, decaying with a half-life of 21 hours, was observed in the mendelevium and fermium fractions. In order to establish that the 7.08 Mev alpha group in the mendelevium fraction was due to electron capture decay from mendelevium, the mendelevium fraction was transferred to a second cation column and again separated into mendelevium and fermium fractions. The 7.08 Mev alpha group was observed in both new fractions. It was concluded that in the time interval between cation columns, Fm^{255} grew in as a result of the electron capture decay of Mv^{255}. A half-life of the order of 1/2 hour was estimated for the electron capture decay of Mv^{255}. In a parallel determination, the observations of spontaneous fission events from Fm^{256} in the mendelevium and fermium fractions, confirmed the decay of Mv^{256} by electron capture. Approximately 100 times as many fission events were seen in one experiment as compared to the number previously reported.[5] A revised half-life of 1.5 hours was measured for the electron capture decay of Mv^{256}.

A 7.34 Mev alpha group, decaying with a half-life of approximately 3/4 hours, was observed in only the mendelevium fraction. This alpha group appeared in low

intensities at all bombardment energies and was therefore interpreted as possibly being due to alpha decay branching of Mv^{255} (Table 1).

The cross-sections for the formation of Mv^{256} and Mv^{255} at the various helium ion energies are given in Table 1. Included also, are the overall formation cross-sections of Fm^{256}, Fm^{255}, and Fm^{254}, uncorrected for possible contribution from the electron capture decay of the mendelevium isotopes. A revised spontaneous fission half-life of 160 ± 10 minutes is reported for Fm^{256} (Fig. 1).

Eighteen separate experiments were done in this series of bombardments. The observable half-life range for an alpha emitting isotope of mendelevium, formed with 1 millibarn cross-section, was approximately 5 minutes to 1.5 months.

We would like to give our thanks to the Chemistry Division Instrumentation Group for their aid with the electronic counting equipment. We should also like to thank the crew of the Crocker Laboratory 60-inch cyclotron for the dependable service encountered during our bombardments.

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Table I

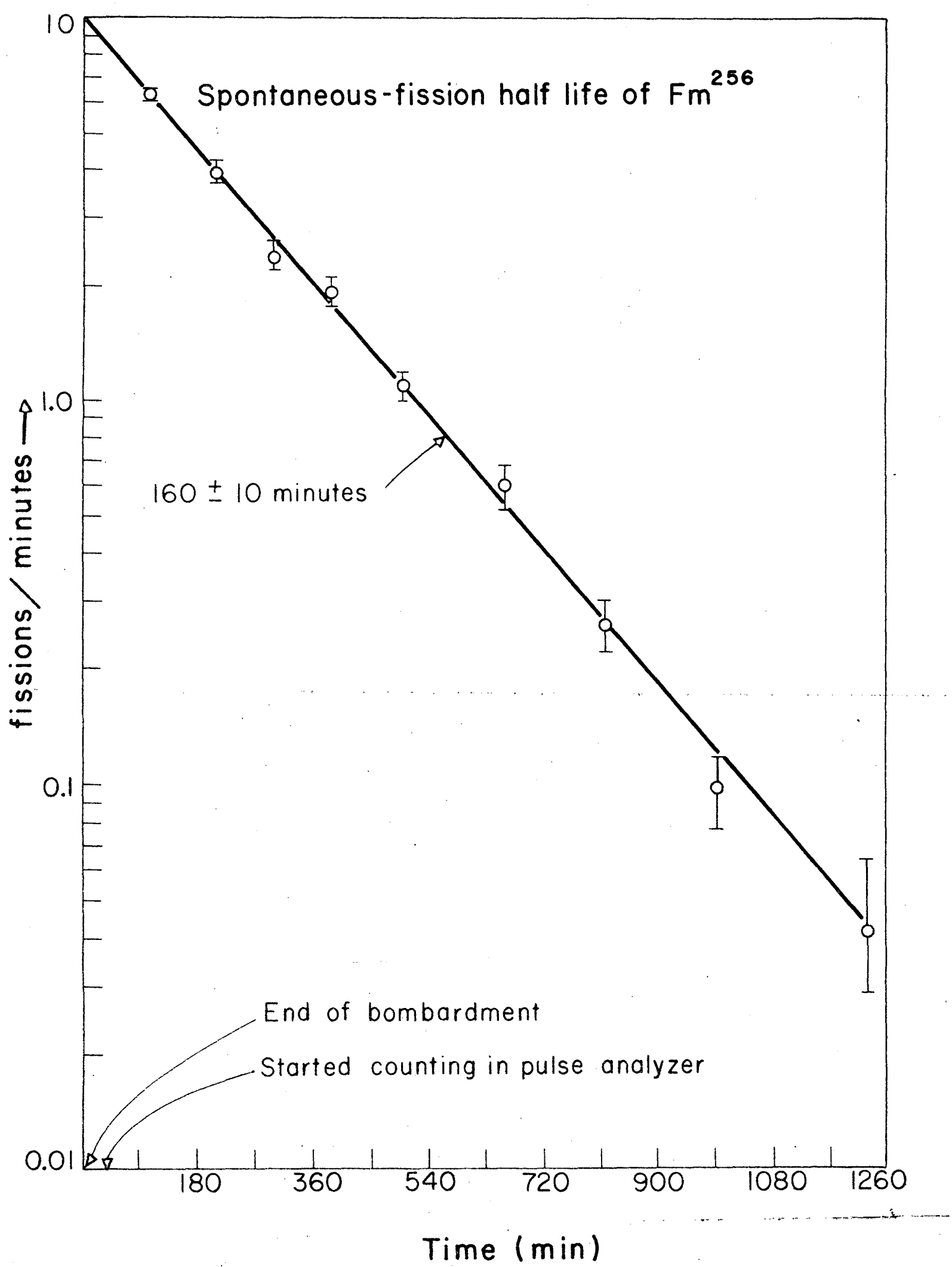
Summary of Helium Ion Bombardments of E^{253}

Isotope	Mode of Decay	Half-Life	Cross-Section			
			24 Mev	29 Mev	36 Mev	42 Mev
Mv^{256}	Electron Capture	~ 1.5 hr	~ 0.1 mb	~ 1 mb	~ 1 mb	~ 1 mb
Mv^{255}	Electron Capture	~ 1/2 hr	ψ	~ 1 mb	~ 1 mb	~ 1 mb
	7.34 Mev α	~ 3/4 hr	ψ	~ 0.2 mb	~ 0.2 mb	~ 0.2 mb
Fm^{256}	Spontaneous Fission	160±10 min	~ 0.1 mb*	~ 1 mb*	~ 1 mb*	~ 1 mb*
Fm^{255}	7.08 Mev α(1)	21.5 hr(1)	~ 0.4 mb*	~ 4 mb*	~ 6 mb*	~ 6 mb*
Fm^{254}	7.20 Mev α(1)	3.24 hr(1)	ψ	~ 0.5 mb*	~ 10 mb*	~ 10 mb*

(1) Reference 1.

* These are over-all cross-sections.

ψ Activity insufficient for calculation of cross-section.


Spontaneous-fission half life of Fm^{256}
160 ± 10 minutes
End of bombardment
Started counting in pulse analyzer
10
1.0
0.1
0.01
fissions / minutes
180
360
540
720
900
1080
1260
Time (min)

51,115-1