Phys. Lett., 1967, v.25B, N5
p. 331-332

ОБЪЕДИНЕННЫЙ
ИНСТИТУТ
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ИССЛЕДОВАНИЙ

Дубна

E6 - 3386

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SOME DECAY PROPERTIES OF Fm^{251} AND Fm^{252}

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SOME DECAY PROPERTIES OF Fm^{251} AND Fm^{252}

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Introduction

The isotope ^{251}Fm was first prepared in 1957 [1] by the bombardment of ^{249}Cf with helium ions in the energy range of 20-40 MeV.

It was found that ^{251}Fm decays by electron capture and by 6.89MeV alpha-particle emission. The observed half-life was 7 hours and the ratio of electron capture to alpha decay of about 100.

The mass anomaly [2] indicating the subshell of 152 neutrons makes the total transition energy especially interesting.

It can be expected that the ground state of ^{251}Fm is characterized by the Nilsson quantum number 9/2-/734/ like that of ^{249}Cf [3], whilst the daughter product ^{247}Cf by 7/2+/624/ as assigned to ^{245}Cm [4] and ^{243}Pu [4].

The main group of alpha-particles would then populate the excited state of ^{247}Cf and the alpha gamma coincidences could give the total transition energy.

The ^{252}Fm isotope was first identified by Friedman and co-workers [5], then investigated by Amiel and co-workers [1]. The half-life was measured to be 22.7 hours [5] and 30 hours [1] and the energy 7.04 and 7.05, respectively.

Experiment

The fermium isotopes were produced by the reaction ^{238}U $(^{18}O, xn)Fm$ The thick target of U_3O_8 deposited onto a water cooled copper support was irradiated during 10 hours with ^{18}O ions of the JINR cyclotron.

The beam energy of a 100 MeV was chosen according to the results of Dubna group [6], and the current was of a few microamps.

The desired fermium fraction was extracted from the irradiated active layer of uranium oxide by using conventional radiochemical methods: the fluoride cycle and chromatografic separation. The final electroplating from organic fase assured small thickness of the source. The alpha spectrum was measured with a surface-barrier solid-state detector of the energy resolution 18 KeV [7] and the coincidence alpha-gamma spectrum was studied by using multichannel analyser tensor [8] in 64x64 channel system. In that case a bigger alpha detector ($2cm^2$) was used with a poorer resolution (35 KeV) and a NaI(Tl) crystal. To avoid spurious counts a threshould of 100 KeV was set in gamma channel.

The time resolution of the coincidence system was 300 ns. There were three runs each of 3 hours devided by indispensable energy calibration of alpha and gamma axes.

Results

Fig. 1 displays the results of the first run. The peak of the registered events (dotted line) coincide with the position of the ^{251}Fm alpha simple spectrum peak registered before and after the run.

On the other hand, the summing of the counts on gamma axis gives the energy of gamma rays de-exciting the level populated by the main alpha group. It is of (410 ± 10) KeV. The number of counts in the three runs follows the decay curve of the 7 hours ^{251}Fm isotope. The analysis of the simple alpha spectrum from separate irradiation (measured in one hour time intervals) allowed to deduce some additional informations. The half-life of ^{252}Fm was estimated to be $23.0^{+1.5}_{-1.0}$ hours. Fig. 2 shows the spectrum summed over the whole detection period.

There are four distinct peaks belonging to ^{252}Fm, ^{253}Fm, ^{251}Fm and ^{251}Fs, and some unresolved low intensity maxima.

The energy of ^{251}Fm was determined to be 6.83 MeV. The ratio of intensities of the two observed alpha groups of ^{252}Fm was estimated taking

as a standard the ^{251}Fm line and that of ThC'. The main alpha group abundance is approximately 85% whereas a second group is about 15% abundance has an energy 41 KeV lower.

Discussion

From the present investigation of the alpha-gamma coincidence the ground state to ground state transition energy of $^{251}Fm \rightarrow {}^{247}Cf$ has been estimated. Taking into account the re-determined energy of the main alpha-group 6.83 MeV it is 7.24 MeV.

Fig. 3 shows the ground state energy difference, E_Δ of the Fm and Cf isotopes in the Fm neutron number interval 150-156.

The new point grows the evidence stronger for the sharp and almost F_Δ linear diminishing from $N = 150$ to $N = 152$.

It can be seen that the measurements for ^{253}Fm are desirable for final determination of the F_Δ curve shape in the minimum region.

Acknowledgements

The authors are indebted to professor G.N.Flerov for his valuable help in carrying out the experiments and to Dr. S.M.Polikanov for many stimulating discussions. We would like to thank I.Tchuburkova for the help in radiochemical operation and the heavy ion cyclotron crew for their assistance.

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Received by Publishing Department
on 13 June, 1967.

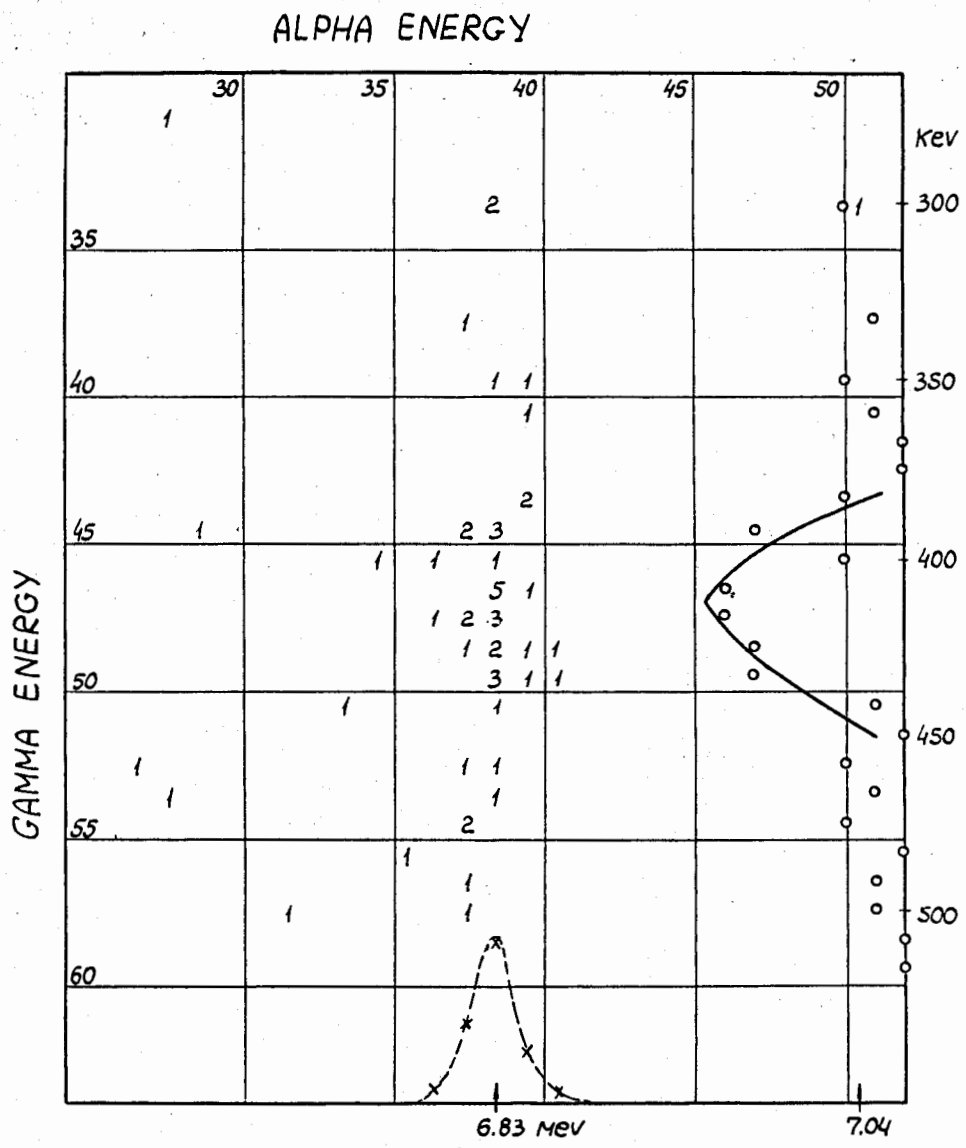
ALPHA ENERGY
GAMMA ENERGY
30
35
40
45
50
Kev
300
350
400
450
500
35
40
45
50
55
60
6.83 Mev
7.04

Fig. 1

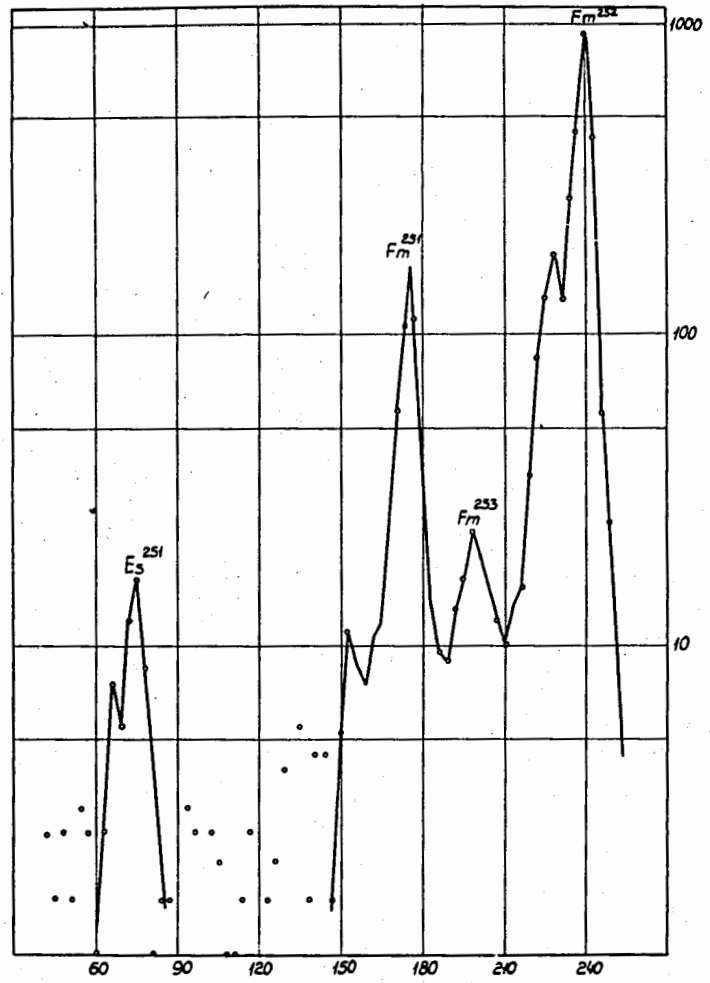
Fm 252
1000
Fm 254
100
Fm 253
Es 251
10
60
90
120
150
180
210
240

Fig. 2

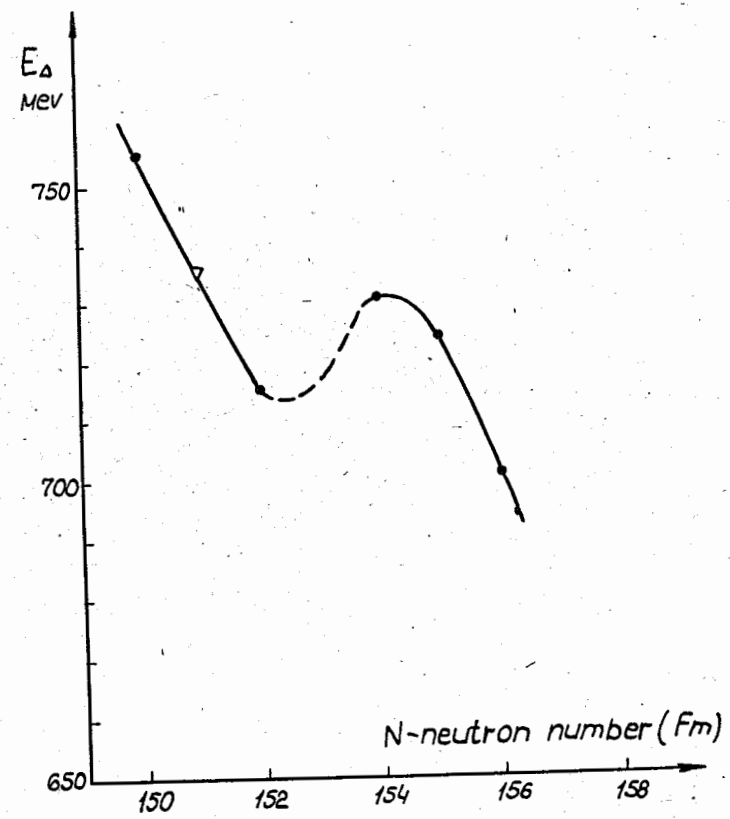
E Δ
Mev
750
700
650
N-neutron number (Fm)
150
152
154
156
158

Fig. 3