TERNARY FISSION OF URANIUM INDUCED BY FAST NEUTRONS

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Ternary fission of U^{238} induced by 14-Mev neutrons is investigated. The fission characteristics are compared with ternary fission of U^{235} induced by thermal neutrons.

DURING the study of fission of uranium induced by 14-Mev neutrons, it was observed that in some cases the uranium undergoes fission with the emission of a third charged particle, an α particle.[1] This phenomenon has been widely studied earlier in the case of fission of U^{235}, Pu^{239}, and U^{233} induced by thermal neutrons,[2] and was also observed in the fission of U^{238} induced by 2.5-Mev neutrons.[3] Comparison of the characteristics of complex fission at different excitation energies is of considerable interest, but the results obtained from the small number of cases observed[1] allows one only to establish the fact that such a reaction occurs with an approximate probability of 1 : (1000 — 1300) with respect to the number of binary fissions. In the present article, we shall discuss more fully the characteristics of the process.

The experiment was carried out by the emulsion method under the same conditions as before.[1] To eliminate background due to a random superposition of α-particle tracks from the natural activity of uranium, we recorded only cases in which the α-particle range was at least 30 μ in the emulsion.

A total of 231 α particles from complex fission was recorded. The ratio of the number of complex fissions to the number of binary fissions was 1 : 1250. Owing to the fact that we recorded only those events in which the range of the α-particle track in the emulsion pellicle was greater than 30 μ, we introduced an appropriate correction, from which it followed that the probability of complex fission should be taken as 1 : (1050 ± 100).

The cited error includes the statistical error and systematic error due to the fact that part of the cases of ternary fission cannot be separated from the random superposition of binary fissions with α particles from nuclear reactions occurring in the emulsion.

To construct the energy spectrum of the α particles from complex fission, we made use of 158 particles which stopped in the emulsion. After introducing the geometrical corrections for the escape of particles from the emulsion, we plotted the spectrum by the method of Ferreira and Waloschek.[4] The spectrum is shown in Fig. 1. Also shown in this figure is the α-particle spectrum from ternary fission of U^{235} induced by thermal neutrons, obtained by the photographic emulsion method of Titterton.[5]

The size of the asymmetry in ternary fission which, in our case, can be characterized by the ratio of the ranges of the two fragments R_l/R_h, is shown in Fig. 2. The corresponding curve is also given for the complex fission of U^{235} induced by thermal neutrons obtained earlier by Solov'eva from 650 cases. The angular distribution of the α particles relative to the fission fragments does not differ from that obtained previously.[1]

There is quite good agreement between the characteristics of complex fission of U^{238} induced by 14-Mev neutrons and of U^{235} induced by thermal neutrons.

The decreased probability of ternary fission of U^{238} induced by 14-Mev neutrons indicates, perhaps, that the emission of α particles during fission takes place only after the nuclear excitation is reduced by the evaporation of one or two

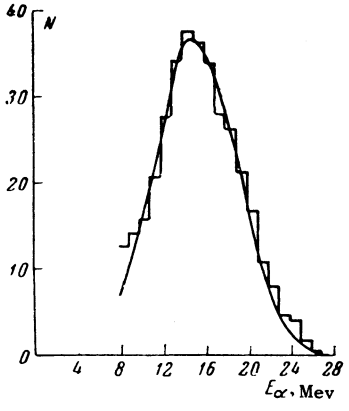

FIG. 1. Energy spectrum of alpha particles from ternary fission of U^{238} by 14-Mev neutrons. Solid curve — spectrum of alpha particles from ternary fission of U^{235} by thermal neutrons.

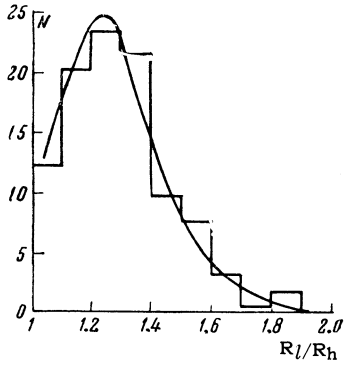

Fig. 2. Distribution of ternary-fission events by asymmetry of fission fragments. Solid curve – analogous data for U^{235} fission by thermal neutrons (R_l and R_h are the ranges of the light and heavy fragments).

neutrons. This considerably complicates the process, since different nuclei undergo fission with different excitation energies.

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