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FISSION OF Th^{232} *BY 14.9-Mev NEUTRONS*

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The energy characteristics of Th^{232} fission induced by 14.9-Mev neutrons were measured with a double ionization chamber with grids. The most probable total kinetic energy and fragment mass ratio were measured and found equal to (157 ± 4) Mev and (1.43 ± 0.05) respectively. The most probable values of the masses of the heavy and light fission fragments are (140 ± 3) and (92 ± 3). Data are obtained which confirm the influence of nuclear shells on fission.

In the investigation of the energy characteristics of the fission of heavy nuclei it was noted[1,2] that the dependence of the kinetic energy of the fragments on their mass ratio exhibits more or less sharply pronounced maxima. It was shown here[2] that in all cases the position of the maxima corresponds to those mass ratios, for which the heavy fragment has a mass number close to 132. A less pronounced maximum is observed at mass ratios for which the light fragments have a mass number in the 82 — 84 region. A hypothesis has been advanced that the increase in the kinetic energy of the fragment at definite mass ratios is connected with the formation during the fission process of heavy fragments with closed shells of 50 protons and 82 neutrons (A = 132) and light fragments with a closed shell of 50 neutrons (A = 82 — 84).

In connection with the fact that the question of the influence of nuclear shells on the fission process is of considerable interest, further experimental data must be accumulated in this field. For this purpose we undertook an investigation of the energy characteristics of the fission of Th^{232} by 14.9-Mev neutrons.

A measurement of the energies of the Th^{232} fission fragments was made by means of a double ionization chamber with grids, with simultaneous recording of the amplitudes of the pulses produced by paired fission fragments.[3] The collimation angle of the fragments was 45°. To reduce the influence of the anisotropy of fission and of the motion of the center of mass of the fragments on the result of the measurements, the neutron beam was aimed at an angle of 3 — 5° to the plane of the target. The bombarding neutrons were obtained from the T (d, n) α reaction.

A thorium target weighing 70 μg/cm² was made by sputtering in an electric field from an alcohol solution of thorium nitrate on a film 25 — 30 μg/cm² thick with subsequent conversion of the hygroscopic thorium nitrate into non-hygroscopic thorium oxide by a method described in the paper by Selitskiĭ.[4] The purity of Th^{232} was determined from the α spectrum plotted with an ionization α spectrometer.

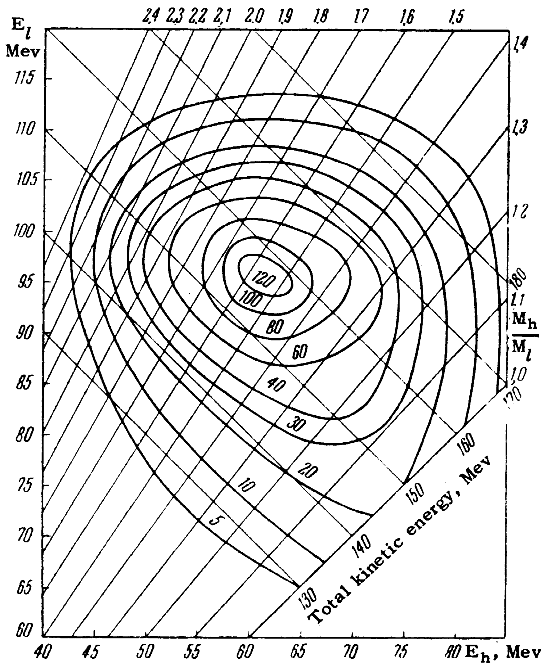


FIG. 1. Contour map of Th^{232} fission by 14.9-Mev neutrons. The subscripts h and l refer to heavy and light fragments respectively.

The energy calibration of the apparatus was by comparison with the energies of the α particles from Am^{241} and Th^{232}. A total of 12,500 fission events were observed. The fission-fragment energy was corrected for the ionization defect and for losses in the substrate of the target and in the

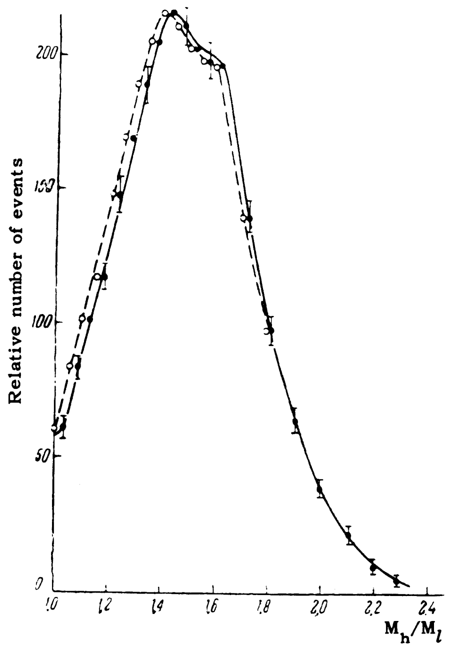


FIG. 2. Fission probability as a function of the mass ratio of the fragments: o – uncorrected data, • – corrected for dropping of neutrons.

collimator. The measurement results are shown on the contour diagram (Fig. 1).

Figure 2 shows the dependence of the probability of fission on the fragment mass ratio. The same diagram shows a curve plotted with allowance for the discarding of neutrons by the fragments.[5] In introducing the corrections it was assumed that the average number of emitted neutrons per fission event was 4.64,[6] and that one neutron evaporates prior to fission. The most probable mass ratio is 1.43 ± 0.05. These data have been used to calculate the most probable masses of the heavy and light fragments, found to be 140 ± 3 and 92 ± 3 respectively.

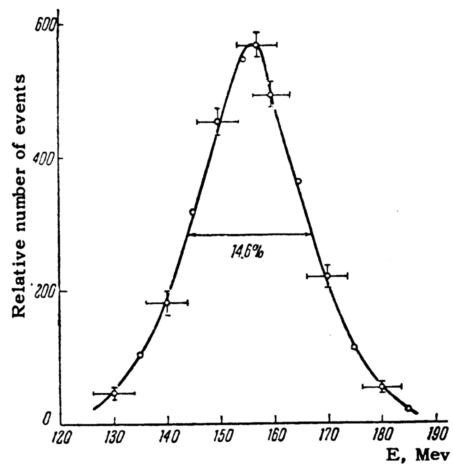


FIG. 3. Distribution of total kinetic energy of Th^{232} fission fragments.

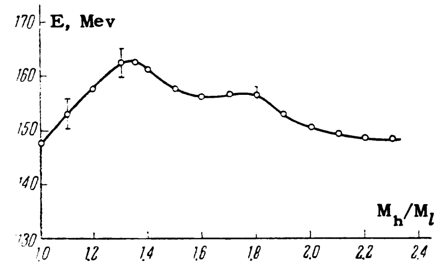


FIG. 4. Dependence of the most probable total kinetic energy of Th^{232} fission fragments on the fragment mass ratio (the statistical errors are indicated).

The distribution of the total kinetic energy of fission fragments is shown in Fig. 3. The half width of the energy distribution is 14.6%. The most probable kinetic energy is 157 ± 4 Mev.

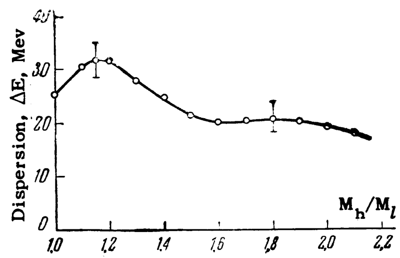
The dependence of the most probable total kinetic energy of fission fragments on their mass ratio is shown in Fig. 4. The curve shows clearly two maxima of kinetic energy at fragment mass ratios 1.32 and 1.8.

Figure 5 shows the dependence of the dispersion of the energy distribution on the ratio of fragment masses. The maximum dispersion is at a mass ratio 1.17. A slight increase in dispersion is noticeable in the region of mass ratio 1.8.

In accordance with the results of reference 2, one might expect that in fission of Th^{232} an increase should be observed in the total kinetic energy of the fragments at mass ratios 1.32 and 1.83. The data obtained in the present work are in good agreement with these values. At the same mass ratios, one might expect also an increase in the dispersion of the total kinetic energy. However, as follows from Fig. 5, the position of the first maximum (1.17) differs considerably from the expected value. This discrepancy is possibly due to an increase in the apparatus dispersion, owing to the great thickness of the thorium layer.

In conclusion, the authors express their indebtedness to Yu. A. Selitskiĭ for preparing the thorium target.

FIG. 5. Dependence of the dispersion of the energy distribution on the fragment mass ratio. The statistical errors are indicated.



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