KINEMATICAL ANALYSIS OF PRODUCTS OF TERNARY FISSION

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Trajectory calculations in a three point charge approximation were performed to obtain the most important value of the scission conditions — the average prescission kinetic energy of fragments E_F^o.

The calculated results are compared with the experimental data obtained by the authors in the thermal-neutron-induced ternary fission of ^{235}U and ^{239}Pu and the spontaneous fission of ^{252}Cf accompanied by light nuclei ^{3}H, ^{4}He, ^{6}He, ^{10}Be. The results of our study are given in detail /1/.

The trajectory calculations were carried out in two ways. In the first case the initial conditions for every event were chosen by the Monte-Carlo method from uniform distributions in wide intervals without correlations:

$$0<E_F^o<70 \text{ MeV}, \quad 0<E_3^o<10 \text{ MeV}, \quad 0<Y<3.5 \text{ Fm}$$

$$0<X_0=x/D_0<1.0, \quad 0<\Theta_{3L}^0<180°, \quad N(\Theta_{3L}^0) \sim \sin \Theta_{3L}^0.$$

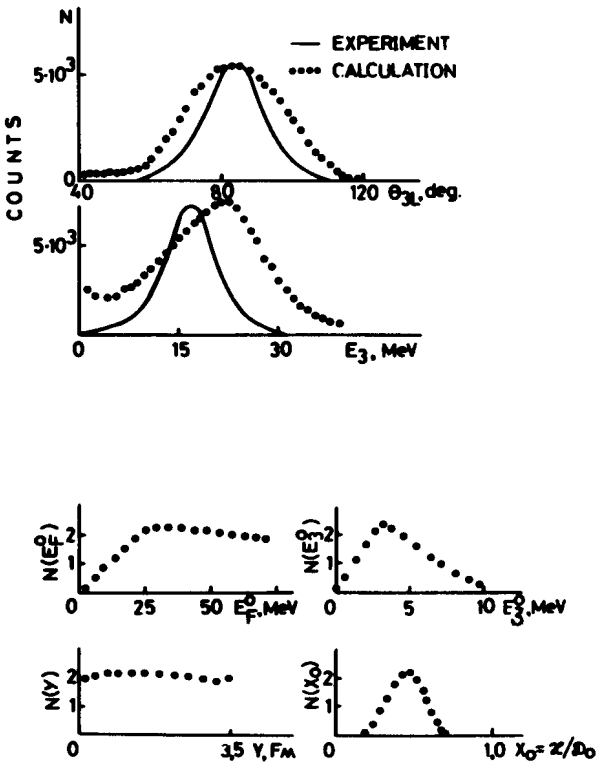

Fig. 1. Energy and angular distributions of α-particles without limitations on initial parameterstop part. Distributions of initial parameters obtained in fitting experimental spectra by calculations — lower part

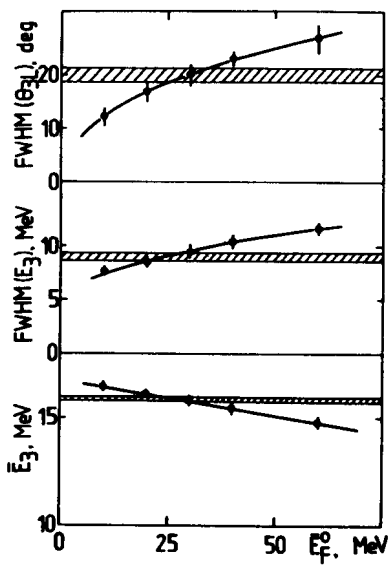

Fig. 2. Dependence of E_3 FWHM(E_3), FWHM(Θ_{3L}) on E_p^0. Hatched regions represent experimental data

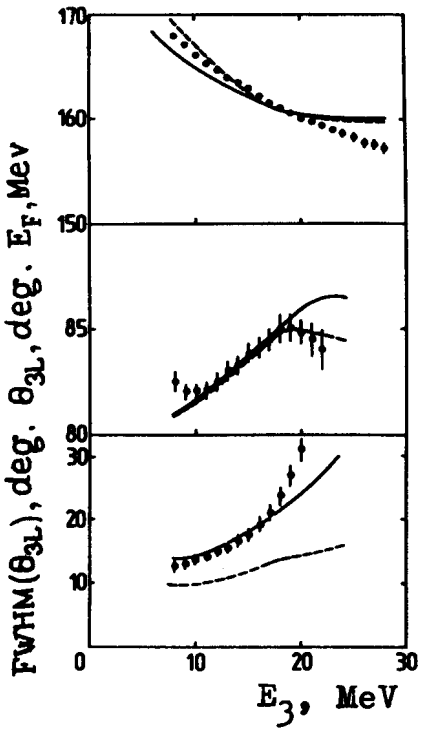

Fig. 3. Experimental (dots) and calculated (lines) values of E_p, Θ_{3L} and $W(\Theta_{3L})$ as functions of α-particles energy. Calculations have been done with E_p^0=30 MeV-solid lines and with E_p^0=10 MeV-broken lines

X — axis coinsides with the fragment axis, Y — axis is perpendicular to X, and D_0 is the distance between the centres of the fragments. In each set of calculations we have fixed a mass ratio $R=M_H/M_L(\pm 0.05)$ and a total energy $E_t=E_F+E_3(\pm 2$ MeV). First of all, the main role of the Coulomb stage of the three charge body motion have been established. We have performed calculations of energy and angular distributions of alphas without any limitations on the initial conditions which are shown on the top part of fig. 1. One may come to the conclusion that the solution of the three body Coulomb problem roughly reproduces the experimental data. The next goal was to define the distributions of the initial parameters in the case of a coincidence of the experimental and calculated energy and angular spectra. (Lower part of fig. 1). In the wide range of initial parameters the distribution of prescission fragment energies tends to zero at small energies. If we fix some parameters such as $X_0(\Delta X_0=0.06)$ we can obtain an initial fragment energy distribution peaked close to 30 MeV. The main conclusions from this model of calculations are:

1. The initial energy distributions of alphas are well fitted by Maxwellian distributions $N(E_3^0)\sim \sim\exp(-E_3/T)$, $T=T_0+aE_F^0$.
2. The widths of the angular distributions mainly depend on the value of X_0.

In the second case the experimental distribution of E_F at a fixed R was taken into account, thus

$$W(E_F)=\sqrt{[W(E_F^0)]^2+[W(V_C)]^2},\ \textit{where}\ V_C=\frac{Z_H\cdot Z_L}{D_o}\cdot e^2\ .$$

The distribution of E_3^0 was used in the Maxwellian form while of X_0, E_F^0, V_c in the Gaussian one distributions of Y and Θ_{3L}^0 were chosen as in the first case. A comparison of the experimental and calculated parameters — (fig. 2,3) leads to the main conclusions:

1. In the fission of ^{240}Pu with an emission of α-particles, the best fit to the experimental data is obtained at the following set of initial parameters: $E_F^0=30$ MeV, $T=1.4$ MeV, $\Delta X_0=0.27$, $Y_{max}=3.5$ Fm, $W(E_F^0)=10$ MeV, $W(V_c)=16$ MeV.
2. The angular interval $0<\Theta_{3L}^0<180°$ is more preferable than $0<\Theta_{3L}^0<360°$. This shows that alphas mainly arise from a nuclear neck before scission.
3. Extrapolation to the early stage of the process may decrease the value of E_F^0 by about 10 MeV.
4. The constancy of the most probable energy of light nuclei in ternary fission (^{3}H, ^{4}He, ^{6}He) and the width of the angular distribution with increasing Z^2/A from U to Cf can be explained quantitatively by the increase of E_F^0 from 28 MeV (U) to 32 MeV (Cf).

REFERENCES

1. *Borkovski M. Ya., Gusev Yu. I., Seliverstov D. M., Zalite Yu. K.* Preprint LNPI—1540. Leningrad. 1989. 36 p.