[4] Gol'din, Novikova, and Tret'yakov, Izv. Akad. Nauk SSSR, Ser. Fiz. 20, 868 (1956), Columbia Tech. Transl. p. 789.

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ANGULAR DISTRIBUTION OF LONG-RANGE ALPHA PARTICLES, CONNECTED WITH THE FISSION PROCESS

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WE investigated the complex fission of U^{235} by thermal neutrons with thick photographic emulsions. In the experiments we used type P-8 photographic plates, prepared in our laboratory. The emulsion used had good discriminating ability with respect to tracks of fragments, α particles, and protons.

Cases in which a track of a long-range α particle was connected with the fission point were counted. We selected those cases, in which both the fragments and the α particle stopped in the emulsion. For approximately 600 such cases we calculated the ranges of all particles and the angles between the α particle and the fragments. The distribution of α particles by ranges, corrected for the probability of their exit from the emulsion, for the angular distribution of the α particles (Fig. 1), and for the asymmetry of fission were in good agreement with the results given in other papers.[1,2]

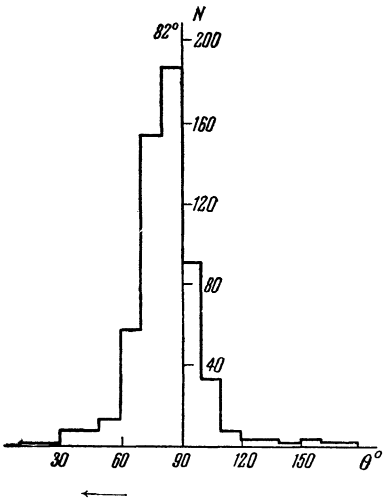

FIG. 1. Angular distribution of particles about the direction (shown by an arrow to the left) of light fission fragment.

Reference 1 proposes a mechanism whereby the production of a long-range α particle is considered as the scattering, under the influence of Coulomb forces, of three particles produced as the result of vibrations of a drop of nuclear liquid, in which the fourth harmonic, which is responsible for the triple fission, has a noticeable amplitude. Such a scheme explains satisfactorily the following: a) That the most probable angle of emission of an α particle deviates noticeably from 90° towards the lighter fragment. In fact, it is seen from Fig. 1 that the maximum in the angular distribution is located near 82° from the light fragment. b) That the energies of the α particles are close in order of magnitude to the total of the Coulomb barriers of the fragments.

Within the framework of this scheme, one would also expect the angle of emission of an α particle to be related to the asymmetry of the fragment, i.e., deviations from the most probable value in the angular distribution (82°) should result either from a more symmetrical fission (towards 90°), or a more asymmetric one (towards smaller angles). In addition, the angle of emission of the α particle should not be greater than 90° relative to the light fragment.

The experimental data,* however, indicate lack of agreement with the expected results.

1. There is a considerable number of cases when the α particle is emitted more than 90° from the track of the light fragment. Furthermore, it has been noted that the angular distribution broadens with increasing range of the α particle. If the graph shown in Fig. 1 is broken up into three parts for three α-particle ranges (up to $100\,\mu$, from 100 to $200\,\mu$, and above $200\,\mu$ of range in photographic emulsion), the graphs obtained (see Fig. 2) differ noticeably from each other. The half-width of the distribution curve increases with range, and at maximum range the angular distribution for the α particles becomes nearly isotropic. On the other hand, almost no angles greater than 90° are observed for α particles with ranges less than $100\,\mu$. Thus, the greater the energy of the α particle, the more independent its behavior in the field of two heavy fragments.

2. To estimate the influence of the magnitude of the mass asymmetry on the α-particle emission angle we can employ, with a certain degree of approximation, the value of the asymmetry of the fragment ranges provided we neglect the difference in $v(R)$ of the light and heavy fragments. The mean values of R_L/R_H for α particles emitted at angles both greater and less than 82°

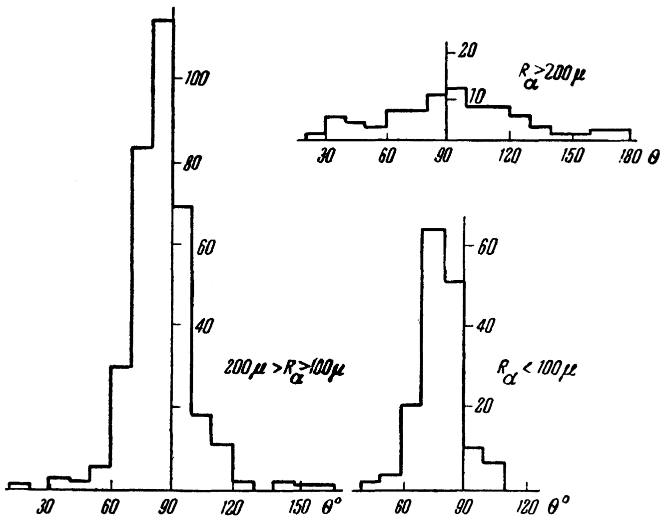

FIG. 2

(to the light fragment) were found to be approximately 1.3, i.e., the method of division of the uranium nucleus into two heavy fragments does not influence noticeably the deviation of the angle of emission of the α particle from its most probable value. Apparently the spread in the angles about the most probable value is caused by another circumstance.

On the basis of the present observations we can assume that at the instant of fission the α particle has a considerable velocity, the direction of which is equally probable relative to the line of fragment divergence. The presence of an initial velocity causes a spread in the angular distribution, the general character of which is established by the effect of the Coulomb fields of the fragments on the motion of the α particle. At high initial velocities the angle of emission of the α particle can deviate noticeably from the most probable value (82°), determined by the pattern of the scattering of the three particles at rest.

The existence of an α-particle initial velocity may serve as a confirmation of the existence of α complexes in heavy nuclei. If such a complex happens to be near the point of scission at the instant of fission, complex fission with a third long-range α particle will be observed.

*The preliminary data were reported by N. A. Perfilov at the Conference on Fission Physics in January, 1956.[3]

[1] Tsien, Chastel, Ho, and Vigneron, J. Phys. radium **8**, 165, 200 (1947).

[2] E. W. Titterton, Phys. Rev. **83**, 673 (1951).

[3] N. A. Perfilov, Supplement to Атомная энергия (Atomic Energy), No. 1, 1957.

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FEATURES OF MAGNETIC HYSTERESIS PHENOMENA IN THE SYSTEMS $Pr_2O_3 \cdot Fe_2O_3$ *AND* $La_2O_3 \cdot Fe_2O_3$

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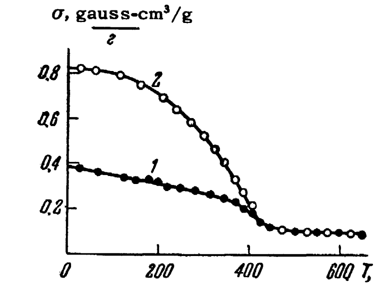
FERRITES of rare-earth elements, with a general formula $M_2O_3 \cdot Fe_2O_3$ (where M is the rare-earth ion) have a perovskite structure. Although ferromagnetic, they exhibit weak ferromagnetic properties in a fixed temperature interval.[1-3] Many of them are characterized by so-called thermoremanence phenomena, whereby the magnetization temperature-dependence curves plotted during the initial heating differ from those obtained in the subsequent cooling. The curve obtained upon cooling in the field is always the upper one (thermoremanence effect). Figure 1 shows by way of an example the curves obtained in our measurements (in a 5500-oe field) for the ferrite $Pr_2O_3 \cdot Fe_2O_3$ (1 — heating, 2 — cooling).

FIG. 1. Temperature dependence of specific magnetization of $Pr_2O_3 \cdot Fe_2O_3$ ferrite in a field of 5500 oe; 1 – heating, 2 – cooling.



In the present investigation we were interested in the unusual hysteresis in specimens of $Pr_2O_3 \cdot Fe_2O_3$ and $La_2O_3 \cdot Fe_2O_3$ both stoichiometric and with excess iron oxide. The specimens were prepared by the usual ceramic technology. The preliminary annealing was at a temperature of 900°C for 6 hours, after which the specimens were sintered four hours at 1300°C in air and slowly cooled in the furnace. The hysteresis curves were plotted by the ponderomotive method in fields up to 7500 oe for ferrite samples in the initial state and after cooling in the magnetic field from the Curie point. In all cases of cooling in the magnetic field from the Curie point, the hysteresis in the investigated specimens was highly asymmetric about the coordinate axes, the hysteresis curve being shifted upward along the magnetization axis (Fig. 2). It can be seen that this shift increases the closer the