Letters to the Editor

α-PARTICLE SPECTRUM FROM TERNARY SPONTANEOUS FISSION OF Cm^{244}

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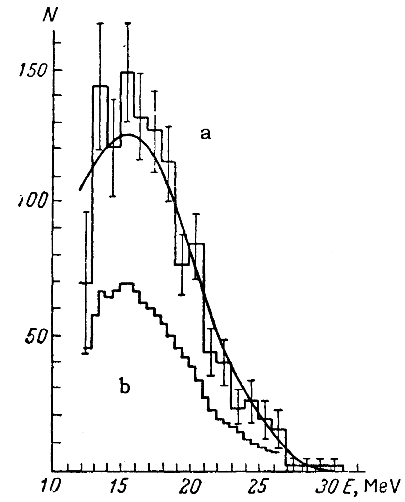
IN our investigation of the ternary fission of the different isotopes of uranium [1] and plutonium [2], it was observed that the characteristics of the energy spectra of fission α-particles are similar for the different isotopes of a single element, but can differ markedly with change of Z. Thus, the most probable energies of the fission α-particles of the isotopes of uranium and plutonium are different, amounting to approximately 15 and 17 MeV, respectively. Such a change could be related to the increase in the charge of the nucleus, but existing data on the ternary fission of Cm^{242} (E_{prob} = 15.5 MeV) [3] contradict this simple assumption. Therefore it is appropriate to verify the observed relationship (the independence of the spectral characteristics on the mass number) for an additional element and at the same time to confirm the correctness of observed values of E_{prob}. With this purpose we have investigated the α-particle energy spectrum from ternary spontaneous fission of Cm^{244}.

The experiment was performed under the same conditions as in the study of the ternary fission of Cm^{242} and the plutonium isotopes: the fissile material was deposited in a thin layer on a platinum substrate and long-range α-particles were counted by means of a nuclear emulsion, a lead foil being placed between the active layer and the emulsion to absorb α-particles from natural radioactivity and spontaneous fission fragments. In the analysis we accepted α-particle tracks not less than 40 μ long. Altogether 530 stopping particles were recorded for which the full range was established. Geometrical corrections were introduced into the experimentally observed distribution. The spectrum obtained is shown in the figure (histogram a). For the best demonstration of its features the experimental spectrum, plotted in 0.5 MeV intervals, was analyzed by the method of Ferreira and Woloschek [4] (see spectrum b in the figure; the solid curve is the Gaussian distribution giving the best agreement with experiment).



As the figure shows, the α-particle spectrum from ternary spontaneous fission of Cm^{244} has a peak at an energy of about 15.5 MeV. In the interpretation of the experimental spectrum by a Gaussian curve, the best agreement was obtained for the following parameters:

$$E_{prob} = 15.5 \pm 0.5 \text{ MeV}, \quad \Delta E = 11.5 \pm 0.5 \text{ MeV},$$

where ΔE is the width of the spectrum at half height. These values are in good agreement with those obtained by the same method for Cm^{242}:

$$E_{prob} = 15.5 \pm 1 \text{ MeV}, \quad \Delta E = 12 \pm 1 \text{ MeV}.$$

Thus, the spectral characteristics are found to agree within the experimental error also for two isotopes of curium. However, because of the inadequate number of elements studied (U, Pu, Cm), it is difficult to establish the cause of the shift in the most probable energy of the ternary fission α-particles. The data in the literature on the α-spectrum from the spontaneous fission of Cf^{252} are inconsistent [5-7] and cannot be subjected to analysis.

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ISOTROPIC DISCHARGE CHAMBER FOR RECORDING TRACKS OF RELATIVISTIC CHARGED PARTICLES

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AT the present time spark chambers have received wide application in experiments with high energy elementary particles. While they possess a number of important advantages over other types of track detectors, they also have some substantial deficiencies which limit the field of their use. Thus, spark chambers have anisotropic properties for particles traversing the working volume at different angles relative to the electric field direction. Furthermore, it is impossible to observe in them the stopping of charged particles in the working volume of the chamber gas. And finally, spark chambers do not allow effective discrimination of charged particles with different ionizing ability. Attempts to remove these deficiencies are continuing at the present time [1,2], based on the obvious idea that, up to the moment of initiation of a streamer in a chamber, a limited multiplication of the primary electrons occurs, which under certain conditions can be localized near the path of the incident charged particle.1)

In this paper we describe an isotropic discharge chamber with which, under conditions of local multiplication of the primary electrons, we have obtained clear images of the tracks of charged particles with ionizing ability near minimum. A general diagram of the apparatus is shown in Fig. 1. The discharge chamber was a plane parallel capacitor with brass electrodes P_1 and P_2 rounded at the edges and about 15 cm in size. The electrodes were placed in a vacuumtight plexiglass case filled with various gases to a pressure of 1 atm. The interelectrode distance was 5 cm, and the working volume of the chamber, i.e., the volume where the electric field is uniform with high accuracy, was about 500 cm^3. Scintillation counters C_1 and C_2, connected to the coincidence circuit, selected cosmic rays passing through the working volume roughly in a vertical direction. The chamber was mounted in two different ways with respect to the cosmic ray trajectories: in the first case the electrodes P_1 and P_2 were arranged vertically, and in the second case horizontally. A pulse from the coincidence circuit was fed to the control circuit CC which produced a high voltage pulse of amplitude 15 to 56 kV. The pulse had an approximately triangular shape with a half-width of about 0.05 μsec. The total delay of the pulse in the control circuits was about 0.7 μsec. On arrival of this pulse at the electrode P_1, local multiplication of the primary electrons produced by the incident cosmic ray occurred in the gas filling the chamber. The resulting weak light arising along the particle trajectory was focused by the objective O onto the photocathode P of the multistage electron-optical image amplifier IA, which is described, for example, by B. A. Demidov and S. D. Fanchenko [5]. The track image, amplified in brightness, was photographed from the screen S by the camera C. Good track images for each cosmic ray passing through the chamber could be obtained only under image amplifier gain conditions allowing observation of light flashes corresponding to single electrons from the first photocathode. Suppression of intrinsic image amplifier noise was achieved by supplying a pulsed voltage to the screens S_1 and S of the image amplifier.

Cosmic ray track photographs obtained with this apparatus are shown in Figs. 2a and b for a chamber filling of helium, and in Figs. 2c and d for a neon filling. In Figs. 2a and c the track direction is approximately perpendicular to the electric field, and in Figs. 2b and d, approximately parallel. From analysis of data obtained for different values of electric field, the conclusion follows that with an electric field strength of 5.0—5.2 kV/cm for helium and 3.2—3.4 kV/cm for neon the intensity

1)Recently papers have been published by Dolgoshein and Luchkov[3] and by Mikhailov et al[4] which describe a discharge chamber whose operating principle consists of terminating the streamer process by a rapid decrease of the electric field intensity in the chamber. Such a chamber is not completely isotropic, since the track brightness depends strongly on the angle between the particle trajectory and the field direction.