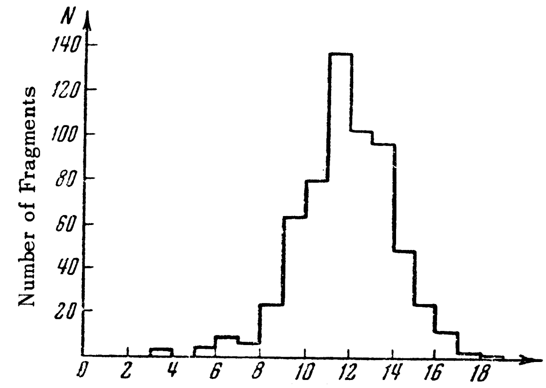

FIG. 1. The distribution of tracks of single fragments in uranium nuclear fission by slow π^- mesons.

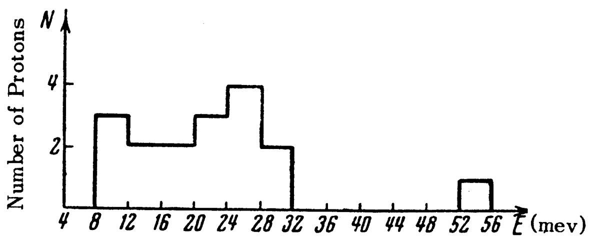

FIG. 2. Distribution by energy of protons emitted in the process of fission of uranium nuclei by slow π^- mesons.

The authors are grateful to Mr. M. G. Meshcheriakov and his laboratory staff for cooperation in carrying out the experimental work related to the study of interaction of slow π^- mesons with nuclei. The authors also remember with deep thanks the late Academician P. I. Lukirskii who showed a steady interest in this work.

* The first report was completed in March, 1950. Almost simultaneously and independently of us, fission of uranium with capture of π^- mesons was discovered by Frank and Belovitskii [Report FIAN (Institute of Physics, Academy of Sciences, USSR)]. The first communication concerning fission of uranium by slow π^- mesons appeared in October, 1951, in the work of Al-Salam[6].

** Experimental proof of such unequal distribution is contained in the work of Lozhkin and Shamov[8].

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131

The Probability of Uranium Nuclear Fission by its Absorption of Slow Π^- Mesons[1]

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THE first determinations of the probability of fission of the uranium nucleus by the capture of π^- mesons were carried out in our laboratory in 1951. Perfilov and Ivanova, and Perfilov and the authors[2,3], with the use of thick-layered emulsions, came to the conclusion that apparently practically every capture of a π^- meson by a uranium nucleus leads to fission of the latter. The same conclusion was reached later by Al-Salam[4], using a similar method.

The same method was adopted for the experiments being described. Nuclear plates were soaked in a 4% solution of $UO_2Na(C_2H_3O_2)_3$ and exposed to slow π^- mesons. Under microscopic examination of a given stage of the plate there were counted the number of times that a π^- meson stopped in the photo-layer, the number of cases of fission of uranium nuclei by π^- mesons, and the number of uranium nuclei (by means of the number of α-particle tracks arising from the natural radioactive decay of uranium). For the determination of the total number of cases of capture of π^- mesons by uranium nuclei, it is necessary to know first, how the uranium is distributed throughout the volume of the emulsion, and second, how the probability of capture of slow π^- mesons depends on the Z of the nucleus.

The distribution of uranium in the soaked emulsion was investigated in the following manner. The soaking of the emulsion in uranium salt was carried out and stirred in a special container in a

TABLE

Trial	No. of cases of fission of U per cm^2	No. of cases of stopping of π^- mesons per cm^2	No. of U nuclei per cm^2 × 10^{-17}	No. of cases of capture of π^- mesons by U nuclei per cm^2	Probability of U fission
I	25	7050	6.2 ± 0.6	98 ± 10	0.25 ± 0.05
II	21	5040	5.7 ± 0.2	64 ± 5	0.33 ± 0.08

super-centrifuge (20,000 revolutions per minute). After 20 minutes of centrifuging, the grains of AgBr settled almost completely, covering the walls of the container. The resulting precipitate of grains of AgBr and the leftover gelatin were analyzed for uranium content. The results lead to the conclusion that all the uranium penetrating into the emulsion during the soaking is found in the gelating, and that the adsorption of uranium on the surface of AgBr crystals does not occur. Therefore, in determining the number of π^- mesons interacting with uranium nuclei, it is necessary to count only those mesons which stop in the gelatin (~42% from our data). Assuming further, in agreement with Fermi[5], that the probability of capture of a slow π^- meson in a chemical bond is proportional to the atomic number Z, it is possible to write the following expression for the number of π^- mesons captured by the nuclei of uranium atoms adsorbed by the gelatin, under the condition that the π^- mesons are stopped with uniform distribution throughout the depth of the emulsion:

$$N = 0.42 N_0 \frac{N_U Z_U}{N_U Z_U + \sum_i N_i Z_i}$$

Here N_0 is the number of π^- mesons stopped per square centimeter of the layer of emulsion; Z_i, N_i are the charge and number of nuclei of the elements composing the gelatin per square centimeter of the layer of emulsion.

Two groups of measurements were carried out. The data, reduced to tabular form, are for a layer of emulsion 100 microns thick.

Thus the results of the present work lead to the conclusion that on capture of π^- mesons, uranium nuclei undergo fission in 30% of the cases. However, it should be noted that this conclusion is valid only if the assumption is correct that the probability of capture of π^- mesons by the different nuclei in the mixture is proportional to the atomic number.

The results of the present work were obtained in December, 1953. There are available at the present time in the literature[6] determinations of the probability of fission of the uranium nuclei upon capturing π^- mesons which differ somewhat from our values. In the referenced work the probability of fission is determined to be 0.18 ±0.06.

In conclusion, the authors wish to express their appreciation to Professor N. A. Perfilov for valuable instruction and discussion of the results of the work.

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134

The Scattering of Fast Neutrons by Non-Spherical Nuclei II

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OUR previous article[1] contains the computation of the effective cross section for scattering of fast neutrons by the black nucleus, which has the form of an ellipsoid of revolution and a spin equal to zero. We shall examine the established results under the assumption that before the scattering interaction the nucleus is found in a particular state.