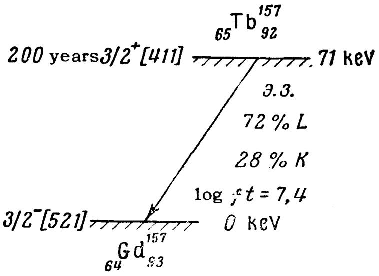

Decay scheme of Tb^{157}.

the Tb^{157} compound was $N_0 = (4.0 \pm 1.3) \times 10^{12}$. A measurement of the activity of the compound made four months later showed that it emits 5300 ± 500 K-quanta per minute. Taking the ratio of L to K capture to be $L/K = 2.64$[2], we obtain for the decay rate $dN/dt = (1.9 \pm 0.2) \times 10^4$ decays per minute. Thus, the value of the half-life of Tb^{157} is $T_{1/2} = (2.8 \pm 1.2) \times 10^2$ years.

After the completion of the present work a paper was published by the Japanese physicists Iwata et al.[3], containing the result of a measurement of the half life of Tb^{157}, namely $T_{1/2} = 160 \pm 40$ years. This number agrees with our data within the limits of error.

The calculated value of log ft = 7.4 ± 0.2 is somewhat higher than in other cases, when the transition goes between the states $\frac{3}{2}^+$ [411] and $\frac{3}{2}^-$ [521], viz.: $\mathrm{Sm}^{153} \rightarrow \mathrm{Eu}^{153}$, $\mathrm{Sm}^{155} \rightarrow \mathrm{Eu}^{155}$, $\mathrm{Dy}^{159} \rightarrow \mathrm{Tb}^{159}$ $\mathrm{Gd}^{159} \rightarrow \mathrm{Tb}^{159}$, $\mathrm{Tb}^{161} \rightarrow \mathrm{Dy}^{161}$, and $\mathrm{Eu}^{156} \rightarrow \mathrm{Gd}^{156}$.

The introduction of corrections for superfluidity explains in part the difference in the values of ft. The figure shows the decay scheme of Tb^{157}.

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ANGULAR AND ENERGY CHARACTERISTICS OF U^{235} *FISSION NEUTRON EMISSION*

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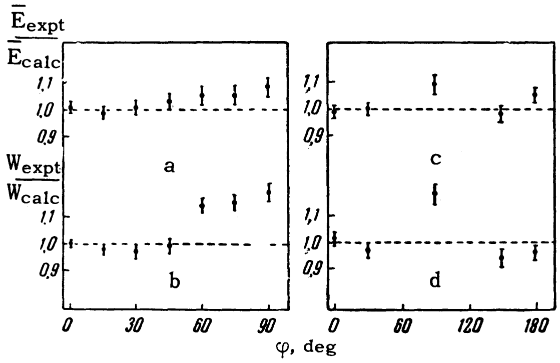
In contrast to the work of Nefedov [1] and our own earlier investigation [2], in the present study we have experimentally determined the energy spectrum of neutrons in the center-of-mass system (c.m.s.) (referred to as the emission spectrum) for thermal neutron fission of U^{235}. This spectrum has then been used to calculate the angular and energy distributions in the laboratory system (l.s.). The results of these calculations have been compared with experimental distributions measured in more detail than those previously reported [1,2].

In the first part of the work, using the time-of-flight method, we made simultaneous measurements of the velocities of a fission fragment and a neutron emitted by this fragment at an angle of 15° to its direction of motion. From the vector difference in these velocities we calculated the c.m.s. neutron velocity (it was assumed that the neutrons are emitted by fragments moving with their full velocities). As a result we obtained a neutron emission spectrum ($\bar{\varepsilon} = 1.28$ MeV) which can be numerically represented in the form

$$F(\varepsilon) = \Sigma \alpha_i T_i^{-3/2} \sqrt{\varepsilon} \exp\left(-\varepsilon / T_i\right),$$

where $\alpha_1 = 0.696$, $T_1 = 1.0$ MeV, $\alpha_2 = 0.310$, $T_2 = 0.5$ MeV, $\alpha_3 = -0.006$, and $T_3 = 0.1$ MeV. The emission spectra from light and heavy fragments turned out to be identical within the limits of accuracy of the experiment ($\bar{\varepsilon}_L - \bar{\varepsilon}_H < 0.02$ MeV).



Ratio of experimental to calculated values of mean energy $\bar{E}_{expt}/\bar{E}_{calc}$ (a), and intensity W_{expt}/W_{calc} (b), as a function of neutron angle; plots (c) and (d) are the same quantities as (a) and (b) except that only the light fission fragments are counted. The indicated errors include both statistical errors and the scatter between runs.

In the second part of the work we measured the intensities and energy spectra of neutrons emitted at different angles to the fission fragment direction. The distributions were studied both counting all fragments and counting only the light fragments. The experimental data show that a systematic "softening" of the spectra occurs as the angle is increased from 0 to 90°, with a simultaneous decrease in intensity. This agrees qualitatively with the hypothesis that the neutrons are emitted from moving fragments. Neutrons move with greater energy and with greater number in the direction of motion of the light fragment, as was to be expected from the contribution of the larger velocity of the fragment.

Using the emission spectrum of neutrons obtained for $\varphi = 15°$, and assuming an isotropic distribution in the c.m.s., we calculated the spectra and intensities in the l.s. for different angles and compared them with the experimental distributions. Ratios of experimental to theoretical values of average neutron energy and intensity are plotted in the figure as a function of neutron angle. We can see from the figure that the average energies of the experimental spectra agree satisfactorily with the calculation (there is only a small excess of $\bar{E}$ for 60—90°). Furthermore, this agreement exists not only for the mean energies of the spectra, but also for their shapes, through an intensity range of more than a factor of ten. In the angular distribution a somewhat greater relative intensity can be noted for the angles 60—90° and thus a smaller anisotropy in the l.s. in comparison with the calculation.

Possible causes of the discrepancy between the experimental and calculated data include the emission of a fraction of the neutrons from the compound nucleus prior to the instant of fission, and emission of neutrons from partially accelerated fragments (use of the latter assumption, however, did not lead to complete agreement of the data). The same effect (an increase of the relative intensity of neutrons at 60—90°) can be produced by screening of the neutrons by the masses of the fragments, for neutrons emitted near the neck where the nucleus has split.

Thus it can be seen that in spite of some differences from the calculation, which can be explained in several ways, the overwhelming majority of neutrons ($\approx 90\%$) emitted in thermal neutron fission of U^{235} are emitted in an ordinary cascade evaporation process from completely accelerated fragment nuclei. Our knowledge of the nature of the process depends on the fact that the neutron emission spectrum obtained experimentally agrees with the results of our calculations based on the theory of cascade evaporation of neutrons [3].

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