P-odd asymmetry of neutron emission in the fission of ^{233}U by polarized thermal neutrons

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As a result of fission of ^{233}U by polarized thermal neutrons, it was determined that the fission neutrons are emitted principally in the spin direction of captured neutrons with an asymmetry $a_n = (4.5 \pm 0.7) \times 10^{-5}$.

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A *p*-odd asymmetry of the escape of fragments in the direction of nuclear spin and opposite to it, which was produced as a result of fission of ^{239}Pu, ^{233}U, and ^{235}U by polarized thermal neutrons, was osberved in Refs. 1–3. Since the fission neutrons are emitted principally in the direction of motion of the light fragments, there is also an order of magnitude smaller asymmetry of the escape of fission neutrons. This effect was clearly observed in the fission[4] of ^{240}Pu and not so clearly observed in the fission[5] of ^{236}U. Subsequently, the asymmetry of the escape of fragments in the fission of ^{234}U and ^{236}U was confirmed in Refs. 6 and 7.

We investigated the neutron emission in the fission of ^{233}U by polarized thermal neutrons. The uranium oxide target absorbed 65% of the beam of polarized neutrons. The fission neutrons were detected by two plastic scintillators, one of which recorded the neutrons emitted in the polarization direction of the beam, while the other recorded those emitted in the opposite direction. The 40-mm-thick lead filters were placed in front of the detectors to reduce the γ-ray background. Using amplitude discriminators, we isolated the recoil protons in four energy ranges. To allow for the instrumental asymmetry, we performed measurements alternately in a polarized and unpolarized beam.

To compare the measured asymmetry with that of the fragments,[2,6] we ran a special calibration experiment with a thin ^{233}U target in which the intensity of neutron coincidences, recorded by the same detectors as in the primary experiment, and of the fission fragments, recorded by using two TAD, was measured. These measurements were made at different angles between the fission axis and the direction to the neutron detector. The ratios of the asymmetry of neutron emission to that of the fragment escape $\eta = a_n/a_f$ for each energy range of the recoil protons were calculated from the results of the calibration experiment. The predicted a_n values were calculated from the η values measured by us and from the a_f values from Refs. 2 and 6, in order to compare them with the a_n values measured in this work. The experiment setup and the measurement method were described in greater detail in Ref. 5.

The results of the measurements averaged over the two detectors are given in Table I.

The first column Table I gives the energy range of the recoil protons the second

E, MeV	$a_{meas} \times 10^5$	$a_n \times 10^5$	$a_{calc} \times 10^5$		η
			[2]	[6]	
0,7 – 1,0	2,1 ± 0,7	3,5 ± 1,1	3,1 ± 0,5	5,4 ± 0,8	0,11 ± 0,01
1,0 – 1,5	3,3 ± 0,7	5,5 ± 1,1	2,7 ± 0,4	4,7 ± 0,7	0,10 ± 0,01
1,5 – 2,0	2,1 ± 0,9	3,6 ± 1,5	4,0 ± 1,7	6,9 ± 1,0	0,14 ± 0,02
> 2,0	2,4 ± 0,8	4,7 ± 1,4	5,5 ± 1,0	9,4 ± 1,6	0,19 ± 0,03

column gives the asymmetry values $a_{meas} = (N_+ - N_-)/(N_+ + N_-)$ that were measured in the experiment. The a_{meas} value was determined as the difference of the values in the polarized beam. The third column gives the asymmetry of the neutron escape obtained after insertion of corrections for the γ-ray background from the β decay of the fragments, for the capture γ-ray background, the degree of beam polarization, counting circuit errors, and for the dimensions of the target and detectors. The fourth and fifth columns give the predicted asymmetries which were calculated from the data of Refs. 2 and 6 and from the results of the calibration experiment. The values of $\eta = a_n/a_f$ obtained in the calibration experiment are given in the sixth column.

The total asymmetry of the escape of fission neutrons in the entire energy range is $a_n = (4.5 \pm 0.7) \times 10^{-5}$ and the corresponding predicted asymmetries are $a_{calc} = (3.4 \pm 0.4) \times 10^{-5}$, according to the data of Ref. 2 and $a_{calc} = (5.8 \pm 0.6) \times 10^{-5}$, according to the data of Ref. 6.

The obtained results indicate that the spatial parity is violated in the fission of ^{234}U; a comparison of the measured and predicted neutron escape asymmetries demonstrates a qualitative agreement between this work and that of Refs. 2 and 6.

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[1]G. V. Danilyan, B. D. Vodennikov, V. P. Dronyaev *et al.*, Dronyaev *et al.*, Pis'ma Zh. Eksp. Teor. Fiz. **26**, 86 (1977) [JETP Lett. **26**, 186 (1977)].
[2]B. D. Vodennikov, G. V. Danilyan, V. P. Dronyaev *et al.*, Pis'ma Zh. Eksp. Teor. Fiz. **27**, 68 (1978) [JETP Lett. **28**, 62 (1978)].
[3]G. V. Danilyan, B. D. Vodennikov, V. P. Dronyaev *et al.*, Yad. Fiz. **27**, 42 (1978) [Sov. J. Nucl. Phys. **27**, 21 (1978)].
[4]V. N. Andreev, M. M. Danilov, O. N. Ermakov *et al.*, Pis'ma Zh. Eksp. Teor. Fiz. **28**, 53 (1978) [JETP Lett. **28**, 50 (1978)].
[5]V. N. Andreev, M. M. Danilov, O. N. Ermakov *et al.*, Yad. Fiz. **30**, 306 (1979) [Sov. J. Nucl. Phys. **30**, 283 (1979)].
[6]A. K. Petukhov, G. A. Petrov, S. I. Stepanov *et al.*, Pis'ma Eksp. Teor. Fiz. **30**, 470 (1979) [JETP Lett. **30**, 439 (1979)].
[7]N. V. Borovikova, V. A. Vesna, A. I. Egorov *et al.*, Pis'ma Zh. Eksp. Teor. Fiz. **30**, 527 (1979) [JETP Lett. **30**, 495 (1979)].