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

B. D. Vodennikov, G. V. Danilyan, V. P. Droyanov,
V. V. Novitskii, V. S. Pavlov, and S. P. Borovlev

(Submitted 22 November 1977)
Pis'ma Zh. Eksp. Teor. Fiz. **27**, No. 1, 68–70 (5 January 1978)

We measured the *P*-odd asymmetry of the emission of light (or, respectively, heavy) fragments along and against the orientation direction of the spins of the fissioning nuclei produced on capture of polarized thermal neutrons by ^{233}U. The asymmetry coefficient turned out to be $a = (2.8 \pm 0.3) \times 10^{-4}$. The positive sign means that the light fragments are emitted predominantly in the direction of the neutron-spin orientation.

PACS numbers: 25.85.Ec, 24.70.+s

We have previously reported[1,2] an investigation of the *P*-odd angular correlation $W(\theta) \sim 1 + a\vec{\sigma}\cdot\mathbf{p}$, where $\vec{\sigma}$ is a unit vector in the direction of the nuclear spin orientation, $\mathbf{p}$ is a unit vector in the direction of the momentum of the light (heavy) fragment,

 0021-3640/78/2701-0062$00.60

and θ is the angle between these vectors, in the fission of ^{235}U and ^{239}Pu by polarized thermal neutrons. The asymmetry coefficients for the fissioning nuclei ^{236}U and ^{240}Pu turned out to be:

$$a(^{236}U) = (1.7 \times 0.4) \cdot 10^{-4} \text{ and } a(^{240}Pu) = (-4.8 \pm 0.8) \times 10^{-4}.$$

The positive sign of the asymmetry means that the light fragments are predominantly emitted in the direction of orientation of the neutron spins. We present below the results of analogous measurements in the fission of ^{233}U by polarized thermal neutrons. The measurements were performed with a beam of polarized thermal neutrons of the heavy-water reactor of the Institute of Theoretical and Experimental Physics, which is described in[3,1] The measurement procedure and the reduction of the results were the same as in[1,2].

Two measurement runs were performed with the target of ^{233}U oxide. In the first run we used the fission chamber employed in[2]. The following asymmetry coefficient was obtained:

$$a(^{233}U) = (2.73 \pm 0.33) \times 10^{-4}.$$

For the second measurement run we estimated roughly the dependence of the *P*-odd effect on the mass asymmetry of the fission fragments. We used for this purpose a new higher transmission fission chamber with a geometry analogous to that described in[1].

Figure 1 shows a typical pulse-height spectrum of the fission fragments. The left-hand and right-hand maxima are due to the heavy and light fragments, respectively. The dashed lines indicate the spectrum intervals resolved by the corresponding differential discriminator.

We measured the count asymmetry for each of the spectrum intervals. The results are gathered in Table I.

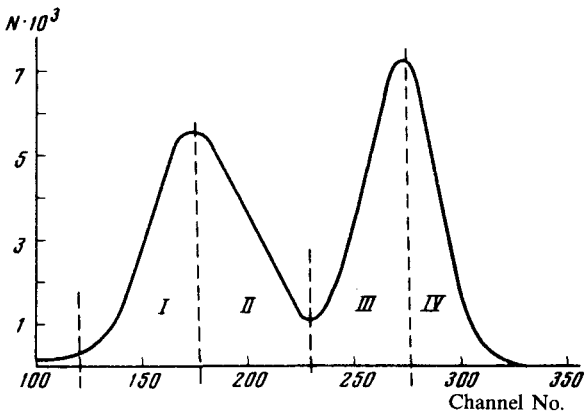

FIG. 1.

TABLE I.

Beam polarization	Asymmetry, a_j			
	Heavy fragments		Light fragments	
	a_{I}	a_{II}	a_{III}	a_{IV}
0.84	-2.07 ± 0.31	-1.85 ± 0.34	1.94 ± 0.32	2.39 ± 0.30
0.08	-0.14 ± 0.35	-0.78 ± 0.31	-0.16 ± 0.35	0.06 ± 0.32

The slight difference between the asymmetries for the inner and outer regions of the pulse-height spectrum can be attributed to a partial overlap of the corresponding maxima. The results offer evidence that no substantial monotonic dependence of the effect on the mass asymmetry of the fission fragments is observed.

The mean-weighted value of the asymmetry coefficient for the fissioning nucleus ^{234}U, with allowance for the finite solid angle of the fragment registration ($\cos\theta = 0.89$) and for the degree of polarization of the neutrons, turned out to be

$$a(^{234}\mathrm{U}) = (3.6 \pm 1.0) \cdot 10^{-4}.$$

The error includes the uncertainty of the instrumental asymmetry. The asymmetry averaged over the two runs is

$$a(^{234}\mathrm{U}) = (2.8 \pm 0.3) \cdot 10^{-4}.$$

The experiments were performed in collaboration with V.A. Emel'yanov, R.S. Zinatulin, and A.I. Ponomarev, to whom the authors are grateful. The authors thank also the reactor crew.

[1]G.V. Danilyan, V.P. Dronyaev, B.D. Vodennikov, V.V. Novitskiĭ, V.S. Pavlov, and S.P. Borovlev, Preprint ITEP-4, 1977.
[2]G.V. Danilyan, B.D. Vodennikov, V.P. Dronyaev, V.V. Novitskiĭ, V.S. Pavlov, and S.P. Borovlev, Pis'mas Zh. Eksp. Teor. Fiz. **26**, 198 (1977) [JETP Lett. **26**, 186 (1977)].
[3]G.V. Danilyan, V.V. Novitskiĭ, V.S. Pavlov, S.P. Borovlev, B.D. Vodennikov, and V.P. Dronyaev, Pis'ma Zh. Eksp. Teor. Fiz. **24**, 380 (1976) [JETP Lett. **24**, 344 (1976)].