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PARITY NON-CONSERVING ASYMMETRY OF LONGITUDINALLY POLARIZED THERMAL NEUTRONS PROPAGATION

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Résumé - L'asymétrie ne conservant pas la parité dans la propagation de neutrons thermiques polarisés longitudinalement a été mesurée pour quelques éléments. Les valeurs suivantes concernant la différence relative des sections efficaces totales pour des neutrons d'hélicités opposées (unités 10^{-6}) ont été obtenues : uranium - 233 : $0,9 \pm 0,9$, plomb 207 : $0,9 \pm 1,7$, plomb naturel : $0,0 \pm 0,6$, thorium - 232 : $0,7 \pm 2,3$, zirconium naturel : $0,5 \pm 0,9$, brome naturel : $11,4 \pm 1,4$.

Abstract - The parity-non-conserving (PNC) asymmetry of the longitudinally polarized thermal neutron propagation was measured for some elements. The following values (in units of 10^{-6}) for the relative difference in total cross-sections for neutrons of opposite helicities have been obtained : uranium - 233 : 0.9 ± 0.9 , lead - 207 : 0.9 ± 1.7 , natural lead : 0.0 ± 0.6 , thorium - 232 : 0.7 ± 2.3 , natural zirconium : 0.5 ± 0.9 and natural bromine : 11.4 ± 1.4 .

The investigation of parity-non-conserving effects aims to a better knowledge of the nucleon weak interaction structure. It requires a profound understanding of both the complex excited nuclear states and probably the nuclear fission mechanism.

In our opinion, it is necessary to collect further experimental data over a wide range of effects and for a larger number of nuclei.

Our previous work /1/ was devoted to measuring the relative difference in the total cross-sections of uranium - 233 for thermal neutrons with opposite helicities :

$$P = (\sigma_+ - \sigma_-) / (\sigma_+ + \sigma_-)$$

This was of interest in connection with the discovery by G.V. Val'skii et al. /2/ of a sign change in the PNC asymmetry of fragment emission from ^{233}U fission occurring for 0.17 eV neutrons. Indeed, this feature indicates that there is at this energy a neutron resonance and, within the assumption that it is a p-wave resonance, theory predicts $P = 5 \times 10^{-5}/3,4/$.

A zero result was obtained /1,5/ which stimulated O.P. Sushkov and V.V. Flambaum /6/ to produce a new estimate of $P = (1-2) \times 10^{-6}$ based on some additional assumptions about the parameters of the compound nucleus.

We have now carried out a further search for PNC asymmetries in thermal neutron propagation with the facilities described in /1/. The results obtained for a number of nuclei are presented here.

The target was placed in front of a neutron detector in a polarized thermal neutron beam with a longitudinally directed magnetic field. The sign of neutron polarization was reversed by means of a "spin-flipper" i.e. a bending electromagnet and a current-sheet /7/. The experimental asymmetry was calculated from the difference in detector readings with opposite neutron helicities.

A compensation method was used to cancel the effect of any false asymmetry due to instabilities in the intensity of the incident neutron beam. A special monitor detector was placed in part of the neutron beam by-passing the target, and the difference between the monitor and main detector currents was measured. Thus the influence of any instability in the intensity of the incident neutron beam was reduced in the ratio of this compensated current to the main detector current. As a result, this type of false asymmetry was suppressed by a factor of 100 - 1000. Since the detector and monitor were connected to the same load impedance, instabilities in both the impedance and the measuring instrument were also suppressed to a considerable extent.

The spin-guiding magnetic field at the target was also reversed periodically to counter any possible asymmetry in the apparatus.

The neutron detectors, consisting of assemblies of ^3He counters of the SNM - 16 and SNM - 17 types, were operated under ionization chamber conditions. The total intensity of the polarized neutron beam was $\approx 5 \times 10^7$ n/sec with a degree of polarization of $(74 \pm 0.5)\%$ and the polarization was reversed with a frequency of 1 Hz. The measurements were made automatically by means of a high stability digital voltmeter controlled on-line by an Elektronika - 60 computer. The work was carried out at the IR-8 reactor of the I.V. Kurtchatov Atomic Energy Institute.

Table I presents the results obtained. No PNC asymmetry in the propagation of thermal, longitudinally polarized, neutrons for newly investigated nuclei was observed within the current accuracy of the experiments.

TABLE I

Target	: σ_0 :	Asymmetry, $\times 10^{-6}$		
		experimental	: apparatus	: $P = (\sigma_+ - \sigma_-) / (\sigma_+ + \sigma_-)$
1. KBr	1.9	3.0 ± 0.3	0.3 ± 0.3	8.5 ± 1.0
2. Converted to Br natur.	-	-	-	11.4 ± 1.4
3. Zr-natur.	1.5	0.4 ± 0.7	-0.7 ± 0.7	0.5 ± 0.9
4. Th-232	0.4	0.3 ± 0.9	0.4 ± 0.9	0.7 ± 2.3
5. Pb-natur.	2.4	0.0 ± 0.3	0.2 ± 0.3	0.0 ± 0.6
6. Pb-207	0.6	0.3 ± 0.6	0.4 ± 0.6	0.9 ± 1.7
7. U-233	2.2	0.1 ± 0.1	0.0 ± 0.1	0.9 ± 0.9

Note : The apparatus asymmetry $A_{app} = \frac{A_+ - A_-}{2}$, where $A_{\pm}$ are the experimental asymmetry values obtained for opposite directions of the guiding magnetic field.

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REFERENCES

1. BONDARENKO L.N. et al. JETP Lett., 1983, v.38, p. 141 (in Russian)
2. VAL'SKII G.V. et al., Preprints LINP 796 and 797 (1982), issued by Leningrad Institute of Nuclear Physics (in Russian)
3. BUNAKOV V.E. and GUDKOV V.P. Preprints LINP nn 661 (1981), 763 (1982), issued ibid. (in Russian)
4. SUSHKOV O.P. and FLAMBAUM V.V., Uspekhi Fiz. Nauk, 1982, v.136, p. 3 (in Russian)
5. VESNA V.A. et al. JETP Lett., 1983, v. 37, p. 410 (in Russian)
6. SUSHKOV O.P. and FLAMBAUM V.V. Preprint INP 83-31, issued by Novosibirskii Institute of Nuclear Physics (1983), (in Russian)
7. MOSTOVOY Yu.A., Priory i Tekhnika Experimenta, 1982, n. 3, p. 24 (in Russian)
8. HECKEL et al., Ph. Lett. v. 119B, p. 298, 1982.