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V.S.Evseyev, V.A.Chernogorova, F.Kilbinger,
V.S.Roganov, M.Szimchak

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The asymmetry coefficient B in the angular distribution of high energy neutrons from mu-capture in sulfur has been measured. The value of the asymmetry coefficient reduced to 100% of mu-meson residual polarization is close to −1, which contradicts calculations on the basis of the universal weak interaction theory.

As follows from refs.[1,2], the asymmetry coefficient B in the angular distribution of neutrons

$$N(\theta) = 1 + P_{\mu} B\cos\theta \qquad (1)$$

from mu-capture in Ca (P_{μ} is the mu-meson residual polarization, θ is the angle between mu-meson spin and the neutron momentum) is rather close to its limit value −1, if the neutron detection threshold is $E_n \gtrsim 18$ MeV.

Theoretical calculations[3] done basing on the universal weak interaction theory with various nuclear models used provide for the asymmetry coefficient B the value 10 times smaller than unity.

The aim of the present paper is the description of the method and the results of measuring the asymmetry coefficients in the neutron-angular distribution from mu-capture in sulfur. The results of this experiment were reported shortly at the International Conference on High Energy Physics at Dubna, 1964[4].

There were no special reasons to choose the sulfur nucleus. We were to check up whether the result obtained with Ca was unique due to some specific features of the twice magic nucleus Ca^{40}. In the described experiment the same technique as earlier[1] was used.

The difference of this experiment on sulfur was that by in creasing the layer thickness in a scintillation laminated detector[5] up to $\ell = 8$ mm (see also Appendix in ref.[1]) the detection efficiency of high energy neutrons was increased.

The neutron angular distribution was studied by the method of muon spin precession in the magnetic field. The time distribution of neutrons was increased.

The neutron angular distribution was studied by the method of muon spin precession in the magnetic field. The time distribution of neutron pulses was investigated, also as in ref.[1], with an oscilloscope. The distribution is written as

$$N_i(t_i) = N_0 e^{-t_i/\tau_s}[1 + B\cos(\omega t_i + \delta)] + C \quad , \qquad (2)$$

where $N_i(t_i)$ is the number of events in the i-th time interval, t_i is the time interval, ω is the frequency of muon spin precession, δ is the angle between the muon spin direction at the moment of stopping and the line connecting the centre of the target with that of the neutron detector, B is the asymmetry coefficient, N_0 is the number of neutrons from sulfur at $t = 0$, C is the random coincidence background, i varies from 0 to 12. The scanning and treatment of experimental data do not differ from those described in ref.[1].

In our experiment the ratio N_0/C was reduced comparing to that in experiments with Ca[1]. This was made due to some increase of the external background and to the smaller probability of negative muon capture in sulfur. To increase N_0/C in experiments on sulfur use was made of the fact that neutrons produced in the absorption of negative pions stopped in the meson telescope moderator made a considerable portion of the background C in operating with a beam not purified of negative pions. To separate such neutrons (see ref.[1]) a scintillation counter about 20 cm in diameter was placed in front of the moderator which overlapped the whole π^-, μ^- meson beam. The pulses of this counter and those of the neutron detector were fed to the coincidence circuit having the resolution time of about 10^{-8} sec. Formed coincidence pulses entered the linear locking circuit of neutron pulses. (See ref.[5]).

Thus, from neutron pulses fed to the oscilloscope for the amplitude and time analysis those were rejected which either corresponded to neutrons from π^- capture or to neutrons from muon capture in sulfur accidentally coincided with the π^- meson pulse. Owing to high intensity at the meson input of our coincidence circuit some (10-15)% of neutrons from sulfur were not detected. Since in the neutron detector use was made of photomultipliers FEU-24 having the time rise of about 8 nsec, the decrease of the resolution time of the coincidence circuit caused the increase of the detection background efficiency. This system made it possible to decrease C about 2.5 times and to obtain N_0/C to be 4.5.

In our experiments the pulses of neutrons detected with a neutron detector were photographed simultaneously both after mu^- meson stop and before it, i.e. the random coincidence background.

Precession frequency was increased about twice compared to that in experiments with calcium /1/.

To avoid systematic errors the asymmetry coefficient B was measured at two precession field values equal in the absolute value and opposite in sign. Besides, B was measured simultaneously with a $T \rightarrow A$ amplitude analyzer also at two directions of the precession field.

The mu^- meson lifetime in sulfur was taken from ref. /6/. Unlike in the described experiment in the case with Ca τ_{Ca} should be known to a great accuracy because the precession curve was obtained only with one direction of the precession field whereas the asymmetry coefficient B was considerably dependent of τ_{Ca} and therefore τ_{Ca} was measured with our device to a sufficient accuracy /1/.

The results of treating experimental data by the least squares method with an electronic computer are enlisted in Table 1. It follows from the Table that all four values of $|B|$ coincide with each other. The precession curve shown in Fig. 1 is the result of adding two precession curves (phase inversion being in one of them) obtained with an oscilloscope at two precession field directions.

The weighted mean according to four values of the asymmetry coefficient $-B = 0.109 \pm 0.028$.

The neutron detection threshold was 18 ± 2 MeV. The mean neutron energy $\bar{E}$ at the given threshold can be defined in the same way as it was done earlier (see Appendix of ref. /1/). However, the neutron spectrum from mu^- capture in sulfur is obtained with a large error and therefore the value of $\bar{E}$ can be evaluated approximately as follows. If one assumes that the neutron spectrum from sulfur is of the same form as in mu^- capture on calcium, then $\bar{E}$ is about 40 MeV for sulfur.

The residual polarization P_{μ} was measured also by using the decay electrons by the mu^- meson spin precession method in the magnetic field. In contrast to our preliminary experiments the electronic telescope consisted of three scintillation counters each 4 mm thick (earlier the thickness was 10 mm) and two moderators. The target ≈ 12 g/cm^2 thick both in the direction of the beam and that of the neutron detector (or the electron telescope) was placed into a carcasless coil. This allowed to avoid the "carbon" background of electrons from the carcas. To reduce the background of decay electrons from negative muons stopped in counters nearest to the target use was made (similar to the experiments with calcium) of anticoincidence circuits a) between the meson telescope T_μ and the counter of the electron telescope T_e nearest to the target; b) between T_e and the counter T_μ nearest to the target.

Radiation and other corrections for the target and T_e were taken into account as earlier/1/ and P_μ^s was obtained to be equal to 0.128 ± 0.016.

Reduced to a 100% polarization of the μ^- meson the asymmetry coefficient was close to -1:

$$-B/P_\mu^s = 0.85 \pm 0.24.$$

The obtained result being in good agreement with that of the experiment on calcium/1/ (as follows from Fig. 2) contradicts the calculations on the basis of the weak interaction theory and the nuclear model of independent particles/3/.

In conclusion the authors wish to express their gratitude to V.G.Zinov and Tsao Go-cheng for help in the measurements and A.V.Rakitsky for help in calculations.

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Table 1

Precession direction	|B|	
	The (T → A) convertor	Oscilloscope
↑	(0.122 ± 0.040)	(0.123±0,053)
↓	(0.088 ± 0.033)	(0.105±0.036)
Mean	0.107 ± 0.026	0.111 ± 0.030

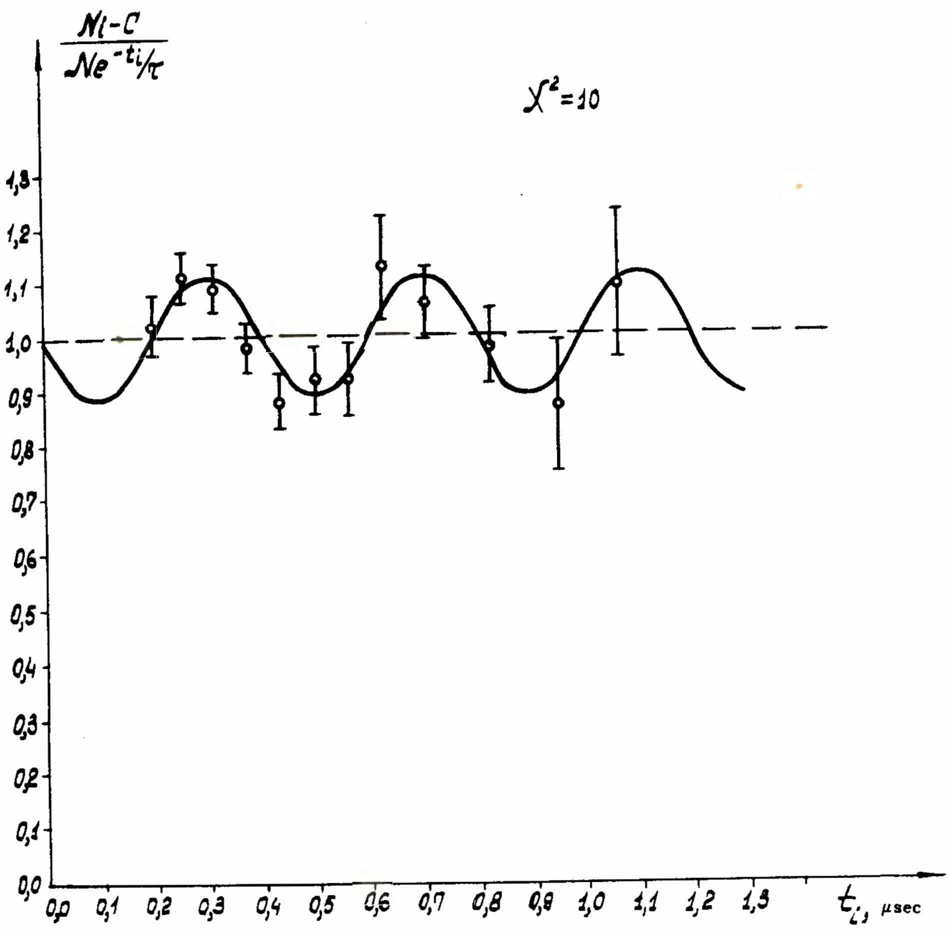

Fig. 1. Precession curves for neutrons.

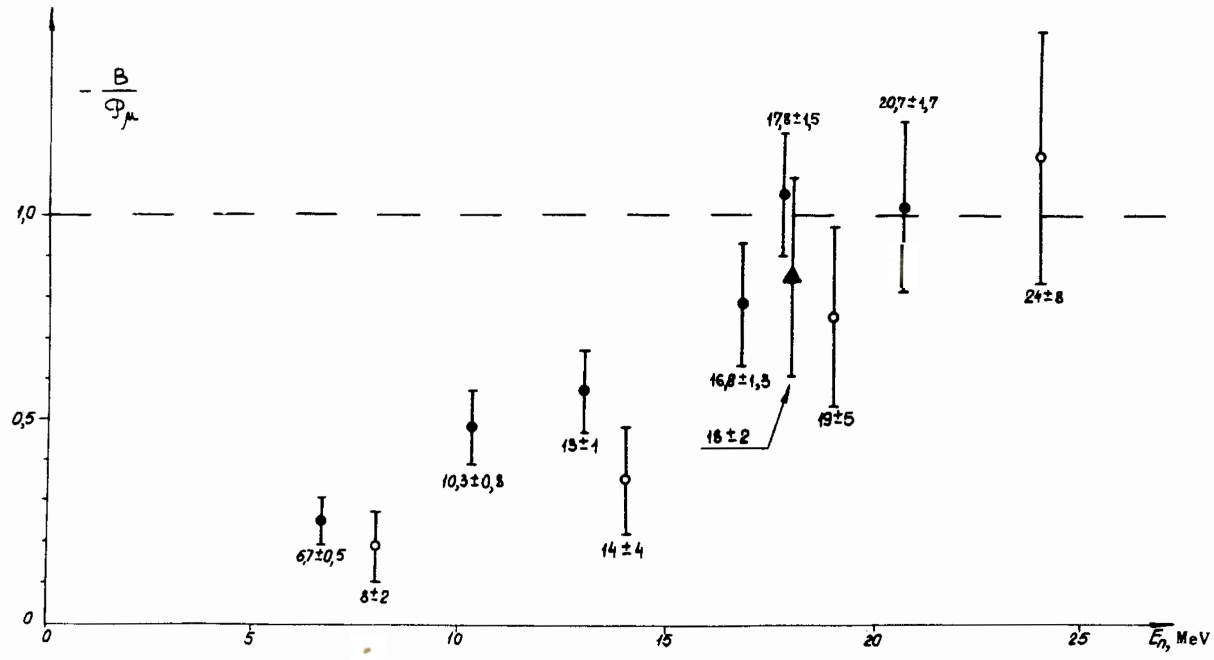

Fig. 2. Dependence $-B/P_{\mu}$ upon E_n. Solid circles are data of ref.[1], open circles are data of ref.[2]. The solid triangle is the present paper. The numbers near the point are $E_n \pm \Delta E_n$.