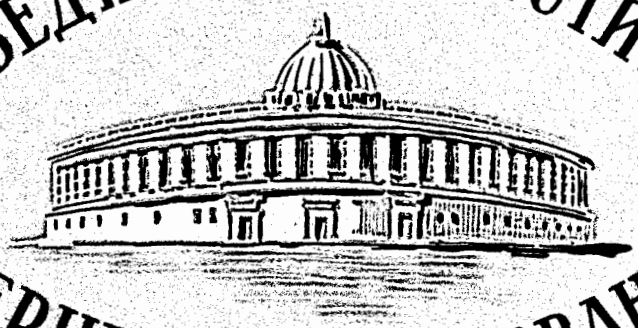
ЛАБОРАТОРИЯ ТЕОРЕТИЧЕСКОЙ ФИЗИКИ

ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ



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ON THE POLARIZATION CROSS-SECTION OF FAST NUCLEON SCATTERING

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In the last time, much attention is payed to polarization measurements in elastic small-angle scattering of fast nucleons. We want to show in the following consideration , that such experiments are of great theoretical interest.

As already known, the square of the one-pion term gives no contribution to the polarization cross-section of the elastic scattering of two unpolarized nucleons. Nevertheless, for the scattering without polarization, the strong cosine-dependence[1] of the cross-section near $\cos\theta = \pm 1$ is given by the interference term rather than by the one-pion term squared (the latter vanishes at $\cos\theta = \pm 1$ together with its first derivative, while the interference term has a large derivative in these points). Therefore, one could expect that the interference term plays an important role also in the polarization. However, we shall show that this term gives no contribution to the polarization cross section.

The calculation has been performed in the reference system of the polarized nucleon. The problem consists in calculating five products of traces which are combinations of sixteen expressions

$$i\,\mathrm{tr}\left(\frac{-i\hat{p}+m}{2m}\gamma_4\gamma_5\gamma_4\frac{1+\gamma_4}{2}\hat{e}\gamma_4\gamma_5\gamma_A\right)\cdot\mathrm{tr}\left(\frac{-i\hat{k}+m}{2m}\gamma_4\gamma_5\gamma_4\frac{-i\hat{k}'+m}{2m}\gamma_A\right) \qquad (1)$$

where $i\hat{e}\gamma_4\gamma_5$ is the spin-tensor of Racah and γ_A denotes one of the sixteen terms of the corresponding γ algebra. From (1), five sums are to be formed in order to obtain the following structure terms

$$S = 1\times 1\,, \quad V = \sum_\mu \gamma_\mu \times \gamma_\mu\,, \quad T = \sum_{\mu<\nu} i\gamma_\mu\gamma_\nu \times i\gamma_\mu\gamma_\nu\,, \quad A = \sum_\mu i\gamma_\mu\gamma_5 \times i\gamma_\mu\gamma_5\,, \quad P = \gamma_5\times\gamma_5\,.$$

It may easily be shown that all these five sums are equal to zero. The second one-pion term, which has a complicated structure in the chosen representation, may be brought into the $\gamma_5\times\gamma_5$ form by the Fierz transformation.

From this point of view, polarization measurements of recoil protons in elastic scattering of two unpolarized nucleons seem to be of great theoretical interest. Such an experiment is in progress in Joint Institute in Dubna[2] at 9 GeV laboratory energy. The scattering cosines are 0.961 and 0.997, while the cosine of the pole is 1.002 (all values in the c.m. system). Since the pole dependence of the cross-section is completely eliminated, this arrangement allows to measure directly the contribution of the higher terms, which theoretically are very little known, but are expected to be small.

References

1. G.F. Chew, Phys.Rev. 112, 1380 (1958); Annual Review of Nuclear Science, 1959.

2. K.D. Tolstov, private communication.

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