BIREFRINGENCE OF DEUTERONS IN AN UNPOLARIZED TARGET: THEORY AND EXPERIMENT

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The interaction of light and anisotropic matter depends on the polarization of light. For example, the birefringence effect can be observed when light is transmitted through a plate of Iceland spar because two unequal refractive indices correspond to the components of light with polarizations parallel and orthogonal to the crystal plane. The interaction of light and optically anisotropic matter is also accompanied by the dichroism effect: differential absorption of light rays having different polarizations. As a result of the development of the wave-particle duality concept, many notions and phenomena from optics were expanded to particle physics.

In this regard, the quasi-optical birefringence effect of particles with spin $S \geq 1$, which was predicted in [1], is of particular interest. For particles with the rest mass $m \neq 0$, the birefringence effect occurs even in a uniform, isotropic medium because of the inherent anisotropy of particles with spin $S \geq 1$ (as contrasted to those with spin 0 и 1/2). The feature of quasi-optical birefringence effect is the presence such dichroism type in which a transmitted unpolarized particle beam acquires tensor polarization [1, 2], along with that in which particle polarization is converted from vector to tensor and vice versa.

First experiments on birefringence of deuterons involved measuring their spin dichroism effect. The experiments, carried out by the international Collaboration at the accelerator of the University of Cologne (Germany), used an unpolarized deuteron beam of energy 5—20 MeV and carbon targets of thickness up to 188 mg/cm^2. Tensor polarization of the deuteron beam transmitted through the target has a magnitude from +0.02 to –0.1, depending on the energy and the target thickness [3]. These experiments discovered the spin dichroism effect as well as revealed the sign reversal of the effect with varying beam energy. It was found out that the sign reversal of spin results from the Coulomb-nuclear interference of deuteron-carbon interaction [4].

Further spin dichroism experiments were performed at the Nuclotron in JINR (Russia) using a 5 GeV/s deuteron beam and carbon targets of thickness 140 g/cm^2. The magnitude of tensor polarization was 0.3 [5], and its experimentally determined sign coincided with theoretical prediction. We report a theoretical study of the deuteron birefringence effect for energies from 5 to 20 MeV and the experiments on spin dichroism measurements for high and low energies.

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