HIGH-ENERGY NUCLEAR OPTICS OF POLARIZED PARTICLES

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The phenomena of interference, diffraction and refraction of light are well known, and their applications are described in school and university manuals.

Further analysis showed that the effects due to optical activity of matter, which we consider in optics, are a particular case of coherent phenomena emerging when polarized particles pass through matter with unpolarized and polarized electrons and nuclei [1].

The effects of optical anisotropy are very important for the interpretation of the experiments to search for electric dipole moments (EDMs) of deuterons.

The study of the deuteron birefringence effect in experiments for the EDM search is essential to distinguish the contributions from the deuteron birefringence effect and the deuteron EDM to spin rotation.

According to [1], in both EDM experiments and studies of deuteron spin rotation in storage rings, one should take into account deuteron electric and magnetic polarizabilities.

The advent of the Facility for Low-Energy Antiproton and Ion Research (FLAIR) has spurred the rapid development of low–energy antiproton physics

For low–energy neutrons, the phenomenon of "optical" spin rotation (nuclear precession of the neutron spin in a nuclear pseudomagnetic field of a polarized target) is studied with slow neutrons passing through targets with polarized nuclei.

In contrast to neutrons, a charged particle moving in matter undergoes Coulomb interaction with the atoms of matter, which causes multiple scattering and rapid deceleration of the charged particle due to ionization energy losses.

When the energy of a positively charged particle diminishes, the Coulomb repulsion eliminates nuclear interaction between the incident particle and the target nucleus, thus suppressing the phenomenon of spin rotation due to nuclear interaction. Conversely, a negatively charged particle (antiproton, hyperon) is attracted to the nucleus and, as a result, participates in nuclear interaction even at low energies. As a consequence of this, spin rotation of a negatively charged particle in polarized matter does not disappear at low energies either and becomes observable.

1. V.G.Baryshevsky. High-Energy Nuclear Optics of Polarized Particles. Singapore: World Scientific Publishing, 2012.