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"Optical" spin rotation phenomenon and spin-filtering of antiproton (proton, deuteron) beams in a nuclear pseudomagnetic field of a polarized nuclear target: the possibility of measuring the real and imaginary spin-depended part of the coherent zero-angle scattering amplitude

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Despite long-lasting study and seeming simplicity, the investigation of two- and three-particle interactions is still a topical problem. Because these investigations are very important, the experiments with antiproton, proton and deuteron interactions are included in scientific programs of modern accelerators COSY, GSI and LHC.

For study of these interactions, polarization observables sensible to different mechanism of interaction is of particular interest as well as the differential reaction cross-section. Modern storage rings with a long lifetime of a beam permit one to carry out qualitatively new experiments with polarized beams and targets. Particularly, in the spin-filtering experiments [1] of antiprotons (protons, deuterons), it is possible to measure the spin-dependent part of a forward scattering amplitude [1-3]. Moreover, it is possible to measure the real part of a coherent elastic amplitude of proton (antiproton, deuteron) scattering at zero angle when the plane formed by the target polarization vector and the beam momentum direction lies in the orbit pane of the beam and the angle between these two vectors differs from 0, π or $\pi/2$ [2]. Measurement of the spin-dependent part of a forward scattering amplitude is possible by measuring the lifetime of the unpolarized beam passing through a polarized internal target [2]. Direct measurement of the tensor part of the deuteron-proton interaction can be performed by measuring the lifetime of the unpolarized proton beam passing through a tensor polarized deuterium target [3]. Let us note that in the considered methods with a deuteron beam or a target, the magnitude of the observable polarization effects depends on behavior of the wave functions of the deuteron ground state at small distances, which is important for studying non-nucleonic degrees of freedom in the nucleus.

The influence of high-frequency (g-2) spin precession in a ring is one of the problems we encounter in spin rotation measurements in a storage ring. In this regard, attention should be drawn to the EDM experiments based on freezing the horizontal spin motion, i.e., forcing the particles'spin to always point along the direction of motion thus cancelling the (g-2) precession [1]. Applying this method and polarized targets, the "optical" spin rotation phenomenon in a nuclear pseudomagnetic field of a polarized nuclear target can be observed, which is beneficial for the investigation of spin-depended interactions in the above experiments.

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