The Schwinger scattering of the twisted neutrons by nuclei

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Abstract: The process of elastic scattering of the plane-wave neutrons by nuclei is known to have a considerable contribution from the interference between a nuclear amplitude and an electromagnetic one in a region of the small scattering angles. This interference depends on the transverse polarization of the incoming neutron and on an imaginary part of the nuclear amplitude, thus allowing for important measurements of a phase of the latter. In this contribution we study such a Schwinger scattering of the twisted neutrons, i.e. neutrons carrying an orbital angular momentum with respect to a propagation direction. For a wide macroscopic target we predict that the interference shifts to a region of the relatively large scattering angles, which nearly coincide with the conical angle of the incoming twisted neutron and, therefore, are much more convenient for an experimental study. For a small mesoscopic target (ideally, one nucleus) we predict that the scattering probability develops dependence on the incoming neutron's helicity and on the real part of the nuclear amplitude. We make quantitative estimates of an angular momentum- and/or a spin asymmetry, which amounts to several percent for heavy nuclei and the realistic parameters of the neutron beam.