T Invariance and Polarization Effects in the Elastic Scattering of a Spin-1/2 Particle on an Unpolarized Target

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Abstract—The general dependence of the effective cross section for the elastic scattering of a spin-1/2 particle by an unpolarized target on the initial and final polarizations of the particle has been analyzed within the T-invariance framework. A simple proof of the Wolfenstein theorem, according to which the degree of transverse polarization that arises in the elastic scattering of an unpolarized particle on an unpolarized target is equal to the left–right asymmetry in the elastic scattering of a transversely polarized particle of the same nature on the same target, has been given on the basis of only the T symmetry of the differential cross section for scattering without resort to a traditional analysis of the spin structure of scattering amplitudes. The spin dependence of the differential cross section for elastic scattering has been considered for the case of P violation; it has been shown that, if T symmetry is conserved, the P-odd longitudinal spin asymmetry coincides with the average helicity of the scattered particle. It has also been demonstrated that, in the case of T invariance, the amplitude and the cross section for backward neutron scattering on spinless nuclei are spin-independent; the observation of such a dependence would be unambiguous evidence for T violation. Estimates presented in this study reveal, however, that, in backward scattering, T-noninvariant spin asymmetry is very small (about 10 ^{8}–10 ^{7}).