A large N_c approach to the study of spin effects in low-energy electron-nucleon scattering with two-photon exchange

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The transverse single-spin asymmetry in inclusive electron-nucleon scattering, $e+N(S_T) \to e' + X$, represents a pure two-photon exchange observable and is of fundamental interest for exploring higher-order QED effects in electron scattering. We compute this observable in the resonance region, where excitation of Δ isobars occurs in both intermediate and final states. We employ a novel theoretical method based on the large-N_c limit of QCD. Our predictions could be tested in future measurements of electron-nucleon scattering with polarized targets.

Summary

A particularly interesting observable in inclusive electron-nucleon scattering is the target normal single-spin asymmetry (SSA). Zero in one-photon exchange approximation it represents pure two-photon exchange (TPE) effect [1].
We consider inclusive electron scattering on the nucleon,

$$e(k_i) + N(p_i) \to e(k_f) + X(p_f), \tag{1}$$

where X denotes the hadronic final states accessible at the incident energy. The electron is unpolarized, the nucleon is polarized.
The contributions to the SSA come from the interference of e^4 and e^2 amplitudes (Fig.1). These contributions involve only the imaginary part of the $N \to X$ TPE amplitude, which is given by on-shell matrix elements of EM current.
We study the normal SSA in the resonance region using the $1/N_c$ expansion of QCD [2–8]. This method, allows us to consistently combine nucleon and Δ states and predict the elastic, inelastic, and inclusive spin-dependent cross section. Our results aim at disentangling the different contributions of nucleon and Δ states organizing them according to their $1/N_c$ scaling.
Our predictions could be tested in future measurements of electron-nucleon scattering with polarized targets in the few-GeV energy range. Such experiments would complement earlier measurements of the inclusive single-spin asymmetry in the DIS regime (JLab, HERMES) and allow one to study the unknown dependence of two-photon exchange dynamics on the energy/momentum of the probe.

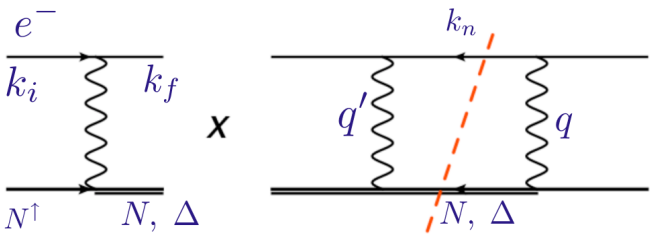

Figure 1: Spin-dependent cross section from interference of e^4 and e^2 amplitudes

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