π^0 electroproduction

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Recent experimental results on pion electroproduction provided clear evidence for strong contributions from transversally polarized virtual photons. This observation is in sharp contrast to the handbag factorization which tells us that for asymptotically large photon virtualities, Q, longitudinally polarized photons dominate. According to the handbag approach the amplitudes for transverse photons are suppressed $\sim 1/Q$ as compared to those from longitudinal photons.

The experimental evidence for strong $\gamma_T^* \to \pi$ transitions comes from the HERMES π^+ data [1] on the $\sin\phi_s$ harmonics measured with a transversally polarized target and from the CLAS measurement [2] of the π^0 cross sections which reveals a transverse-transverse interference cross section that amounts to a substantial fraction of the unseparated cross section.

It has been argued in [3, 4] that, within the handbag approach, the amplitudes for $\gamma_T^* \to \pi$ transitions are under control of transversity GPDs, in particular of H_T and $\bar{E}_T = 2\widetilde{H}_T + E_T$

$$\mathcal{M}_{0-,++} = e_0\sqrt{1-\xi^2}\int_{-1}^{1} dx \mathcal{H}^{\text{twist}-3}_{0-,++} H_T\,, \quad \mathcal{M}_{0+,\pm+} = -e_0\frac{\sqrt{-t'}}{4m}\int_{-1}^{1} dx \mathcal{H}^{\text{twist}-3}_{0-,++} \bar{E}_T\,. \quad (1)$$

The subprocess amplitude $\mathcal{H}$ is of twist-3 accuracy since quark and antiquark forming the pion have the same helicity and, hence, a twist-3 pion distribution amplitude is required. This distribution amplitude goes along with a parameter μ_π which is fixed by the divergency of the axial vector current. It is given by

$$\mu_\pi = \frac{m_\pi^2}{m_u + m_d} \simeq 2 \text{ GeV}\,, \quad (2)$$

where the m_q are current quark masses. The numerical value of μ_π holds at a scale of 2 GeV. Therefore, this is an enhanced twist-3 effect and the parametric suppression μ_π/Q of the transverse amplitudes is not relevant for values of Q accessible in current experiments.

In order to evaluate the amplitudes (1) the transversity GPDs are modelled with the help of the double-distribution ansatz. The pertinent parameters are fixed by fitting the HERMES data on π^+ electroproduction and by lattice QCD results [5]. Estimates of

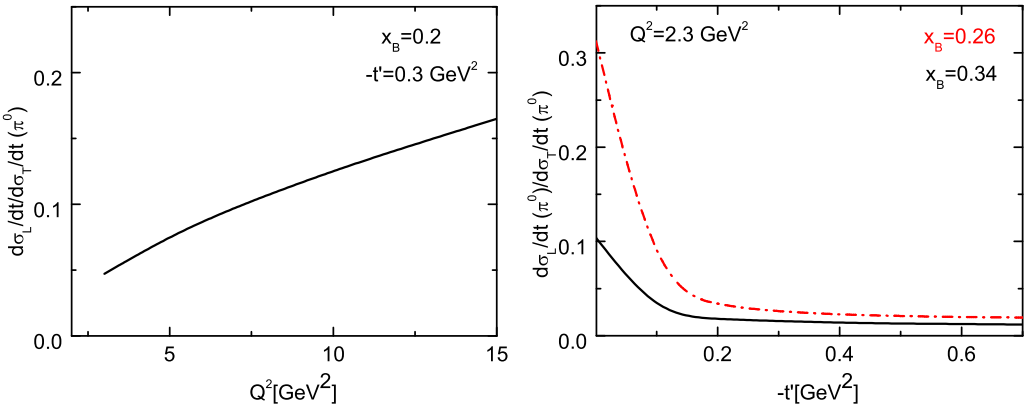

Figure 1: The ratio of the longitudinal and transverse cross section for π^0 electroproduction. The predictions are taken from [4]; they have an uncertainty of about a factor of 2.

various observables using these GPDs are in fair agreement with experiment. One should bear in mind that these estimates have uncertainties of about a factor of two. In order to determine the transversity GPDs more precise data on π^0 (and on other pseudoscalar meson) electroproduction at larger values of Q^2 and W as available at Jlab 6, are needed. A particularly clean probe of large transversity effects in pion electroproduction is the measurement of the ratio σ_L/σ_T as a function of Q^2. The standard handbag approach predicts $\sigma_L >> \sigma_T$ while strong transversity effects would lead to $\sigma_L < \sigma_T$. Predictions [4] for σ_L/σ_T are shown in Fig. 1. For other predictions it is referred to [4]. Transversity GPDs in pion lectroproduction have also been studied in [6].

References

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