Study of Helicity Amplitudes in hard exclusive Electroproduction of ρ^0 meson on proton and deuteron at HERMES

Bohdan Marianski[a] on behalf of HERMES Collaboration

[a] Soltan Institute for Nuclear Studies

Commonly, the differential cross section of hard exclusive electroproduction of vector mesons(V) on nucleons(N), $\gamma^* + N \rightarrow V + N'$, is described by Spin Density Matrix Elements (SDMEs). In turn, the SDMEs are expressed in terms of helicity apmlitudes $T_{\lambda_V \lambda\gamma}$ and $U_{\lambda_V \lambda\gamma}$ where T and U correspond to natural and unnatural - parity exchange, λ_V, $\lambda\gamma$ are helicities of vector meson and virtual photon. The helicity amplitudes are "more fundamental quantities" and easier to interpret. The SDMEs are extracted from angular distribution of final state particles. Substituting the SDMEs in the formula for the angular distribution by helicity amplitudes or precisely by helicity amplitudes ratios, we can also extract helicity amplitudes ratios. Production of ρ meson with a polarized electron beam and an unpolarized target is described by 23 SDMEs. These SDMEs are expressed by 18 complex helicity amplitudes. Since SDMEs depend on ratios of these complex amplitudes, the number of real parameters which determine all SDMEs is 34. Using symmetry relation, the hierarchy of amplitudes in the kinematic region of HERMES [1] $|T|_{00}^2 \sim |T|_{11}^2 \gg |U|_{11}^2 > |T|_{10}^2 \sim |U|_{01}^2 \sim |U|_{10}^2 \sim |U|_{1-1}^2$ and neglecting all UPE amplitudes except U_{11}, we can aproximate the SDMEs through nine real parameters, namely: $Re\{T_{11}/T_{00}\}$, $Im\{T_{11}/T_{00}\}$, $Re\{T_{01}/T_{00}\}$, $Im\{T_{01}/T_{00}\}$, $Re\{T_{10}/T_{00}\}$, $Im\{T_{10}/T_{00}\}$, $Re\{T_{1-1}/T_{00}\}$, $Im\{T_{1-1}/T_{00}\}$,
$|U_{11}/T_{00}|$ where $|U_{11}/T_{00}|$ is the module of U_{11}/T_{00}. In this work kinematic depenedency on Q^2 and $-t'$ of the largest amplitudes ratios T_{11}/T_{00}, T_{01}/T_{00}, $|U_{11}/T_{00}|$ for proton and deuteron data are presented. The ratios T_{10}/T_{00}, T_{1-1}/T_{00} are found to be compatible with zero within experimental uncertainties. The amplitude ratios for deuterons are compatible with those for protons. It has been found that $Re\{T_{11}/T_{00}\}$ follows the asymptotic 1/Q behavior predicted within pQCD while $Im\{T_{11}/T_{00}\}$ grows with Q^2 in contradiction to the high - Q^2 asymptotic behaviour expected from pQCD. The ratio $|U_{11}/T_{00}|$ has been found to be constant in the HERMES kinematic region, in disagreement with the asymptotic pQCD behaviour at high Q^2. The UPE signal is seen with very high significance for both proton and deuteron data.

The behaviour of $Im\{T_{01}/T_{00}\}$ is found to be in agreement with the asymptotic pQCD behavior $\sqrt{(-t')}/Q$. The $Re\{T_{01}/T_{00}\}$ disagrees with pQCD prediction.

[1] A.Airapetian et al.(HERMES Collaboration),Eur.Phys.J.C 62 659.

E-mail: bohdan@fuw.edu.pl