Abstract

The measurements of exclusive $e^+n$ and $e^+\pi$ electroproduction with the CLAS detector in Hall B at JLab provided the dominant part of the world data on observables of these channels [1] stored in the CLAS Physics Data Base [2]. The data on exclusive $Xe$ and $e^+p$ electroproduction are the major source of the information on nucleon resonance $N^*$ electroproduction amplitudes. They offer insight into the nucleon and $N^*$ structure and strong QCD dynamics which underlie the nucleon resonance generation from quarks and gluons [1, 2, 3, 4, 5, 6]. The approach for evaluation of the unpolarized, transverse-transverse, longitudinal-transverse exclusive structure functions will be presented in the talk. The estimates of these $Xe$ electroproduction observables have become available from the measured with the CLAS detector differential cross-sections for the first time. They cover a broad kinematics area of the invariant masses of the final hadron system of $W < 1.7 \, \text{GeV}$ and the photon virtuality range of $Q^2 < 5.0 \, \text{GeV}^2$. The estimated $Xe$ exclusive structure functions are of particular importance in the studies of the $N^*$ structure.

Objective

- Evaluation of exclusive structure functions $\frac{d\sigma}{dt}(W, Q^2, \cos \theta, \phi)$, $\frac{d\sigma}{dt}(W, Q^2, \cos \theta)$ for $p^*n$, $e^+p$ electroproduction channels at $W < 1.7 \, \text{GeV}$, $Q^2 < 5 \, \text{GeV}^2$

Cross sections and structure functions

The structure functions were obtained by fitting the CLAS experimental data $\frac{d\sigma}{dt}(W, Q^2, \cos \theta, \phi)$ differential cross sections as a function of the angle $\phi$ between electron scattering and the reaction planes:

$$\frac{d\sigma}{dt}(W, Q^2, \cos \theta, \phi) = \frac{d\sigma}{dt}(W, Q^2, \cos \theta) + \frac{d\sigma}{dt}(W, Q^2, \cos \theta \cos 2\phi) + \frac{d\sigma}{dt}(W, Q^2, \cos \theta \cos \phi)$$

where $\frac{d\sigma}{dt}$, $\frac{d\sigma}{dt}$, $\frac{d\sigma}{dt}$ stand for: unpolarized, transverse-transverse, and longitudinal-transverse structure functions, respectively; $\phi$ is the CM frame emission angle; $W$ and $Q^2$ are the invariant mass of the final hadrons and photon virtuality.

Data selection

- The data points with relative uncertainties $> 9$ were excluded.
- The data in each bin of $(W, Q^2, \cos \theta)$ were fitted according to equation (1). The data points which deviated from fit by 2.5 sigma were excluded.
- $(W, Q^2, \cos \theta)$ bins with less than 4 data points were excluded.

The methods for extraction of the exclusive structure functions

- Method 0: The data cover the full $\phi$ range $[0, 2\pi]$. The data fit according to equation (1).
- Method 1: The data are available in $\phi$ range $[\phi_{\text{min}}, \phi_{\text{max}}]$

$$\frac{d\sigma}{dt_{\phi_{\text{min}}}} = \frac{1}{\phi_{\text{max}} - \phi_{\text{min}}} \int_{\phi_{\text{min}}}^{\phi_{\text{max}}} \frac{d\sigma}{dt} \, d\phi$$

- Method 2:

$$\frac{d\sigma}{dt_{\phi_{\text{min}}, \phi_{\text{max}}}} = \frac{1}{\phi_{\text{max}} - \phi_{\text{min}}} \int_{\phi_{\text{min}}}^{\phi_{\text{max}}} \frac{d\sigma}{dt} \, d\phi + \int_{\phi_{\text{min}}}^{\phi_{\text{max}}} \frac{d\sigma}{dt} \, d\phi$$

$\frac{d\sigma}{dt}$ are taken from the equation (1).

- Methods 3 and 4: There are one method (3) or two (method 4) gaps in the $\phi$-dependence of the experimental data

$$\frac{d\sigma}{dt_{\phi_{\text{min}}, \phi_{\text{max}}}} = \frac{1}{\phi_{\text{max}} - \phi_{\text{min}}} \sum_{i=1}^{N_{\text{gaps}}} \left( \int_{\phi_{\text{min}}}^{\phi_{\text{min}+i} \phi_{\text{th}}} \frac{d\sigma}{dt} \, d\phi + \int_{\phi_{\text{min}+i} \phi_{\text{th}}}^{\phi_{\text{max}}} \frac{d\sigma}{dt} \, d\phi + \int_{\phi_{\text{min}+i} \phi_{\text{th}}}^{\phi_{\text{max}}} \frac{d\sigma}{dt} \, d\phi + \int_{\phi_{\text{min}+i} \phi_{\text{th}}}^{\phi_{\text{max}}} \frac{d\sigma}{dt} \, d\phi \right)$$

References


