Beam-Recoil Transferred Polarization in K^+Y Electroproduction in the Nucleon Resonance Region with CLAS12

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Over the past decade new precise data from exclusive meson photo- and electroproduction have resulted in significant progress in mapping out the spectrum of excited nucleon states (N^*s) and understanding their structure. These studies hold the key to gain insight into the nature of the strong interaction dynamics that govern these systems.

Based mainly on exclusive meson electroproduction data acquired with the CLAS detector in Hall B at Jefferson Laboratory (JLab), the nucleon resonance electroexcitation amplitudes, *i.e.* the $\gamma_v p N^*$ electrocouplings, have become available for most N^* states in the mass range up to 1.8 GeV for photon virtualities Q^2 up to ∼5 GeV^2. These data offer unique information on the strong interaction in the regime of large QCD running coupling, known as strong QCD, which is responsible for the generation of these N^* states as bound systems of quarks and gluons, with different quantum numbers and distinctively different structural features.

The recent progress in understanding the structure of the nucleon excited states has been provided by analyses of the CLAS data for exclusive electroproduction of the $\pi^+ n$, $\pi^0 p$, ηp, and $\pi^+\pi^- p$ channels from a proton target. However, K^+Y ($Y = \Lambda, \Sigma^0$) electroproduction data will also be valuable as this final state is sensitive to coupling to higher-lying N^* states for $W > 1.6$ GeV - the mass range where the understanding of the N^* spectrum is most limited.

In this work, measurement of the beam-recoil transferred polarization for the $K^+\Lambda$ and $K^+\Sigma^0$ final states is provided over a kinematic range of Q^2 from 0.3 to 4.5 GeV^2 and W from 1.6 to 2.4 GeV with a dataset from CLAS12 that is five times larger than any electroproduction dataset available from CLAS for these channels. These data significantly reduce the uncertainties on the available $K^+\Lambda$ beam-recoil transferred polarization measurements, while providing the first statistically meaningful measurements for the $K^+\Sigma^0$ final state. These data were taken as part of the Run Group K beam time in Dec. 2018 at beam energies of 6.535 GeV and 7.546 GeV. The statistical sample was sufficient for the first-ever multi-dimensional analysis for these observables vs. Q^2, W, and $\cos\theta_K^{c.m.}$.

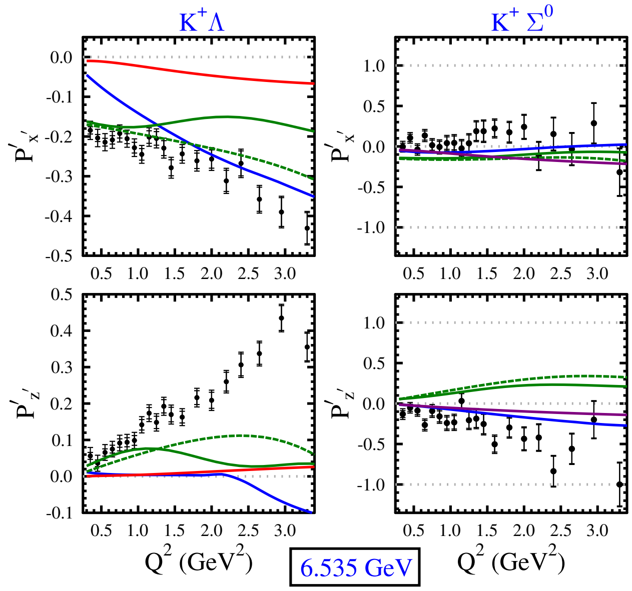

Figure 1: Transferred Λ (left) and Σ^0 (right) polarization components $\mathcal{P}'$ with respect to the (x', z') axes (x' in hadron plane, z' along K^+) vs. Q^2 for a beam energy of 6.535 GeV. The data span Q^2 from 0.3 to 3.5 GeV^2 and W from 1.625 to 2.4 GeV. The curves are calculations from available hadrodynamic models that have not been constrained by these data.

These new CLAS12 data (*e.g.* see Fig. 1) have been compared to predictions from several available single-channel models that have varying sensitivities to the s-channel resonance contributions. It is expected that these new polarization transfer data from CLAS12, along with the measurement of additional observables from CLAS12 in the K^+Y channels that are in progress, will spur further development of reaction models that can be used to access the rich underlying information to which these channels are expected to be sensitive. Such models are essential in order to determine the contributing N^* and Δ^* states in the s-channel at the upper end of the nucleon resonance region and to enable extraction of the electrocoupling amplitudes for the excited nucleon states that provide access to the underlying structure of these states that arises due to the interplay between the meson-baryon and quark-gluon degrees of freedom.