Separated Structure Functions for Exclusive $K^+\Lambda$ and $K^+\Sigma^0$ Electroproduction at 5.5 GeV Measured with CLAS

A complete mapping of the nucleon excitation spectrum is the key to a detailed understanding of the effective degrees of freedom of the nucleon and its associated dynamics. Quark model calculations of the nucleon spectrum have predicted more states than have been seen experimentally. The existence of these states is tied in directly with the underlying degrees of freedom of the nucleon that govern hadronic production at moderate energies. New high precision data sets, particularly in the strangeness sector, can provide new and complementary information to disentangle the N^* spectrum.

In the $K^+\Lambda$ and $K^+\Sigma^0$ electroproduction sector, dramatic changes to the world's database occurred with the publications from the CLAS Collaboration. This paper now adds to and extends this database with the largest data set ever acquired in the resonance region for polarized electrons on an unpolarized proton target. This work includes measurements for the $K^+\Lambda$ and $K^+\Sigma^0$ final states of the separated structure functions $\sigma_U = \sigma_T + \epsilon\sigma_L$, σ_{LT}, and σ_{TT} from fits to the Φ dependence of the differential cross sections, as well $\sigma_{LT'}$ from fits of the Φ dependence of the beam-spin asymmetry $A_{LT'}$ [1]. The measurements were completed at a beam energy of 5.499 GeV, spanning W from threshold to 2.6 GeV, Q^2 from 1.4 to 3.9 GeV^2, and the full center-of-mass angular range of the kaon. The full set of differential cross sections $d\sigma/d\Omega_K^*$ consists of nearly 500 bins in Q^2, W, and $\cos\theta_K^*$ for each final state.

Fig. 1 shows a small sample of the separated structure functions vs. $\cos\theta_K^*$ at one Q^2/W point compared against the predictions of several single-channel models. These comparisons clearly indicate that significant new constraints on the model parameters will be brought about when these new electroproduction data are included in the fits. We conclude that these data for $K^+\Lambda$ and $K^+\Sigma^0$ production provides strong evidence for baryon resonance activity within the reaction mechanism, but that the data in comparison to present models do not allow any simple statement to be made. Clearly more work on the modeling and possibly the fitting/convergence algorithms is required to be able to fully understand the contributing $N^* \to K^+\Lambda$ and $N^*, \Delta^* \to K^+\Sigma^0$ states and to reconcile the results from the single-channels models with the currently available coupled-channel models.

The structure function data for both $K^+\Lambda$ and $K^+\Sigma^0$ indicates that for W below 2.2 GeV and back angles, there is considerable strength of contributing s-channel resonances. For higher W, the t-channel non-resonant background dominates and the reaction dynamics are well described solely through interference of K and K^* Regge trajectories. Our own Legendre fit analysis confirms these statements. For the $K^+\Lambda$ final state, the Legendre moments of the structure functions indicate possible s-channel resonant contributions in the S-wave near 1.7 GeV, in the P-wave near 1.9 GeV, and in the D-wave near 2.2 GeV. This is in qualitative agreement with the more detailed amplitude analysis of Schumacher and Sargsian [Phys. Rev. C 83, 025207 (2011)]. For the $K^+\Sigma^0$ final state, strong S-wave strength is seen at 1.8 GeV and strong D-wave strength is seen above 1.9 GeV, precisely where several Δ^* states are expected to couple. Of course, more quantitative statements await including these data into the coupled-channel partial wave fits. Such analyses would help to provide important complementary cross checks of the recent Bonn-Gatchina coupled-channels fit results that seem to favor a much richer mix of states to describe the available photoproduction data.

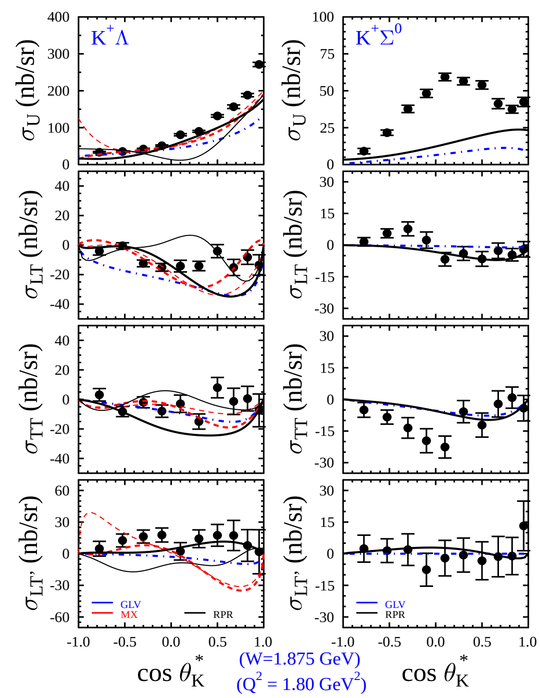

FIG. 1: Structure functions σ_U, σ_{LT}, σ_{TT}, and $\sigma_{LT'}$ (in nb/sr) for $K^+\Lambda$ and $K^+\Sigma^0$ production vs. $\cos\theta_K^*$ at 5.499 GeV for Q^2=1.80 GeV^2 and W=1.875 GeV. The curves represent the hadrodynamic model of Maxwell (MX), the Regge model of Guidal *et al.* (GLV), and the Regge plus resonance model of Ghent (RPR).

[1] D.S. Carman *et al. (CLAS Collaboration)*, Phys. Rev. C 87, 025204 (2013).