Induced Polarization of $\Lambda(1116)$ in Kaon Electroproduction

Constituent quark models predict the existence of excited nucleon states, many of which have yet to be observed experimentally. Much of our understanding of the N^* spectrum has come from studies of $\pi N \rightarrow N^* \rightarrow \pi N$ reactions. However, because the density of states for this channel is high, unambiguously identifying the signal for a relatively weak or broad resonance is difficult. To more fully understand the production and decay of excited baryon states, other reaction channels such as KY electromagnetic production must be explored.

Beyond measurements of the differential cross sections, polarization observables have been shown to possess a strong discriminatory power to distinguish between different theoretical models that seek to describe the N^* spectrum. In a new CLAS paper [1] results are presented for the induced polarization of the Λ from the reaction $ep \rightarrow e'K^+\vec{\Lambda}$, with $\Lambda \rightarrow p\pi^-$, over a broad kinematic range.

This experiment employed a 5.5 GeV electron beam incident upon an unpolarized liquid-hydrogen target, and the analysis required the detection of the scattered electron and the final state K^+ and p. The hyperon was identified using the missing-mass technique and its polarization was determined using the self-analyzing nature of its weak decay, in which the Λ polarization can be determined relative to a given spin quantization axis from the forward-backward yield asymmetry of the angular distribution of the decay p in the hyperon decay frame. In this analysis the hyperon yields were background subtracted and corrected for detector acceptance.

For the $K^+\Lambda$ electroproduction reaction, the induced Λ polarization summed over the angle Φ between the electron scattering and hadron production planes is presented for 215 ($\cos\theta_K^{CM}$,W) bins summed over Q^2 (at an average value of Q^2 = 1.90 GeV^2 - the data show a flat Q^2 dependence over the kinematic range of this experiment from 1 to 3 GeV^2). The data span W from 1.6 to 2.7 GeV and the full kaon center-of-mass angular range. In this case only the induced polarization component normal to the hadronic plane is allowed to be nonzero. Fig. 1 shows the W dependence of $\mathcal{P}_N^0$ for all $\cos\theta_K^{CM}$ bins. The average systematic uncertainty on the polarization is 0.1.

Several of the most advanced single-channel reaction models are compared against the data and none can explain the data well over its full kinematic range. Each of these models has been constrained by the existing precision KY photoproduction data. These findings are a strong indication that these KY electroproduction data can be used to provide important constraints on future model fits,

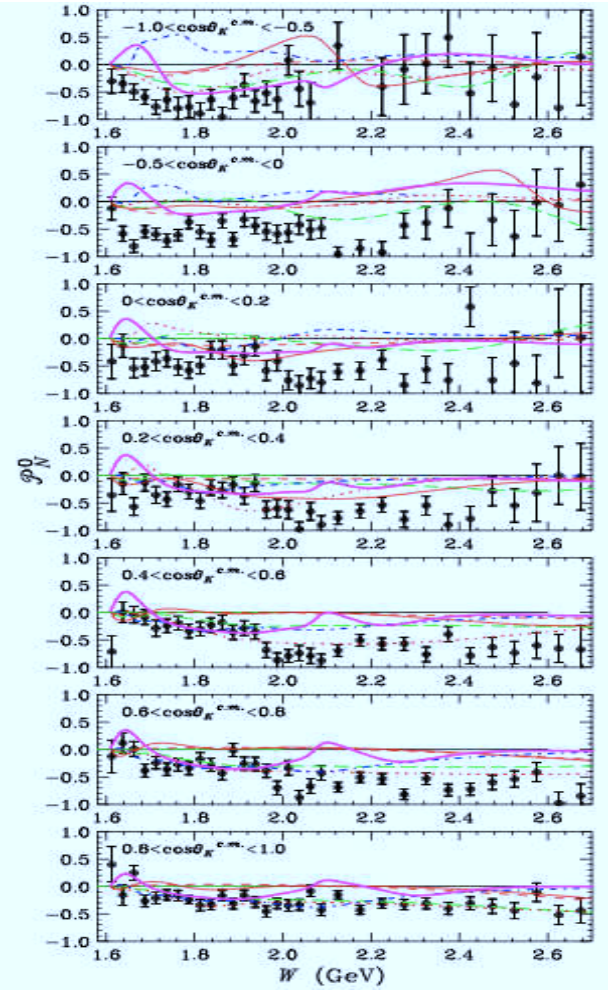

FIG. 1: Induced Λ polarization $\mathcal{P}_N^0$ vs. W at an average Q^2 of 1.90 GeV^2 for the seven $\cos\theta_K^{CM}$ bins. The overlaid curves are single-channel hadrodynamic models that have been constrained by the available KY photoproduction data from CLAS and elsewhere. See Ref.[1] for details.

particularly when included within a fully coupled-channel partial-wave analysis. The disagreement of the theory predictions to the electroproduction data (both cross sections and polarization observables) make clear that a reaction model that describes the KY production process is not yet available, and that for a detailed understanding of the contributing resonant and non-resonant terms to the $K^+\Lambda$ final state, combined fits to both the photo- and electroproduction data will be essential.

[1] M. Gabrielyan *et al.* *(CLAS Collaboration)*, Phys. Rev. C 90, 035202 (2014).