Beam-Recoil Polarization Transfer in the Nucleon Resonance Region in the Exclusive $\vec{e}p \to e'K^+\vec{\Lambda}$ and $\vec{e}p \to e'K^+\vec{\Sigma}^0$ Reactions at CLAS

D.S. Carman, Jefferson Laboratory

An important requirement to better understand nucleon structure is to map out its spectrum of excited states. Ideally, we should expect the fundamental theory of the strong interaction, quantum chromodynamics (QCD), to provide a prediction for the nucleon excitation spectrum. However, due to the non-perturbative nature of QCD at the relevant energies, this has not yet been fully realized. Thus, we have looked instead to effective models of QCD, such as constituent quark models, to gain insight. Interestingly, such calculations of the nucleon spectrum have predicted more states than have been seen experimentally. This has been termed the "missing" resonance problem, and the existence or lack thereof of these states is tied in directly with the underlying degrees of freedom of the nucleon that govern hadronic production at moderate energies and length scales.

Most of our current understanding of nucleon resonances comes from reactions involving pions in the initial and/or final states. It could be that the missing states might manifest themselves in decays to non-traditional (i.e. non-single-pion) channels. Indeed, there are indications from theory that some missing states have a sizeable probability of decaying into channels such as ωN, ηN, $\pi\pi N$, and KY $(Y = \Lambda, \Sigma)$ compared to the πN channel. One experimental avenue is to search for these hadronic states in processes with electromagnetic probes (i.e. real or virtual photons) and strange final states (e.g. $K\Lambda$ and $K\Sigma$), which defines a search in both a non-traditional initial and final state. As baryon resonances have large widths and are often overlapping, studies of different final states provide important complementary cross checks in quantitatively understanding the contributing amplitudes.

Recently, the CLAS Collaboration published measurements of spin transfer from a longitudinally polarized electron beam to the ground-state hyperons produced in the reactions $p(\vec{e}, e'K^+)\vec{\Lambda}, \vec{\Sigma}^0$ at beam energies of 4.261 and 5.754 GeV (D.S. Carman *et al.*, Phys. Rev. C **79**, 065205 (2009)). We provided extensive new polarization data, studying its dependence on the kinematic variables Q^2, W, and $\cos\theta_K^{c.m.}$. This work represents a higher-statistics follow-up to the first data presented by CLAS in the $K^+\Lambda$ channel for an electron beam energy of 2.567 GeV (D.S. Carman *et al.*, Phys. Rev. Lett. **90**, 131804 (2003)). The $K^+\Sigma^0$ data included in the new work represent the first-ever published data for this observable in electroproduction.

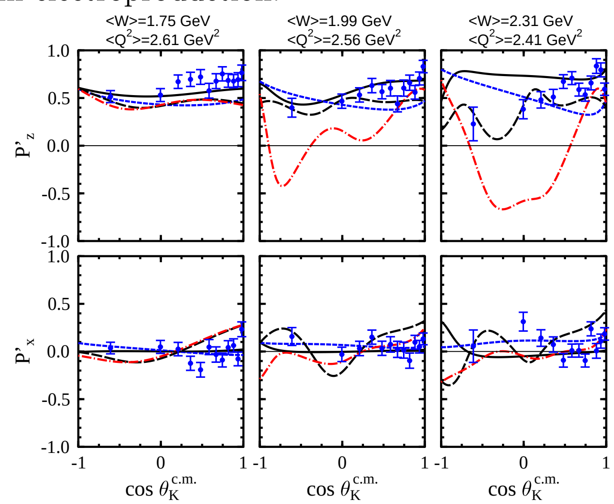

Figure 1: Transferred Λ polarization with respect to an axis along the virtual photon (z) and the orthogonal axis in the electron scattering plane (x) vs. $\cos\theta_K^{c.m.}$ for three bin-averaged W/Q^2 values as indicated for a beam energy of 5.754 GeV. The curves are calculations from theory models with different nucleon resonant states.

Our data have been compared to predictions from several theoretical models, which have varying sensitivities to the intermediate resonance contributions. It is expected that with the increased statistical precision of these new data, they will provide for improved constraints on theory parameters and thus to a better understanding of the nucleon excitation spectrum.