CEBAF EXPERIMENT 93-030

Measurement of the Structure Functions for Kaon Electroproduction

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CEBAF Experiment 93-030 will measure the four structure functions, $\sigma_T, \sigma_L, \sigma_{TT}$ and $\sigma_{TL}$ which describe kaon electroproduction over the range $Q^2$ from 1. to 2.5 GeV$^2$/c$^2$ and $W$ from threshold (1.62 GeV) to 2.2 GeV. The small amount of data which exists for these reactions was taken at Cornell and at DESY in the 1970’s. These two-spectrometer experiments were only able to measure well the unpolarized structure function, $\sigma_T$. The unique capabilities of the CLAS detector will allow detection of the K$^+$ over practically the entire solid angle, making it possible to measure all four structure functions.

Kaon electroproduction data will be complementary to pion data because s quarks are not present as valence quarks within the nucleon and thus certain quark diagrams are suppressed. Also, for the $\Delta K^+$ final state, the fact that $\Delta$'s are isoscalar means that $\Delta^{*+}$s cannot contribute as S-channel intermediate states, simplifying the calculations. In fact, a selection of $\Delta$ or $\Sigma$ as the recoiling hyperon yields a clear isospin separation of contributing amplitudes.

We mention several items of interest which this experiment will address:

1) determine the $\sigma_{TT}$ interference term, which is a measure of the dependence of the amplitudes upon the transverse polarization of the virtual photon. The interest here is to see how this term changes with $Q^2$ and $t$ as the form factor of the kaon causes the dominant $t$ channel term to diminish.

2) measure the ratio $\sigma_L / \sigma_T$. This ratio is sensitive to the spin and transverse momentum of the object which absorbs the virtual photon, being large for spin zero objects, such as mesons, or for spin 1/2 objects (quarks) with large perpendicular momentum. For small values of $t$, $\sigma_L$ is sensitive to the kaon form factor, while for large $t$ (backward going kaons) a large value for the $\sigma_L / \sigma_T$ ratio might be indicative of anomalies in the baryon form factor due to, for instance, processes in which a pre-existing diquark in the proton is struck.

3) measure the production ratio of the various hyperons, $\Delta, \Sigma, \Delta(1405), \Sigma(1385)$, and $\Delta(1520)$ as a function of $Q^2$. If these are simple quark states differing only by spin and orbital angular momentum orientation, then we would expect similar $Q^2$ dependence for their production amplitudes. Previous data already indicate that the electroproduction ratio of $\Sigma$ to $\Delta$ differs markedly from the photoproduction value and also shows a large $Q^2$ dependence.

4) study the polarization of the produced $s\bar{s}$ pair by measuring the polarization of the outgoing $\Delta$. Large effects have been observed previously but the explanation is still not settled.

5) search for missing $N^*$ resonances which decay to K$^+$ hyperon final states. This experiment could detect, for instance, orbitally excited $N^*$ resonances which decay readily to L=1 hyperons such as the $\Delta(1405)$ but which have very small branching ratios to $N\pi$ and $\Delta\pi$ modes.