CEBAF EXPERIMENT 93-018

Longitudinal/Transverse Amplitude Separation in Kaon Electroproduction

O.K. Baker, Spokesperson

Most of the meson, nucleon and nuclear systems studied in nuclear physics in the past are believed to be made up of up (u) and down (d) constituent quarks, and gluons. Systems with strangeness have in addition to u and d quarks, strange (s) constituent quarks. The present proposal aims to study the electroproduction of kaons, which are mesons with s quarks, using a proton target.

The experimental reaction investigated will be

$$e + p \rightarrow e' + K^+ + \Lambda(or\Sigma^0)$$

where e (e') is the incident (scattered) electron, p is the proton (target), K^+ is the electroproduced kaon, while Λ and Σ are the associated hyperons. These reactions will be studied in Hall C using the High Momentum Spectrometer (HMS) to detect the scattered electrons and the Short Orbit Spectrometer (SOS) to identify the short-lived kaons before their decay in flight.

The electron scattering reaction above may be described, to better than one percent accuracy, as the scattering of a 'virtual' photon by one of the quarks inside the nucleon. The experimental quantity measured in the reaction, the scattering cross section

$$\frac{d^3\sigma}{dEd\Omega_e d\Omega_{K^+}},$$

may then be written (for an unpolarized electron beam) as:

$$\frac{1}{\Gamma}\frac{d^3\sigma}{dEd\Omega_e d\Omega K^+} \equiv \frac{d\sigma}{d\Omega}|K+ = \alpha_U + \varepsilon\sigma_L + \varepsilon\sigma_T \cos 2\varnothing + \sqrt{\frac{\varepsilon(\varepsilon+1)}{2}}\cos\varnothing\sigma_1$$

where Γ, and ε are qualities which depend upon the electron energy (E is the initial electron energy), and scattering angle. ϕ is the angle between the virtual photon direction (obtained from the electron kinematics) and the electroproduced kaon. The four terms on the right hand side of equation (2) arise because of the different properties of the virtual photon.

By varying the electron kinematics and simultaneously identifying the coincident kaon in this proposed equipment, each of the terms on the right hand side of equation (2) can be separated and the cross sections, $\sigma_U, \sigma_L, \sigma_T$ and σ_I may be determined for these settings. The first two terms have not been separated in a single measurement previously. These four cross sections bring out new and interesting features of the nucleon system, in addition to yielding information about kaons and hyperons.

A study of the t-dependence of σ_L should allow for extraction of the electromagnetic form factor (the Fourier transform of the charge distribution) of the kaon. The variable t essentially measures the (polar) angular dependence of the kaon electroproduction cross section (the angle between the virtual photon and the emergent kaon). The study of the x-dependence of σ_U should yield, according to some models, limits on the strangeness content of the proton. Here x measures the momentum carried by the struck quark in the proton or neutron system. A measurement of the Q^2 dependence (square of the momentum transferred to the nucleon system by the scattered electron) of these separate cross sections should also give insight into the nucleon's quark substructure. Future work could include a program to investigate the reaction (1) on heavier nuclei and at higher momentum transfers to the proton.