CEBAF EXPERIMENT 91-016

Electroproduction of Kaons nnd Light Hypernuclei

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The study of the structure of nuclei containing strange baryons is one of the frontier areas of nuclear research. While there has been a marked increase in the data available from (K^-,p) and (p^+,K^+) reactions, relatively little progress has been made in providing unambiguous answers to questions relating to modification of interactions, the symmetries and simple degrees of freedom that arise when, in addition to neutrons and protons, a third kind of quasistable particle is introduced into the nuclear medium. Examples of such questions are the relationships between 2-body and 3-body interactions in complex hypernuclei and the existence and widths of bound sigma-hypernuclear states. The proposal focuses upon hypernuclear interactions in the lightest nuclei inasmuch as study of two-body and few-body systems limits the complexity of possible interactions and provides information in systems that are amenable to detailed theoretical calculations.

The experiment involves coincident detection of scattered electrons and kaons, i.e., (e,e'K^+) reactions, on targets of liquid or cooled, pressurized D, ^{3}He, and ^{4}He. The HMS and SOS spectrometer systems in Hall C will be used to detect the emergent electrons and K^+, respectively. Since the reaction involves three-body (or more) final states, each detector covers a broad range of energies for a given final state or fixed missing mass. The focal plane detector packages will be instrumented to provide optimum detection capability for detection of kaons in the presence of high fluxes of protons and pions.

A number of issues are addressed with each of the targets. The D target will provide information about K-Nucleon-Y coupling constants, where Y is either Λ or Σ (the masses of the Λ and Σ differ by <80 MeV), and a unique method for studying the poorly understood Y-neutron interaction at low relative energy. Of particular interest is a cusp, expected to be seen near the threshold for Σ production, whose shape and magnitude depend upon the unknown phase between the elementary production amplitudes for Λ and Σ. More speculative are the possibilities for observing strange di-baryons with masses predicted to be near the Σ threshold. Bound Λ-hypernuclear states will be produced by the first studies (e,e'K^+) reactions on ^{3}He and ^{4}He targets. Investigation of the bound state angular distributions will provide tests of the wave functions used to describe these states, while the mass spectra will be examined carefully to see if there is evidence for low-lying unbound states. Other features of this study include possible threshold cusps in mass three and four and searches for bound, or nearly bound, Σ-hypernuclei. Several purely hadronic studies have observed unexpectedly narrow peaks at masses corresponding to Σ states and some theoretical models predict bound Σ states in light nuclei. Observation of such states via electroproduction of strange particles will, therefore, have significant implications for future experiments. This initial study will provide a foundation for further investigation of the structure of complex hypernuclei.