CEBAF EXPERIMENT 89-009

Investigation of the Spin Dependance of the Lambda-Nucleon Effective Interaction in the P Shell

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A hypernucleus is a many body system comprised of conventional (nonstrange) nucleons and one or more strange baryons or hyperons. The presence of the strangeness degree of freedom (flavor) in a hypernucleus adds a new dimension to our evolving picture of nuclear physics. At the hadron level, such systems provide a new many body spectroscopy, where dynamical symmetries may appear which are forbidden in ordinary nuclei by the Pauli Principle. Thus a hypernucleus provides a laboratory in which to explore new dimensions of the hadronic many-body problem.

On the elementary interaction level, several novel features of the hyperon in nucleon interaction play a significant role in hypernuclear physics. Because of isospin the _ and the nucleon cannot exchange one pion so there is no dominant OPE tensor force as exists in the nucleon-nucleon interaction. (The K and K* exchange tend to cancel more completely than do the _ and p exchange in the NN force). This may contribute to the anomalously small binding observed in _ + ^{4}He system. The absence of a direct OPE force ensures that shorter range properties of the baryon-baryon interaction are important in hypernuclei, and the two pion exchange, which is overshadowed by the OPE in the NN force, is the major longrange component of the interaction. Because the _ - _ mass difference is only some 80 MeV, the _ and _ couple more strongly than do the nucleon and _ in the nonstrange sector. This strong coupling leads to a nonnegligible second order tensor force in the _-nucleon channel, and to sizable three-body forces. The strong coupling, combined with a sizable $\_^{-}$ to $\_^{+}$ mass difference and the charge dependence in the $\_^{-}$-nucleon OPE force, imply a measurable charge symmetry breaking in the hyperon-nucleon interaction. A large charge asymmetry is in fact observed in the A=4 mass isodoublet. Thus, novel aspects of the hyperon-nucleon interaction produce observable effects in _ hypernuclei. The _ as a distinguishable baryon, resides in the 1S shell for the hypernuclear ground state. Broad structure in the spectra of the light systems has been observed, but the significant physics lies in the fine structure of those spectra which requires a high-intensity, high-resolution facility to exploit.

Electromagnetic production of hypernuclear levels will strongly populate unnatural parity states starting form a $j=0^{+}$ nuclear target. This contrasts to the hadronic production mechanisms where the spin flip amplitude is small. In addition, since the momentum transfer is large, one expects to selectively excite states with high angular momentum transfer. Therefore CEBAF can

not only provide high resolution data, but it also provides complementary data to hadronic production.
Experiment 89-009 is a proposal that emphasizes the fact that the features of CEBAF, including beam quality, as well as the properties of the electromagnetic interaction, can provide unique information about strange nuclear systems, and that this information may address fundamental issues which should shed light on our current understanding of hadronic may body systems. It demonstrates that energy resolutions, an order of magnitude better than previously attainable in hypernuclear reactions, are possible at CEBAF. The ultimate goal of the program is to obtain hyperncULear spectra with resolution on the order of 200-300 keV, and although the first phase of the experimental program will provide about 1 MeV resolution, the implementation of a short orbit high resolution hadron spectrometer at a later date would provide resolution of a few hundred keV. However, a resolution of 1 MeV is a factor of 2 better than present limits with hadronic reactions, and can provide new information on hypernuclear systems, particularly in the light mass region.

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