High Resolution 1p Shell Hypernuclear Spectroscopy

The goal of studying hypernuclear systems with high resolution has been pursued by several Laboratories over many years due to the information on the spin dependence of the effective Λ-N interaction that can be obtained from the energy splitting of hypernuclear spin doublets. At the moment only the electromagnetic production of hypernuclei with electron beams of TJNAF quality together with the high resolution spectrometers of Hall A for detecting the scattered electrons and produced kaons affords the possibility of obtaining high resolution data (280 keV) on hypernuclear spectra as well as precise information on the nuclear-hypernuclear transition.

To obtain maximum cross sections, the electron scattering angle has to be as small as possible (large virtual photon flux) and the kaon angle close to the virtual photon direction where the momentum transfer is a minimum. This means that is is a crucial requirement to have $\theta_e < 10^\circ$, and $\abs{theta_k -\theta_e}< 10^\circ$.

This proposal is based on the PR-93015 proposal presented, among others, for a program to be carried out using the MultiParticle Spectrometer (MPS) proposed at that time. Our present calculations show that hypernuclear spectroscopy can be done with small modifications to the existing devices in hall A, at the cost of reduced resolution ($\sim$ 280 keV instead of $\sim$100 keV), but still about an order of magnitude better than what can be obtained with present devices, also at CEBAF. This allows the obtaining of very important physics information.

The PAC put two questions about feasibility of the PR-93105 experiment: 1) the cross sections for electroproduction are unknown and, 2) the singles rates are very high. The hypernuclear cross sections contain two main ingredients: a) the elementary electroproduction of Λs of the proton; b) the nuclear transition from the target nucleus to the final hypernucleus.

For the "nuclear" part of the cross-section, the reliability of the DWIA type calculations was checked in other hypernuclear production reactions (K,π and especially (π,K) where the kinematics is similar to our kinematics. The measured cross sections are explained satisfactorily. For the elementary process part a new set of coupling constants has been used, taken from a model fitting simultaneously all the available photo- and electroproduction data up to the (virtual) photon energy of 2.2 GeV (used in the present proposal). The model dependence of our calculation is rather small.

The singles rates have been reevaluated by a new code more thoroughly tested and checked for the new kinematics. They are reasonable, about two orders of magnitude small than in the previous proposal so they are not a problem for the standard HRS detector package. It can be shown that in hall A, by moving the scattering chamber upstream and putting two septa for the electron and hadron arms, it is possible to get $\theta_e = \theta_k = 6^\circ$, at a reasonable cost. These devices are thought to be provided by Institutions external to the USA.

We have to emphasize that there is an obvious advantage for many experiments in Hall A to going to the most forward angle, mainly for the class of experiments measuring parity violating asymmetries. Physics motivations and a first experimental program on this subject are presented as part of a physics program that can be done in Hall A.