CEBAF EXPERIMENT 89-028

Polarization Transfer Measurements in the $\mathbf{D}(\vec{e},e'\vec{p})n$ Reaction

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The measurement of spin observables in $(\vec{e},e'\vec{p})$, greatly facilitated by the high duty factor and beam currents anticipated at CEBAF, will open a new window on the physics of strongly interacting systems. In the one-photon exchange approximation, the $(\vec{e},e'\vec{p})$ cross section can be expressed in terms of a set of response functions each determined by different products of components of the nuclear current and, therefore, exhibiting differing sensitivities to various aspects of the reaction process. In particular, measurement of polarization observables allows isolation of certain response functions, many of which are expected to provide crucial constraints on nuclear reaction models.

A fundamental understanding of the nuclear current begins with understanding the electromagnetic form factors of the underlying nucleonic degrees of freedom and then by understanding the character of the nucleon--nucleon (NN) interaction. The latter is best revealed by studying the only fundamental two-body system, the deuteron. These elementary systems provide essential constraints for understanding more complex systems. This experiment on the deuteron will provide insight into the nature of the NN interaction and, by constraining NN interaction models, it will also have impact on the interpretation of experiments which plan to determine the neutron electric form factor via the $d(\vec{e},e'\vec{n})p$ reaction.

A new generation of neutron electromagnetic form factor studies will use polarization observables rather than the traditional and inherently less accurate Rosenbluth method. Many of these experiments will use deuterium as the target since the deuteron is weakly bound and therefore expected to provide a source of nearly free neutrons. Under this assumption, the deuteron should also provide a source of nearly free protons. Thus, comparing $(\vec{e},e'\vec{p})$ measurements from deuterium and hydrogen targets provides a test of the validity of the spectator model which is otherwise assumed in extracting the neutron form factors from the analogous $d(\vec{e},e'\vec{n})$ experiments. Since the $d(\vec{e},e'\vec{n})$ experiments select zero recoil momentum to minimize interaction effects, the first phase of this experiment will also select p_r = 0 and measure the recoil polarization as a function of Q^2.

Although various theoretical calculations suggest that at p_r = 0 interaction effects in the deuteron are virtually ignorable, these calculations predict substantial modifications to the polarizations at large recoil momenta. Therefore, to maximize the sensitivity to these effects, the second part of the experiment will examine the angular distribution of the ejected protons relative to the momentum transfer, $\vec{q}$, direction, at fixed Q^2. In addition, by measuring protons on both sides of $\vec{q}$, separations of several of the polarization response functions will be made providing detailed information to further constrain reaction models.

References

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