CEBAF EXPERIMENT 93-049

Polarization Transfer in the Reaction ^{4}He $(\vec{e},e'\vec{p})^3$H in the Quasi-elastic Scattering Region

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In recent exclusive (e,e'p) experiments on ^{4}He, ^{6}Li, ^{12}C and ^{40}Ca an anomalous ratio of the transverse to longitudinal response function has been observed. Deviations from the value for a free proton have been interpreted as a signature of the modification of the virtual-photon proton coupling in a dense many-body quantum system. It has been argued that the effect of a possible medium modification of this coupling is intertwined with reaction mechanism effects as Final-State Interactions (FSI) and Meson-Exchange Currents (MEC), and that especially the spin-orbit field may be responsible for the relative enhancement of the transverse part of the cross section.

The ^{4}He atomic nucleus is an ideal candidate for a more detailed study of possible medium effects. If the electromagnetic properties of the proton change when it is embedded in the nuclear medium, then significant effects may be expected for this nucleus due to its high density. The signature of these effects is expected to become experimentally observable because advanced microscopic calculations, including FSI and MEC effects, have become possible for the ^{4}He(e,e'p)^{3}H reaction.

Experiment 94-049 intends to study the electromagnetic properties of the proton bound in ^{4}He using spin degrees of freedom. Here, the structure functions enter as an interference in the polarization transfer coefficient D_{lt}. This enhances the sensitivity to the charge distribution, which enables to perform a structure-function separation at large values of the momentum transfer.

This experiment will measure the dependence of the polarization transfer coefficients D_{lt} and D_{ll} in the reaction $^4\mathrm{He}(\vec{e},e'\vec{p})^3\mathrm{H}$, both as a function of the four-momentum transfer, over the range 0.8 to 4.0 $(\mathrm{GeV/c})^2$, and as a function of missing momentum in the range of 0 to 250 MeV/c. The experiment exploits the 100% duty factor polarized electron beam in combination with the Hall A spectrometer pair. The spin vector of the proton will be measured in a polarimeter, presently being developed by a collaboration led by the College of William and Mary and Rutgers University.

It is predicted that the polarization transfer coefficients are quite insensitive to FSI and MEC effects. The measurement of the ratio of these coefficients would then provide a direct measurement of the ratio of the magnetic and the electric form factor of the proton in the ^{3}He nucleus.