# PR12-15-005: *Measurement of the Quasi-Elastic and Elastic Deuteron Tensor Asymmetry*

*R. Schiavilla, J.W. Van Orden*

The authors propose to measure the tensor-polarized asymmetry $A_{zz}$ in inclusive electron scattering on polarized deuterium in the quasi-elastic region with Bjorken $x_B$ in the range $0.3 < x_B < 2.0$ and momentum transfer $Q^2$ varying in $0.2\ (\mathrm{GeV/c})^2 < Q^2 < 2.9\ (\mathrm{GeV/c})^2$. In a plane-wave picture of the scattering process, this observable is sensitive to the ratio of the D- to S-component in the deuteron wave function, and the proposed kinematic conditions are such that large relative momenta $k > 300$ MeV in these components would be probed. This is important for understanding the nucleon-nucleon ($NN$) interaction at short distances and the properties of the dominant $pn$ correlations in heavier nuclei. The same tensor polarized asymmetry has been/will be measured in elastic deuteron scattering (the $T_{20}$ observable) and deep-inelastic scattering (the $b_1$ structure function): the proposed measurements in quasi-elastic kinematics would fill the gap and study the $A_{zz}$ asymmetry in the region where it is most directly related to the short-range $NN$ interaction. The tensor asymmetry at large recoil momenta also provides a sensitive test of relativistic effects in the treatment of deuteron structure as well as final-state interactions (FSI) in the outgoing $pn$ pair, both of which are important aspects of the overall phenomenological framework and the object of ongoing studies by a number of theorists (some of whom are listed as co-authors of the present proposal). Indeed, preliminary results for $A_{zz}$ in kinematics relevant to this proposal are presented corresponding to a variety of different models for the treatment of the above effects and different input deuteron wave functions. Drastically different predictions are obtained depending on whether off-shell effects are included in FSI (see Fig. 11).

The authors of the proposal also plan to measure the tensor polarization in elastic scattering at four $Q^2$ values in the range $0.2\ (\mathrm{GeV/c})^2 < Q^2 < 1.8\ (\mathrm{GeV/c})^2$, the additional planned measurement at $Q^2 = 0.2\ (\mathrm{GeV/c})^2$ being for calibration purposes only. These measurements would complement and corroborate existing ones (projected errors at the proposed $Q^2$ are similar to those of already available data).

The experiment proposed here arises from a well-developed context, presents a clear objective, and enjoys strong theory support. It would further explore the nature of $pn$ correlations in nuclei, the discovery of which has been one of the most important results of the JLab 6 GeV program.