Deuteron Electro-Disintegration at Very High Missing Momenta

High-energy, exclusive electro-disintegration of the deuteron is considered as the most effective process to explore nuclear structure at short distances which is of fundamental importance in understanding the limits of the nucleonic picture of nuclei and the dynamics of the nuclear force at short distances. Many questions related to two-nucleon short range correlations are directly related to high values of relative momenta in the NN system. Deuteron momentum distributions calculated with currently available models are very similar for missing momenta below 0.25 GeV/c but deviate from each other with increasing nucleon momentum. Experiments at Jefferson Lab[1, 2], that for the first time probed exclusive deuteron break-up at large Q^2 and large missing momenta, show that final state interactions (FSI) at large Q^2 can be successfully described by modern models[3, 4, 5]. They also supported the observation that at high Q^2 and $x_{bj} > 1$ FSI are reduced providing a more direct access to the high momentum part of the deuteron wave function. Currently no data exist in this kinematic regime for missing momenta above $p_m = 0.5$ GeV/c. The goal of experiment E12-10-003 is to measure the D(e,e′p)n cross section in a region where FSI are expected to be reduced and for missing momenta up to 1 GeV/c with a statistical precision ranging from 5% for lower missing momenta to 20% at 1 GeV/c. The total beam time for this experiment is 21 days. A portion of Experiment E12-10-003 can serve as part of the Hall C commissioning experiments. For commissioning we propose to measure the D(e,e′p)n cross section for three spectrometer settings centered at $p_m = 0.5, 0.65$ and 0.8 GeV/c. The total amount of beam time required would be 62 hours (not including hydrogen normalization runs) corresonding to about 13% of the entire beam time. From these first data the D(e,e′p)n cross section can be determined for missing momenta $0.5 < p_m < 0.9$ GeV/c with a statistical precision between about 10% and 30%. This commissioning part of E12-10-003 would provide first data in this new kinematic regime providing a 'glimpse' at potential new physics and also offer the opportunity to optimize the utilization of the remaining beam time when the experiment is completed at a later date. New data in this kinematic range are of fundamental interest not only for the short range structure of the deuteron itself, but also for the interpretation of future experiments that probe the structure of short range correlations in heavier nuclei.

References

[1] K. S. Egiyan et al. *Phys. Rev. Lett.*, 98:262502, 2007.

[2] W.U. Boeglin et al. *Phys. Rev. Lett.*, 107:262501, 2011.

[3] W. P. Ford and J. W. Van Orden. *Phys. Rev. C*, 88:054004, 2013.

[4] M. M. Sargsian. *Phys. Rev. C*, 82:014612, 2010.

[5] C. Ciofi degli Atti and L. P. Kaptari. *Phys. Rev. C*, 71:024005, 2005.