Jefferson Lab Hall A Experiment E06-010 and E06-011

Measurement of Single Target-Spin Asymmetry in Semi-Inclusive Charged Pion Electroproduction on a Transversely Polarized ^{3}He Target

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We plan to measure the target single spin asymmetry in the semi-inclusive deep-inelastic $\vec{n}(e, e'\pi^-)X$ and $\vec{n}(e, e'\pi^+)X$ reaction with a transversely polarized ^{3}He target. The topic of single spin asymmetry in semi-inclusive deep-inelastic scattering has received much attention stimulated by the recent data from HERMES, in which non-vanishing azimuthal asymmetries were reported in pion production on a polarized proton target. For the first time, it appears that an observable can be attributed to the effect of the quark transverse spin, and a time-reversal odd quark fragmentation process can be identified.

The transversity distribution can be interpreted as the probability to find a transversely polarized quark in a transversely polarized nucleon. Unlike the unpolarized and longitudinally polarized distributions, which are chiral-even quantities, the transversity distribution has a chiral-odd structure. Due to this chiral-odd nature, the transversity distribution can not be accessed through inclusive DIS processes because an additional chiral-odd object is required.

The goal of this experiment is to provide the first measurement on the neutron transversity, complementary to the HERMES measurement on proton and the COMPASS measurement on deuteron. This experiment focuses on the valence quark region, $x = 0.13 \sim 0.41$, at $Q^2 = 1.31 \sim 3.10$ GeV^2. This kinematics is comparable to the HERMES measurement. The variation of single spin asymmetry as a function of Collins angle and Sivers angle will provide a clear separation between the two competing mechanisms–the chiral-even Sivers effect and the chiral-odd Collins effect. This is a crucial step toward the extraction of the quark transversity distributions in semi-inclusive deep-inelastic scattering. Data from this experiment, when combined with HERMES proton data and COMPASS deuteron data, will provide powerful constraints on the transversity distributions and Sivers functions for both u–quark and d-quark in the valence region. A total of 29 days of beam time at 6 GeV in Hall A was approved by Jefferson Lab PAC-29, with the highest scientific rating of “A”.