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Nuclear Transparency in Double Scattering Processes

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We propose a search for color transparency, not in the heaviest of nuclei, but in the very lightest. Perturbative quantum chromodynamics predicts that quasi-elastic electron scattering from a nucleon at high momentum transfer will sample the components of the nucleon wavefunction with the quarks close together. Recent calculations indicate that the distance over which the resulting point-like nucleon wave-packet expands to normal size is little more than the internucleon spacing for $Q^2 < 6$ GeV^2. Therefore, only interactions with nearest-neighbor nucleons would be suppressed at Jefferson Lab beam energies. This implies we should use the very lightest nuclei, such as the deuteron (d), ^{3}He and ^{4}He, as targets. A precise measure of the final-state interactions in light nuclei as a function of Q^2 provides a complementary approach to quasi-elastic scattering from heavy nuclei. We will rely on the ratio of measured cross sections $(e, e'NN)$ and $(e, e'N)$, as well as the ratio of the $(e, e'NN)$ cross section observed at the kinematics dominated by double scattering to the cross section of the same process measured at the kinematics dominated by screening.

We plan to make a systematic analysis of the $(e, e'NN)$ and $(e, e'N)$ reactions over the full range of Q^2 starting from $Q^2 \approx 1$(GeV/c)^2. The lower Q^2 range will allow us to check the theoretical understanding of standard multiple scattering effects, including corrections caused by two-nucleon correlations and meson exchange currents. This will help us to constrain the analyses for $Q^2 = 4-6$ (GeV/c)^2. Elaborate tests of the eikonal approximation for electron nucleus scattering, which will be performed in the course of the proposed analysis for $Q^2 < 3(GeV/c)^2$, will help us to improve the reliability of interpretation of $(e, e'p)$ color transparency experiments.

The price we pay for switching from nearly exclusive kinematics in the $A(e, e'p)(A-1)^*$ process to the detection of two hadrons in the final state is a substantially smaller cross section. The makes the use of a large acceptance detector like CLAS necessary.