JLab Experiment E01-107

Measurement of Pion Transparency in Nuclei

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Experiment E01-107 will study the electroproduction cross section of positively charged pi-mesons on LH_2, LD_2, ^{12}C, ^{27}Al, ^{63}Cu and ^{197}Au targets. The pion transparency through the nuclear medium will be extracted between $Q^2 = 1$ and 5 $(GeV/c)^2$. Such pion transparency is predicted to be a signature for the onset of nuclear filtering and/or Color Transparency (CT).

Intuitively, one expects an earlier onset of CT for meson production than for hard proton scattering, as it is much more probable to produce a small transverse size in a $q\bar{q}$ system than in a three quark system. In addition, other than the A(e,e′p)A-1 reaction the exclusive A(e,e′π) reaction is the next least model-dependent measurement available to extract an unambiguous signal of CT. For the region of $Q^2 \leq 5$ $(GeV/c)^2$ measurable 40% effects have been predicted.

Studies of both the Q^2 dependence for a given nucleus and the A-dependence at fixed Q^2 will complement each other to provide an unambiguous verification of the onset of CT. Many experiments at $Q^2 \sim$ few $(GeV/c)^2$ have shown indications that CT is already present, while a recent di-jet experiment has reported full CT effects at $Q^2 \simeq 10$ $(GeV/c)^2$. However, in all of these cases the interpretation of the CT signal is rather model dependent.

Even in the exclusive A(e,e′π) reaction nuclear effects other than CT could influence the pion production process and confuse the interpretation. Hence, the kinematics are chosen to optimize the formation length, and quasi-elastic kinematics are chosen to ensure production off a single nucleon. In addition, an L-T separation will be made at $Q^2 = 2$ $(GeV/c)^2$ to verify the quasi-elastic pion production mechanism.

Not observing the CT phenomenon casts doubt on the strict applicability of the QCD factorization theorems recently derived for various deep inelastic exclusive processes. Such factorization theorems are intrinsically related to the access to Generalized Parton Distributions, that in principle allow for a determination of the complete nucleon wave functions. CT is a necessary, but not sufficient, indication of the applicability of the QCD factorization theorems.