Few-Body Physics with CLAS

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The study of few-body, nuclear systems with electromagnetic probes is an essential piece of the scientific program at Jefferson Lab in Newport News, VA. Reactions using real photons and electrons (up to energies of 6 GeV) produce multi-particle final states that are measured using the CLAS detector in Hall B, a nearly 4-pi magnetic spectrometer employing an array of detection systems. We focus here on the transition from the hadronic to partonic degrees of freedom, short-range correlations (SRC) in nuclei, and the manifestation of three-body (3N) forces in nuclei. Evidence for the transition to a quark-gluon description of nuclei has been observed with photon beams in CLAS on deuterium and 3-He targets. Scaling of the cross section is seen in some reactions at higher energies consistent with Constituent Counting Rules (CCR) while other reactions scale, but not at the values expected by CCR. Evidence of oscillations about the scaling cross section hint at possible structure. Short-range correlations probe the high-momentum components of the nuclear wave function and regions of dense, cold nuclear matter. In CLAS these have been studied with electron beams on 3-He and heavier targets. Our first-generation experiments revealed the importance of these correlations and more recent ones map out the character of the SRCs. Finally, three-body forces are an essential feature of nuclei. We will show CLAS measurements using real photons and 3-He and 4-He targets that reveal this importance. Calculations of the three-body contributions describe the data with varying degrees of success.

The measurements described here were performed with the Continuous Electron Beam Accelerator Facility (CEBAF) which provides a continuous-wave, polarized electron beam up to 6 GeV in energy. A photon tagger in Hall B generates real photons. The CLAS detector provides large kinematic coverage (polar angles in the range 8-143 degrees) for charged particles and good momentum resolution of about 1%. We can identify and separate the multi-particle final states to disentangle the few-body physics. Recent results will be presented along with a discussion of the future program after the 12-GeV Upgrade at JLab is completed.