Short-Range Correlations In $^{12}\text{C}(e,e'pN)$

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for the E01 – 015 collaboration

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Physics Motivation

Experiment E01-015$^2$ aims to study the small-distance structure of nuclei, namely the short-range correlations, via the triple coincidence $^{12}\text{C}(e,e'pN)$ measurement. The main signature of short-range correlations is the observation of an $(e,e'p)$ event with a large missing momentum (300 - 600 MeV/c) in coincidence with either a recoiling proton or a recoiling neutron where the recoiling nucleon’s momentum is approximately equal to the missing momentum. In this experiment the kinematic setup was such that the square of the four momentum transfer was $2\gamma^2 > 1$, was to suppress meson-exchange currents, isobar currents and final-state correlations, via the triple coincidence acceptance of BigBite.

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The detector performance has also been tested using the Geant4 computer simulation code. The code was instrumental in determining appropriate kinematics while running the experiment. The following figures show the tracks of neutrons or $\gamma$-rays (green), protons (blue) and electrons (red). The lead wall blocks nearly all charged particles and allows neutrons to enter into the neutron detector. It is also seen that the neutrons are not affected by the BigBite detector and illuminate the neutron detector very well while the protons are deflected by BigBite magnet.

Experiment

This experiment was a three-arm experiment. It utilized the standard Hall A equipment$^2$, the two high resolution spectrometers, as two arms and the BigBite spectrometer along with a neutron detector as its third arm. Scattered electrons and protons were detected in coincidence by the high resolution spectrometers while recoiling protons (neutrons) were detected by the BigBite spectrometer (neutron detector). The adjacent figure shows the detector system in the hall.

Result

The left figure below shows the time-of-flight of neutrons from liquid deuterium calibration runs while the middle one shows the same from carbon production runs. The right figure shows the yield ratio of triple to double coincidences for protons. The ratio shown has not been corrected for the finite angular acceptance of BigBite.

Summary

Recouling protons and recoiling neutrons of momenta above about 300 MeV/c in coincidence with the $(e,e'p)$ events have been observed. This is an indication of two-nucleon short-range correlations, namely pp correlations and pn correlations in the $^{12}\text{C}$ nucleus. We plan to give the final form of yield ratio of $^{12}\text{C}(e,e'p)/^{12}\text{C}(e,e')$ and two other yield ratios [not shown in this poster] $^{12}\text{C}(e,e'p)/^{12}\text{C}(e,e')$ and $^{12}\text{C}(e,e'p)/^{12}\text{C}(e,e')$.

Analysis is ongoing.

References: