Taking a *BigBite* of Short Range Correlations in ^{12}C

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Overview

Nuclear physics is the study of the strong interaction between protons and neutrons within the nucleus. An electron beam provides the ideal probe for investigating the nucleus at extremely small distance scales; the higher the energy, the finer the detail probed. The Thomas Jefferson National Accelerator Facility (JLab) can provide a continuous electron beam with an energy of up to 6 GeV.

Physics Motivation

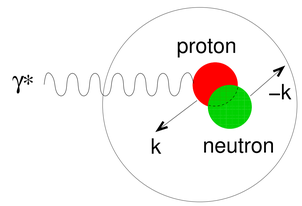

Figure 1: An illustration of the two nucleon knockout process when a virtual photon is absorbed on an overlapping nucleon pair.

A nucleon-nucleon short range correlation occurs when the nucleon wavefunctions strongly overlap inside the nucleus. In the impulse approximation, a virtual photon is absorbed by one nucleon of the pair, knocking it out of the nucleus. To conserve momentum, its partner nucleon recoils with its initial momentum and is also ejected from the nucleus (see Fig. 1).

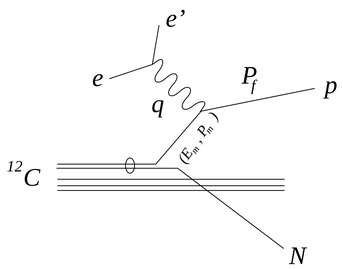

Figure 2: A Feynman diagram of the triple coincidence reaction for ^{12}C.

Short range correlations can manifest between neutron-neutron pairs, proton-neutron pairs and proton-proton pairs; we consider only the *proton-proton* channel here.

$^{12}C(e,e'pN)$ Experiment at JLab

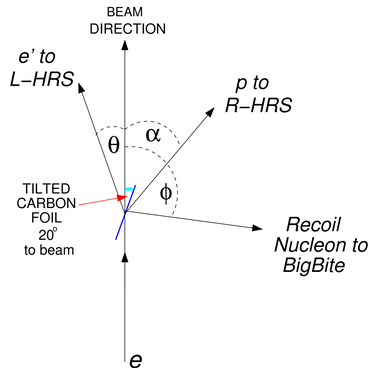

Figure 3: Diagram of kinematics setup for the triple coincident measurement; note the angle of the target foil, to minimize the amount of material traversed by the recoiling partner nucleon.

- Experiment E01-015 to investigate short range correlations in carbon took data from January through April 2005 in Hall A at JLab.
- *Triple coincident* measurement performed using both high resolution spectrometers in Hall A and a third large acceptance spectrometer called *BigBite*.
- Scattered electron detected in left HRS.
- Struck proton detected in right HRS.
- Recoil partner proton detected in BigBite.

Kinematics

- Choose $X_B > 1$ and $Q^2 = 2(GeV/c)^2$ to help minimise competing effects, such as MEC and FSI.
- L-HRS: $\theta = 19.5^o$; $|\vec{p}(e')| = 3.724 - 3.762(GeV/c)$.
- R-HRS: $\alpha = 32.0^o - 40.1^o$; $|\vec{p}(p)| = 1.23 - 1.45(GeV/c)$.
- BigBite: $\phi = 99.0^o$; $|\vec{p}_{recoil}| = 0.25 - 0.6(GeV/c)$

BigBite Spectrometer

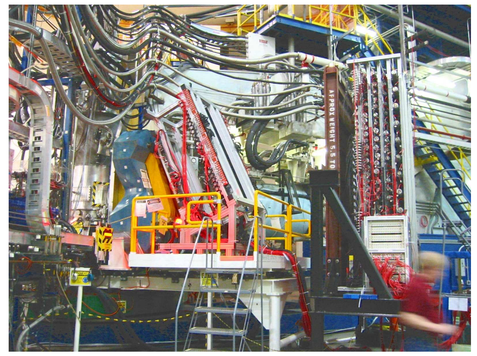

Figure 4: A photo showing the BigBite magnet and proton detector during the experiment in the hall; notice the larger window on the scattering chamber and also the neutron detector (right) used for investigating the proton-neutron channel.

- Spectrometer consists of a large acceptance dipole magnet, *BigBite* and a proton detector which has three layers of scintillator bars.

Summary

The experiment E01-015 to search for short range correlations in carbon took data in Hall A at JLab from January through April 2005. Data was taken on both the (e,e'pp) and (e,e'pn) reactions although only the proton-proton channel is presented here. A preliminary time-of-flight spectrum illustrates the triple coincident events; however, much more work has yet to be done to extract any information about the short range correlations from the data.

For further information please see the BigBite website:
http://hallaweb.jlab.org/equipment/BigBite/index.html