when the nucleon wavefunctions strongly overlap inside the nucleus and examine the details. An electron beam provides the ideal probe for investigating the strong interaction between protons and neutrons within the nucleus. This research requires a suitable instrument to examine these properties should be more easily accessible with kinematics of back-to-back momenta.

Overview

One aspect of nuclear physics involves the study of the strong interaction between protons and neutrons within the nucleus. This research requires a suitable instrument to examine these properties should be more easily accessible with kinematics of back-to-back momenta.

Physics Motivation

The strong repulsive internucleon forces within a nucleus have a Fermi momentum that is observed above the Fermi momentum. The strong repulsive internucleon forces within a nucleus will detect both protons and neutrons. The momentum of the recoil proton is measured in the other HRS and the correlated partner nucleon is measured by BigBite. Thus, BigBite will detect both protons and neutrons.

Kinematic Considerations

Both final state interactions (FSI) and meson exchange currents (MEC) can have large contributions to the scattering cross-sections; these would dominate over the short range correlations. MEC have a Q^2 dependence and are reduced at higher Q^2 values. Also, at higher Q^2 values, the energy of the struck proton is increased, making it easier to distinguish from its correlated partner nucleon. Thus, to the kinematics have been chosen to reduce the effects of MEC and so that the cross-section was dominated by the final state interactions and meson exchange currents, which masked the short range properties of the nucleon-nucleon pairs. The data also indicated that these properties should be more easily accessible with kinematics of X_p > 1.

Previous Experiments

An experiment to study n-p short range correlations through the 12C(p, p + n) reaction was performed at the Brookhaven National Laboratory. The momentum of the knocked out proton and the recoil neutron were measured and compared. For neutron momenta above the Fermi level (X_p = 0.220 GeV/c), a strong back-to-back correlation between the proton and neutron momenta is observed; see figure 2. This is an indication of two-nucleon short range correlations [1].

An experiment in Hall B at JLab studied both the (e,e'p) and (e,e'n) reactions. It was found that the cross-section was dominated by final state interactions and meson exchange currents which masked the short range properties of the nucleon-nucleon pairs. The data also indicated that these properties should be more easily accessible with kinematics of X_p > 1.

12C(e,e'p)n) Experiment at JLab

In the proposed experiment in Hall A at JLab [2], the fraction of (e,e'p) events in which nucleon-nucleon short range correlations are observed as a function of the initial momentum of the proton will be measured.

This experiment will study short range correlations in 12C. A triple coincidence measurement will be made in Hall A, using both high resolution spectrometers (HRS) and a third spectrometer called BigBite. A 12C target was chosen since it is a dense nuclear target which is simple and robust to use. The scattered electrons are detected in one HRS, the momentum of the recoil proton is measured in the other HRS and the correlated partner nucleon is measured by BigBite. Thus, BigBite will detect both protons and neutrons.

The strong repulsive internucleon forces within a nucleus will detect both protons and neutrons. The momentum of the recoil proton is measured in the other HRS and the correlated partner nucleon is measured by BigBite. Thus, BigBite will detect both protons and neutrons.

The charged particle detector consists of two scintillator detectors, the auxiliary plane and the trigger plane. The auxiliary plane is closest to the target and consists of 56, 2.5mm thick scintillator bars. The trigger plane consists of two planes of scintillators. The front layer, called the EE plane, has 24 scintillators, each 3 mm thick. The rear layer, called the E plane, has 24, 30 mm thick scintillator bars. The planes are oriented such that a proton with momentum of 500 MeV/c will be bent by the magnet through the center of the detector package. The auxiliary and trigger planes together can measure the time of flight and the energy (and thus momentum) of the incident proton; timing resolution is better than 250ps and momentum resolution is 12%.

Summary

The BigBite magnet has been tested to 10% power, a complete test will be carried out later in the year. The auxiliary and trigger planes have been completely tested with a running DAQ system. The neutron detector has been tested with a DAQ and now requires the veto layer to be assembled on it and tested. Since BigBite is a much larger acceptance spectrometer than the two HRS spectrometers in Hall A, a new scattering chamber with larger exit windows has also been built. The software for use during the experiment is currently under development. BigBite will be installed in Hall A at JLab in December 2004 with this short range correlations experiment taking place in January - March 2005.

References

2. W. Bertozzi, E. Plastey, J. Watson, S. Wood, Studying the Internal Small Distance Structure of Nucleus via the Triple Coincident (e,e'pN) Measurement, Jefferson Lab Hall A Proposal 001-515

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