CEBAF EXPERIMENT 93-026

The Electric Form Factor of the Neutron from the $\vec{d}(\vec{e},e'n)p$ Reaction

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The form factors of the proton and neutron are fundamental properties of the nucleon, and a critical testing ground for models based on QCD. A detailed knowledge of these form factors is essential to our understanding of the electromagnetic response functions of nuclei. Our present knowledge of the neutron electric form factor is inadequate. The slope of G_{En} (Q^2) at Q^2 = 0 is known accurately from neutron-electron scattering, but at higher Q^2, where G_{En} has been extracted from elastic *e -d* scattering, or inclusive quasielastic *e-d* scattering, the systematic errors are very large. For both of these measurements removal of the proton contribution requires information about the deuteron structure, and large uncertainties are introduced from uncertainties in the theoretical description of the deuteron (mostly from final state interactions and meson exchange current contributions). As a result, G_{En} is known with a systematic error of about $\pm$ 100%.

This experiment is proposed to extract G_{En} by measuring the spin-dependent part of the elastic *e-n* cross section. A measurement of the asymmetry in the quasielastic scattering of longitudinally polarized electrons from polarized deuterium nuclei in deuterated ammonia (ND_3) will determine the product $G_{En} \cdot G_{Mn}$. The idea is to measure the part of the *e - N* elastic cross section that corresponds to the interference between the Coulomb and the transverse components of the nucleon current. The measurement is carried out by observing the asymmetry in the cross section that results when either the beam or the target polarization is reversed.

The deuterium nuclei are polarized via a process known as *dynamic nuclear polarization*. At temperatures of around 1K, in the presence of an intense magnetic field (50,000 times that of the earth's magnetic field), the deuterium nuclei in molecular ammonia can be oriented by irradiation with 140 GHz microwaves. The microwaves induce specific magnetic transitions thereby preferentially populating selected nuclear spin states. The polarized target has been built by the collaboration at the University of Virginia and will be first used in an experiment at SLAC in 1993.

In this experiment, detection of the neutron knocked out of the deuterium nucleus (in coincidence with the scattered electron) will isolate elastic electron-neutron scattering from elastic electron-proton scattering. The neutron detector will consist of a "wall" of plastic scintillators. The coincident detection of a neutron with an electron has been used successfully by the collaboration at a recent experiment at NIKHEF to measure the magnetic form factor of the neutron.

A measurement of the neutron electric form factor is a necessary component of our understanding of nuclei and poses significant experimental challenges. Fortunately the asymmetry method proposed in this experiment will be able to overcome these challenges.