Abstract

We propose to measure the final neutron polarization in the $d(e,e'\vec{n})p$ reaction near threshold for transferred momenta $0.6 \leq Q^2(\mathrm{GeV/c})^2 \leq 1.2$. We argue in favor of studying a normal component of the neutron polarization vector for electron scattering at small angles, where the cross sections are large. These measurements would provide independent information about the magnitude and sign of the $M1 \rightarrow {}^1S_0$ transition amplitude which is affected strongly by nonnucleonic degrees of freedom in the deuteron.

1 Introduction

Measurements of deuteron electrodisintegration cross sections near threshold for large electron scattering angles and high momentum transfers [1-3] provided convincing evidence for nonnucleonic degrees of freedom in the deuteron. In order to reconcile theoretical concepts of the deuteron to these measurements, it has been shown that nonnucleonic degrees of freedom and meson exchange currents (MEC) in particular should be considered[4]; and at $Q^2 > 1.0$ $(\mathrm{GeV}/c)^2$, isobaric configurations [4], heavy meson exchanges [5], and quark degrees of freedom [6] can be significant also.

Generally, most of the theoretical models are unable to give a consistent description of the data [1-3] along with SLAC measurements [2] at higher $Q^2 < 2.77$ $(\mathrm{GeV}/c)^2$. Also, in recent MIT/Bates data with higher accuracy [3] at $Q^2 < 49$ fm^{-2}, a diffractive minimum of the cross section vs. Q^2 was not observed, though predicted by a number of models; however, in some models the diffractive minimum does not show up basically because they include other multipoles in addition to the $M1 \rightarrow {}^1S_0$ transition, and they differ at large Q^2 because of subtle features of the models. The cross section measurements to be done at CEBAF [7] will cover the range of Q^2 up to 3.5 $(\mathrm{GeV/c})^2$ which will put rigorous constraints on theoretical models of the processes in the nucleus at short distances.

In addition to obtaining data to resolve the above discrepancies, it would be desirable to study the spin and the isospin structure of the threshold transition $\gamma^* d \rightarrow np$ (γ^* being a virtual photon). As was shown earlier by Afanasev and Rekalo [8, 9], this information can be retrieved from polarization experiments. For the kinematic domain being considered here, final neutron polarization measurements offer an opportunity to obtain the desired information. In this proposal, we demonstrate that measurements of the recoil neutron polarization in the $d(e,e'\vec{n})p$ reaction yields information about the absolute values and the relative phase of the $M1$ and the $E0$, isovector and isoscalar, multipole transition form factors near threshold. This polarization can be studied at small electron scattering angles where the cross sections are large. There is a unique opportunity at CEBAF to investigate the neutron polarization in the threshold $d(e,e'\vec{n})p$ reaction in the most interesting kinematic regime (for the physics of nonnucleonic degrees of freedom in the deuteron) around $Q^2 \simeq 1.0$ $(\mathrm{GeV}/c)^2$.

In Section 2, we outline a general formalism for polarization observables, introduce definitions of threshold electromagnetic form factors, and present different components of the neutron polarization vector in the $d(e,e'\vec{n})p$ reaction in terms of these threshold electromagnetic form factors. In Section 3, predictions of a relativistic model are given. In Section 4, an experimental arrangement is described; and count rate estimates are given in Section 5 for specific experimental conditions.