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Study of the Quasielastic (e,e'p) Reaction in ^{16}O at High Recoil Momenta

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We propose to make a detailed study of the ^{16}0*(e,e'p)* reaction to determine the high-momentum content of the nuclear wavefunction and to test several ideas that form our basic phenomenology of *(e,e'p)*. Structure function separations will be made at high recoil momenta in non-parallel kinematics for a broad range of momentum transfer and outgoing proton energies.

A first goal of our program is to establish the high-momentum content of ^{16}O, both in the single-particle states and in the continuum. The initial measurements will be done at a four-momentum transfer of 0.58 (GeV)^2 which, while fairly modest, is still significantly larger than usually achieved at present-day facilities. We note that conventional single-particle wavefunctions have little strength for $|\vec{k}| >$ 500 MeV/c so a first measurement needs to be made simply to characterize the single-particle strength at these high momenta. It would be surprising indeed if the simple Woods-Saxon potential produced a correct description of the short-range structure of these wavefunctions.

The single-particle states, the $1p_{3/2}$ and $1p_{1/2}$, are of particular interest as they are spin-orbit partners and the nuclear spin-orbit force remains to be fully understood on a microscopic basis. This force certainly has its origins in the $\vec{L}\cdot\vec{S}$ part of the NN interaction. This in turn results, in boson exchange models, from ρ and σ exchange. We intend to make large variation in Q^2 and this variation, along with separation of individual structure functions, should shed light on the contributions to the spin-orbit force. More generally, the structure of these single-particle states, probed at high Q^2 and initial momenta, will provide an exceptionally stringent test of any nuclear mean-field theory.

It is important to note that nuclear structure calculations incorporating two-body correlations predict that much of the high-momentum strength resides in the continuum of the A-1 system, with hundreds of times greater strength than in conventionally treated discrete states. This relationship between high-momentum components and continuum strength has been confirmed by measurements of ^{3,4}He*(e,e'p)* at Saclay. This basic feature, resulting essentially from the interaction with a correlated nucleon pair, is expected to hold in heavier nuclei as well. Furthermore, an extensive series of ^{12}C*(e,e'p)* measurements at MIT-Bates have revealed the presence of many-body (> 2) reaction mechanisms that also populate deep missing energies. We therefore will study the missing energy continuum out to 300 MeV of excitation in the residual nuclear system.

CEBAF will open up a new window on the high-momentum/short-distance structure of nuclei. The experiment discussed here can accurately probe this new regime of nucear physics and provide important tests not only of nuclear structure models but also of models for the underlying nucleon-nucleon interaction giving rise to the short-range correlations. The calculations presently available are based on non-relativistic potential models. Are they appropriate at momentum transfers > 1 GeV and distances smaller than the nucleon radius? Are significant contributions present from other, non-quasielastic reaction processes? These are some of the questions we wish to address.