Inclusive Scattering from Nuclei at $x > 1$ and High Q^2 with a 6 GeV Beam

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We propose an extension to Jefferson Lab Experiment E89-008, an inclusive electron-nucleus scattering experiment in the domain of large x and Q^2. Additional measurements with a 6 GeV beam would allow study of the scaling behavior at large Q^2 and provide important constraints on the components of the nuclear wave function at large momentum and removal energy. Measurements with few-body nuclei (^{2}H, ^{3}He, and ^{4}He) and a range of heavy nuclei (C, Cu, and Au) allow contact with theoretical calculations via essentially "exact" calculations for few-body systems and extrapolation of the heavier systems to potentially calculable nuclear matter. In addition, direct comparisons of heavy nuclei to deuterium and ^{3}He at large x will allow us to examine the nature of the short range correlations that generate the high momentum nucleons.

I. INTRODUCTION

This proposal requests time to make inclusive electron scattering measurements with both few-body nuclei and heavy nuclei at high momentum transfers. Measurements at large x are sensitive to high momentum nucleons in the nucleus (momenta in excess of 1000 MeV/c for the kinematics of this proposal), and provide clean information on the high momentum components of the spectral function. The measurements with few-body nuclei allow comparisons with essentially exact calculations of nuclear wave functions and provide an important complement to the coincidence $A(e,e'p)$ and $A(e,e'NN)$ measurements already completed or approved. The measurements with heavy nuclei should allow extrapolation to nuclear matter where again rigorous calculations can be performed and compared to the data. In addition to using the data to directly constrain the spectral function at very high momenta, we will use the nuclear dependence of the cross section to study the nature of the short range correlations that are the main source of the high momentum nucleons. By comparing the distribution of high momentum nucleons in heavy nuclei to those measured in ^{2}H we can look for signatures of NN short range correlations in a model independent way. The inclusion of ^{3}He and ^{4}He measurements will also allow us to look for contributions from multinucleon short range correlations.

In addition to the main goal of studying nucleon distributions and short range correlations in nuclei, this data will allow us to extract the nuclear structure functions at large x values. This will allow us to extend measurements of duality and scaling in nuclei, which are related to the connection between the quark and hadronic pictures of nuclear structure. This experiment will also provide the data necessary to make precision measurements of the QCD moments in nuclei.