

CEBAF Experiment 00-101

A Precise Measurement of the Nuclear Dependence of Structure Functions in Light Nuclei.

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Inclusive lepton scattering is one of the most utilized methods for measuring the structure of nucleons and nuclei. Measuring nuclear structure functions allows us to probe the distribution of nucleons in a nucleus, as well as look for nuclear modifications to the structure of a nucleon. Understanding the effects of the nuclear environment is important not only to describe the nucleus itself, but also to extract information about the neutron. Because free neutron targets are not available, most information on neutron structure comes from measurements on light nuclei (deuterium and helium-3).

A significant amount of data has been taken in an attempt to understand the nuclear dependence of the F_2 structure function. The EMC collaboration first measured the difference between the structure function of heavy nuclei and deuterium. They observed a suppression of the structure function in heavy nuclei at large values of x (corresponding to large quark momenta), and an enhancement at low x values. This behavior was termed the 'EMC effect' and has since been measured by several other experiments. Almost all of the data taken is on heavy nuclei ($A > 8$). The ratio of F_2 for the heavy nucleus to F_2 for the deuteron has the same shape for all nuclei, and only the magnitude of the enhancement and suppression depends on the target. Many ideas have been proposed to explain the EMC effect, but none can fully reproduce the observed modifications of the structure function. Even with the large body of data for heavy nuclei, there is no consensus on which effect or combination (if any) explain the data.

This experiment will give additional data that will improve our understanding of the nuclear dependence of the EMC effect, and will allow more direct tests of the models used to explain the effect. By measuring the EMC effect for ^3He and ^4He , we will extend the range of nuclei for which precision data exists. Current data cannot distinguish between an A dependence and a density dependence of the effect. Because ^4He has an anomalously large density for a light nucleus, it is the most sensitive test to determine if the EMC effect scales with A or with nuclear density.

Beyond measuring the nuclear evolution of the EMC effect, we will provide high precision data that can be compared to exact few body calculations. The shape of the EMC effect is basically constant for heavy nuclei. If the EMC effect is caused by few nucleon interactions, it may be that the shape will be different in light nuclei, and that the measured shape is the result of a saturation of the effect in heavy nuclei. This will provide a new way of testing and models of the EMC effect, which will then allow us to refine our models for the effect in heavy nuclei.

Finally, a measurement of $A \leq 4$ nuclei will provide a way to test models of nuclear effects in light nuclei. As we use models of the nuclear effects in deuterium and ^3He to extract information on neutron structure, we need to be able to test and improve these models. This data will allow us to test these models, and help quantify the model dependence of the neutron structure functions inferred from measurements on deuterium and helium-3.