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Two-Body Photodisintegration of the Deuteron at High Energy

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One of the interesting questions in nuclear physics is whether nuclear reactions exhibit any quark effects at high energies. Traditionally, quarks in particle physics have manifested themselves as a rather abrupt change in the momentum transfer dependence of the cross section, eg. Bjorken scaling. A possible method to search for a scale change in photonuclear reactions is to search for such a change in the cross section as a function of the incident photon energy.

Deuteron photo-disintegration at high energies is an excellent process for addressing the question of whether the onset of quark effects can be observed in nuclear reactions because the photon is a relatively well understood probe and because the deuteron is the best understood nucleus theoretically. In addition, a relatively large momentum transfer [1] to the constituents can be obtained in exclusive photonuclear reactions at photon energies of a few GeV, because the absorbed photon delivers all of its energy to the constituents.

The cross section for the $d(\gamma, p)n$ reaction was measured[2] up to a photon energy of 4.0 GeV at the Thomas Jefferson National Accelerator Facility. The cross section at a photoproton center-of-mass angle of 90° exhibits a scaling behavior consistent with the constituent counting rule in the photon energy range from 1 to 4 GeV. The results at a proton center-of-mass angle of 37° are suggestive but inconclusive about the onset of the same scaling behavior at photon energies above 3.0 GeV.

The question that this proposal addresses is whether a nuclear reaction adheres to the quark counting rules or exhibits some scaling feature at high energies. The objective of this experiment is to extend the forward angle differential cross section measurements for the exclusive $d(\gamma, p)n$ reaction up to a photon energy of 5.5 GeV. This work will provide the first data for this reaction above 4 GeV, and permit a test of a threshold effect in the observed scaling at angles smaller than 90°.

1. R. J. Holt, Phys. Rev. C **41**, 2400 (1990).
2. D. Abbott *et al.* Proc. of the Particle and Nuclear Intersections Conference, Williamsburg, VA, May, 1996; Proc. of Int'l Workshop on Electron Scattering from Nuclei, Elba, July, 1996.