EXPERIMENT 00-107

Proton Polarization in Deuteron Photodisintegration to $E_\gamma > 3$ GeV at $\theta_{\rm cm} = 90^\circ$

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At low momentum transfer, the deuteron is well understood by the use of meson – baryon theories. As the momentum transfer increases, corresponding to improved sensivity to the short range structure of the deuteron, one expects that quark – gluon degrees of freedom will become of increasing importance. At some sufficiently high momentum transfer, a satisfactory extension of meson - baryon theories may be either impossible, or merely less efficient, than understanding reactions in terms of quarks and gluons.

The D$(\gamma, {\rm p})$n reaction has been a focus for recent experimental searches for such a transition in the underlying physics. Both meson – baryon and quark models reproduce some of the cross section data, which extend up to 4 GeV for $\theta_{\rm cm} = 37^\circ$ to 90°. For example, the small-angle cross sections agree with the Regge-theory quark-gluon string model, while the data above about 2 GeV are qualitatively reproduced by the QCD rescattering model, which relates photodisintegration to nucleon-nucleon scattering.

Hall A experiment 89-019 measured recoil proton polarization in D$(\gamma, {\rm p})$n at high energies, at 90°_{cm} for $E_\gamma \approx 0.5$ to 2.5 GeV. The induced polarization p_y disagrees dramatically with the highest-energy old data, for $E_\gamma \approx 0.8$ – 1.0 GeV, and with the Bonn meson-exchange calculation. The polarization transfers C_x and C_z had not previously been either measured or calculated.

The Bonn calculation is the most complete existing meson-exchange calculation, including π, ρ, η, and ω exchange, plus all well established nucleon and Δ resonances with $m < 2$ GeV and $J \leq 5/2$. The calculation qualitatively reproduces cross section data up to 1.6 GeV, and previous polarization data up to nearly 1 GeV. Comparison with E89-019 shows that the description of p_y totally breaks down above several hundred MeV. Indeed, above 1 GeV p_y seems entirely consistent with the pQCD prediction of vanishing. While C_x and C_z do not vanish, and thus are inconsistent with pQCD, they are small and consistent with monotonically decreasing.

Given these surprising results, we have proposed to continue the $\theta_{\rm cm} = 90^\circ$ excitation function to higher energies. By improving the polarimeter, reducing backgrounds, and inceasing the luminosity, it is possible to measure polarizations for energies up to ≈ 3 GeV.