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Beyond the Born Approximation: Two Photon Exchange in Nucleon Structure Studies

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Precision measurements of the electric form factor of the proton at Jefferson Lab have revealed a striking difference between Rosenbluth separation and polarization transfer data. Much of this discrepancy has been attributed to two-photon exchange, previously ignored in nucleon structure studies due to lack of precision in the data. Recently, experiments were conducted at Jefferson Lab where unpolarized electrons were scattered from neutrons polarized normal to the electron scattering plane. The polarized neutrons were produced by polarizing ^3He nuclei using spin-exchange optical pumping. The single spin asymmetry for inclusive scattering, formed by flipping the target spin direction, is predicted to be exactly zero in the Born approximation by the Christ-Lee theorem. A non-zero asymmetry is an indication of contributions from two-photon exchange. This asymmetry provides a new tool to study the structure of the nucleon and to directly test models of two-photon exchange contributions. Results will be presented from measurements in the quasi-elastic and deep-inelastic regions.