The GDH Sum Rule with Nearly-Real Photons and the Proton g_1 Structure Function at Low Momentum Transfer

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The study of hadronic structure with electromagnetic probes is deeply concerned with fundamental questions about the basic constituents of hadrons. In particular the spin structure of the nucleon which is one of the main topics in hadronic physics has been investigated for now more than three decades using lepton and photon beams. Measurements of the spin-dependent structure functions g_1 and g_2 have been performed at large Q^2 (Deep Inelastic Scattering region) at several facilities, providing information for the understanding of the nucleon structure in terms of the elementary constituents of QCD, i.e. quarks and gluons. On the contrary much less is known in the low momentum transfer region ($Q^2 < 1 - 2$ GeV^2), where non-perturbative phenomena as nucleon resonances start to play a dominant role, and perturbative techniques fail due to the growth of the strong coupling constant. At very low momentum transfer ($Q^2 < 0.05 - 0.1$ GeV^2), Chiral Perturbation Theory (χPT) provides an effective representation of the QCD Lagrangian based on hadronic degrees of freedom and can be considered as a fundamental theory in the low energy limit. χPT is nowadays a well developed theoretical tool capable of predicting the dynamics of hadronic processes in the non-perturbative regime and its test is important to identify the degrees of freedom which dominate in this kinematic domain. A fundamental prediction concerning the spin structure of the nucleon in the non perturbative regime is the Gerasimov-Drell-Hearn sum rule which relates the helicity-dependent total photo-absorption cross section to the nucleon anomalous magnetic moment. Recently the sum rule was extended to finite Q^2 by Chiral Perturbation Theory. These new theoretical developments have renewed the interest in the very low momentum transfer region. At present the generalized GDH integral has been studied at JLAB for $Q^2 > 0.1$ GeV^2, while no measurements are available in region where χPT is applicable. Therefore with this experiment we intend to measure the polarized inclusive electron-proton cross section to derive the Q^2 dependence of the Gerasimov Drell Hearn sum rule in the very low momentum transfer region ($Q^2 < 0.05$ GeV^2) to test χPT predictions. In the same kinematics we will extract the structure function g_1 and its moments. In order to perform an absolute cross section measurement, we plan to use a modified setup installing a new Cherenkov Counter specifically designed for the outbending field configuration which is necessary to reach such low Q^2. This new detector will have a very high and uniform electron detection efficiency to allow the measurement the absolute cross section with minimal corrections and a high pion rejection rate. We will also use the $^{15}NH_3$ polarized target successfully built and operated for the previous CLAS polarization measurements. The other components of the CLAS detector will be used in the standard configuration.