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Helicity Structure of Pion Photoproduction

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For a photon-proton interaction, the cross section depends on the absolute value of the helicity λ, which characterizes the relative orientations of the photon and proton spins (dark arrows in fig.) and momenta. We preopose to measure the helicity-1/2 and helicity-3/2 contributions to the differencial cross section for the processes $\gamma p \to \pi^0 p$ and $\gamma p \to \pi^+ n$ at photon energies between 0.3 and 2.3 GeV. No direct experimental separation of these contributions has ever been made. The results will test predictions made by existing partial-wave analyses, and will permit a direct calculation of the dominant single-pion photoproduction contribution to the Drell-Hearn-Gerasimov sum rule:

$$I = \int_{K_{thr}}^{\infty} \frac{\sigma_{1/2} - \sigma_{3/2}}{k} dk = -\frac{2\pi^2 \alpha}{m_p^2} k_p^2 \sim -204.8 \mu b$$

which is derived from very basic theoretical assumptions but has never been tested directly. In the equation, $\sigma_{1/2}$ and $\sigma_{3/2}$ are the total cross sections for hadron photoproduction on protons in the helicity 1/2 and 3/2 states, k is the laboratory photon energy, k_p is the proton's anomalous magnetic moment, and m_p is the proton mass. The lower limit of integration is the threshold for pion photoproduction $\approx$ 150 MeV.

The experiment will use circularly polarized tagged photons produced by longitudinally polarized electrons, and a longitudinally polarized proton target in the CLAS detector.