Deeply Virtual Compton Scattering

In the naive parton model, a proton consists of two valence up and one down quarks. With a total proton spin of 1/2, the simplest expectation would be that two valence quarks have spin $+1/2$ and one $-1/2$ (Figure 1). Surprisingly, data from polarized muon-nucleon scattering at CERN in the late 1980s discovered that only 12% to 16% of protons spin is carried by quarks, proton spin puzzle.

The total spin of proton can be presented as:

$$\frac{1}{2} = \frac{\Sigma}{2} + L_q + L_g + \Delta G \qquad (1)$$

where L_q and L_g are the angular momenta of quarks and gluons respectively, Σ is the spin carried by quarks, and ΔG is the gluon spin contribution.

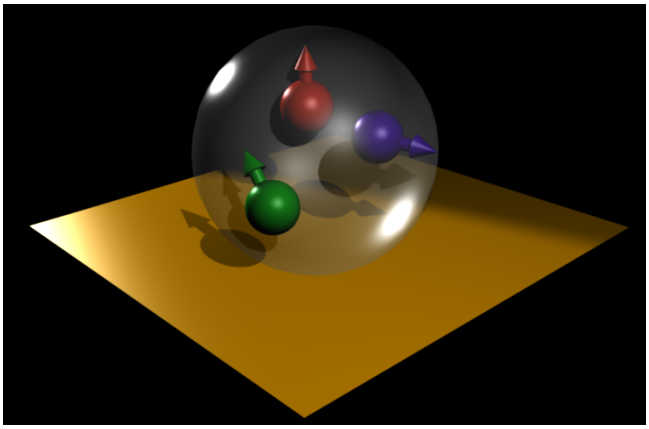

Figure 1: Proton spin structure.

From recent results on gluon polarization it is already clear that the gluon spin is nowhere near as large as would be required to explain the proton spin problem. This suggest that most of the missing spin of the proton must be carried as orbital angular momentum by the valence quarks.

Generalized Parton Distributions (GPDs) have been the new tool in the last few years to study nucleon structure. Unifying the concepts of parton distributions and of hadronic form factors, GPDs contain information on quark/antiquark correlations, and correlation of their transverse spatial and longitudinal momentum distributions.

In leading order there are four nucleon GPDs H, $\tilde{H}$, E and $\tilde{E}$, and the total angular momentum of the quarks is equal to second moments of GPDs H and E (Ji's sum rule).

Generalized Parton Distributions are accessible in Deeply Virtual Compton Scattering (DVCS) through interference with Bethe Heitler (BH) process. Beam spin asymmetry in the deeply virtual production of a real photon give access to a linear combinations of GPDs.

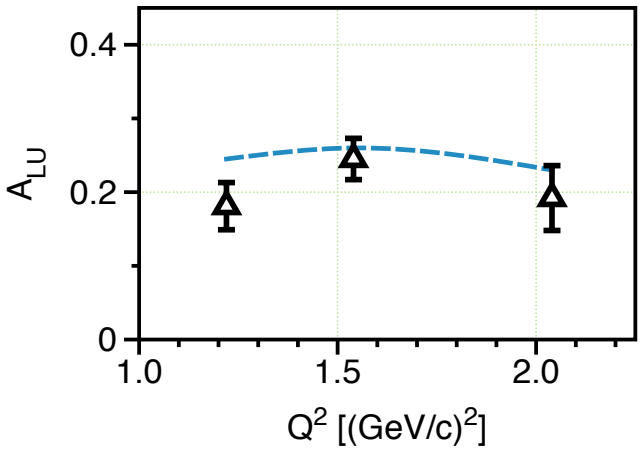

Figure 2: Q^2 dependence of beam spin asymmetry for Deeply Virtual Compton Scattering with CLAS (4.8 GeV).

In Figure 2 the Q^2 dependence of the beam spin asymmetry measured with CLAS detector at Jefferson Lab using 4.8 GeV longitudinally polarized electron beam is presented. The dashed line on the graph corresponds to theoretical calculations of beam spin asymmetry, when in the parameterization of GPDs a small contribution of see quarks was assumed. In this analysis reaction $ep \rightarrow epX$ is used. Fit to the line shape of the missing mass distribution was used to separate DVCS contribution from background reactions, such as π° production.