Moments of Spin Structure Function $g_1(x, Q^2)$

The spin structure function g_1 is important in understanding the quark and gluon spin components of the nucleon spin, and their relative contributions in different kinematic regions.

g_1 is extracted from measurements of the double spin asymmetry in inclusive polarized electron-nucleon scattering. The sensitivity to spin content results from the requirement that the quark's spin be anti-parallel to the virtual photon's spin in order for the quark to absorb the virtual photon, as shown inf Figure 1. This is a consequence of the conservation of angular momentum in the limit of nearly massless and collinear quarks. In the quark-parton model g_1 is related to the quark spin distribution functions Δq, and, at high momentum transfer Q^2, provides information on how the nucleon spin arises from the spin of its constituent quarks and gluons. At low Q^2, hadronic degrees of freedom become more important and dominate the measurements.

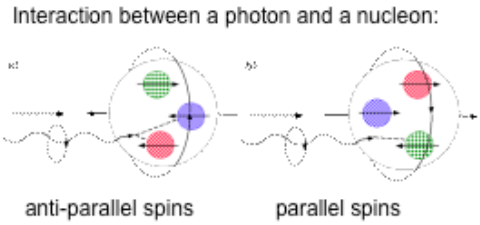

Figure 1: Virtual photon couples to quarks of opposite helicity.

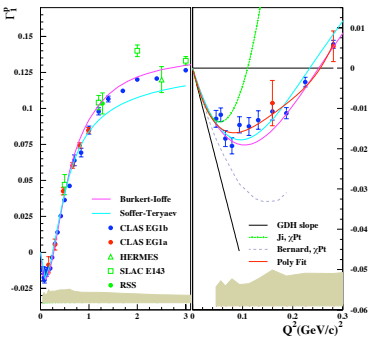

Figure 2: Γ_1^p vs Q^2

There is a particular interest in the first moment of g_1, $\Gamma_1(Q^2) = \int_0^{1-} g_1(x, Q^2)dx$, which is constrained at low Q^2 by the Gerasimov-Drell-Hearn sum rule and at high Q^2 by the Bjorken sum rule and previous experiments. The CLAS experiments E91-023 and E93-009 have measured g_1 on the proton and the deuteron, providing a data sample of high statistical precision and extensive kinematic coverage, that allow us to study the transition from hadronic to partonic degrees of freedom and to accurately determine moment of g_1 as a function of Q^2. The first moments of g_1^p is shown in Figure 2. The integral is observed to turn over at low Q^2, as expected from the GDH sum rule and is consistent with the Chiral Perturbation Theory (an effective theory of QCD at low energies) at the lowest Q^2. In general the data are well described by the phenomenological models of Burkert and Ioffe and Soffer and Teryaev.