

**"G⁰": Measurement of the Flavor Singlet
Form Factors of the Proton**

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The structure of the nucleon is not well understood from the fundamental point of view of QCD, i.e., in terms of the quark and gluon degrees of freedom that appear in the QCD Lagrangian. This experiment will measure two ground state proton matrix elements which are precisely defined in the context of QCD. They are sensitive to (point-like) s quarks and hence to the $q\bar{q}$ ocean in the proton. The matrix elements of interest are the elastic flavor singlet charge and magnetic form factors, G_E^0 and G_M^0 , respectively, which can be extracted from a set of electron-proton parity-violation measurements. If a relationship between proton and neutron structure is assumed (for example that the proton and neutron differ only by the interchange of u and d quarks), the s quark contribution to the form factors of the nucleon can be determined using these flavor singlet form factors. This information is relevant to the discussions of the Ellis-Jaffe sum rule and of the πN sigma term; there is evidence in both cases that the s quark contribution is larger than expected. The present measurements will allow the determination of the s quark contributions to proton observables in a much more straightforward manner than in either of the case noted above. Both the charge and magnetic s quark form factors also have intrinsic interest as fundamental quantities, as they would contribute the first direct measurements of the ocean in low energy observables.

In this experiment, parity-violating electron scattering asymmetries will be measured in the region $0.1 \leq Q^2 \leq 0.5 \text{ GeV}^2$ at both forward and backward angles. These pairs of measurements will allow us to separate G_E^0 and G_M^0 . The asymmetries range from about -3 to -35×10^{-6} ; we are planning to measure the asymmetries with statistical uncertainties of $\Delta A/A \cong 5\%$ and systematic uncertainties of $\Delta A \leq 2.5 \times 10^{-7}$. Initially we will measure concurrently the forward angle asymmetries at five values of momentum transfer in the range $0.1 \leq Q^2 \leq 0.5 \text{ (GeV/c)}^2$. Assuming a beam polarization of 49%, the time required to reach this precision for the initial measurement will be about 1 month. We will also be able to make backward angle asymmetry measurements for momentum transfers of $Q^2 \leq 3 \text{ (GeV/c)}^2$; in addition, backward angle measurements of quasielastic scattering from a ^2H target will allow us to determine the axial form factor G_A and its radiative correction.

The G^0 spectrometer will provide the capability of measuring both the forward and backward angle asymmetries. It will consist of a toroidal array of eight normal conducting coils with a field integral of approximately 1.1 T·m. The spectrometer is designed to focus particles of the same momentum and scattering angle from the length of the extended target to a single point. The bend angle of about 35° at the highest momentum is sufficient to allow complete shielding of the detectors. The detector package will consist of about 14 scintillator elements per segment, each element covering approximately 7% of the full momentum range.