G0 Experiment: E00-006

The G0 experiment will measure the parity-violating asymmetries in elastic electron- nucleon scattering. The asymmetries are sensitive to the interference of the neutral weak and electromagnetic amplitudes. From the asymmetries, therefore, the neutral weak form factors of the nucleons can be determined. The vector neutral weak form factors, G_E^Z and G_M^Z, are analogs of the familiar charge and magnetic elastic form factors of the nucleons; a related axial form factor is measured in neutrino-nucleon scattering.

One of the main goals of the G0 experiment is to compare the electromagnetic and neutral weak vector form factors in order to extract the contributions of each of the three main quark flavors present in the nucleon: *u*, *d* and *s*. The direct relation between the sets of form factors is possible because in the Standard Model the couplings of photons and Z^0's to the quarks are precisely known (the electromagnetic and neutral weak charges, respectively). By measuring asymmetries at both forward and backward scattering angles, the contributions of each quark flavor to the charge and magnetic form factors can be determined.

In this experiment we will also determine separately the effective axial current of the nucleon, G_A^e, determined in the parity-violating scattering. Because the photon can have an effective axial coupling to the nucleon (for example through interaction with a quark which is itself undergoing a weak interaction with a second quark), the axial current measured in parity-violating electron scattering differs from that measured in neutrino experiments. Some differences are due to so-called γ-Z mixing diagrams; the main contributions appear to arise from the "many-quark" or anapole moment diagrams. By measuring quasi-elastic asymmetries using a deuterium target (at a backward angle), the effective axial form factor can be extracted in addition to the neutral weak charge and magnetic (vector) form factors. The axial current of the NΔ transition will be also be measured by detecting in addition the inelastic electrons in the backward scattering experiment.

The experiment will be performed in Hall C using a dedicated setup. The spectrometer consists of an eight sector superconducting toroidal magnet which will focus recoil protons (forward scattering measurement) or electrons (backward measurement) from a 20 cm long liquid hydrogen or deuterium target to pairs of plastic scintillator detectors. In the forward measurement, time-of-flight will be used to separate elastic protons from background using a pulsed 40 μA beam current (31.25 MHz rather than 499 MHz) and custom time digitization electronics. In the backward experiment, the pairs of scintillators are spatially separated to allow momentum and angle measurement. The range of momentum transfers accessible with this apparatus is from about 0.1 to 1 GeV^2. More information regarding the technical elements of the experiment can be found on the experiment web page http://www.npl.uiuc.edu/exp/G0/G0Main.html.

The G0 experiment is a collaboration of approximately 85 physicists from Caltech, Carnegie-Mellon, Connecticut, Illinois, IPN-Orsay, ISN-Grenoble, Jefferson Lab, Kentucky, Louisiana Tech, Manitoba, Massachusetts, Maryland, New Mexico State, Norfolk State, Northern British Columbia, TRIUMF, Virginia Polytech, William & Mary, and Yerevan.