Abstract

In experiment 93-027 and 99-007, we measured with high precision the ratio of the electromagnetic elastic form factors of the proton, G_{Ep}/G_{Mp}, up to four-momentum transfer Q^2 of 3.5 GeV^2 and 5.6 GeV^2, respectively, with the recoil polarization technique. The data from these two JLab experiments have shown an unexpected and significantly different Q^2-dependence for the electric and magnetic form factors, starting at Q^2=1 GeV^2, up to the maximum value of 5.6 GeV^2, revealing a definite difference in spatial distribution of charge and magnetization at short distances. These data also clearly demonstrate that we have not yet reached the perturbative QCD limit, which would be signaled by the ratio Q^2F_{2p}/F_{1p} becoming constant. The new results have created great interest, both theoretically and experimentally, emphasizing the importance of continuing the G_{Ep}/G_{Mp} ratio measurements to higher Q^2.

Here, we propose to measure the ratio G_{Ep}/G_{Mp} in Hall C with the recoil polarization technique, to Q^2=9 GeV^2 in elastic electron scattering from hydrogen with a 6 GeV incident electron beam energy. The proton will be detected in the high momentum spectrometer and the electron in a large solid angle lead glass calorimeter, as was done recently in experiment 99-007.

The proposed data, together with the G_{Mp} extracted from cross section data, will determine both F_{1p} and F_{2p}, the Dirac and Pauli form factors, separately. At large Q^2, F_{1p} was obtained from cross section measurements and assuming $\mu G_{Ep} = G_{Mp}$. Extrapolating the new results from Jlab would result in a 14% change in the F_{1p} values above Q^2 of 10 GeV^2.

This experiment will extend the knowledge of F_{2p}, which is equally sensitive to G_{Ep} and G_{Mp}, and it will also determine F_{1p} accurately in the same Q^2 region. This Q^2 region is thought to be the one of transition between soft and hard scattering, and is the most challenging theoretically. The data from this experiment will give insight into this intermediate region and as such, provide a testing ground for future theoretical developments.

This experiment requires 6 GeV incident electron energy, and thus can be done before the anticipated energy upgrade of the CEBAF accelerator. After the CEBAF upgrade the ratio G_{Ep}/G_{Mp} can be measured to $Q^2 = 12$ GeV^2 with the existing HMS.