ABSTRACT

We propose to measure the ratios $F_2/F_1$ and $G_E/G_M$ in nuclei at low and high $Q^2$. The results, combined with concurrent high precision relative cross section measurements, will determine for the first time the hard scattering $\bar{e}p \to e\bar{p}$ scattering amplitude in nuclei. They will permit a high precision determination of possible effects of color transparency with essentially no model dependence. The low $Q^2$ results will provide a baseline for understanding the high $Q^2$ results. They will yield a measurement of $G_E/G_M$ in nuclei with small systematic error. These values will be compared with previous values determined by Rosenbluth separation which are decreased by about 25% from free nucleon values.

The ratio of recoil proton polarization components $P_t/P_1$ determines the ratios of form factors, $G_E/G_M$ and $F_2/F_1$. The cross sections can be used to determine an $A$-dependent attenuation and an $A$-independent hard scattering amplitude in nuclei. The absolute magnitude of each form factor is determined from the ratio plus the scattering amplitude.

We propose to measure the $(e,e'p)$ reaction on $^{12}$C, $^{27}$Al, $^{56}$Fe, $^{90}$Zr, and $^{197}$Au in quasifree kinematics at two values of the four-momentum transfer, $Q^2$. The first phase of these measurements will determine the ratios $G_E/G_M$ and $F_2/F_1$ to 10% for each target with 1.6 GeV beam energy at $Q^2 \approx 1$ (GeV/c)$^2$, in about two days of beam time per target. The second phase of these measurements will determine the ratios $F_2/F_1$ to 10% and $G_E/G_M$ to 14% for the lighter targets with 5.1 GeV beam energy at $Q^2 = 4$ (GeV/c)$^2$, in about one week of beam time per target. Relative cross sections will be determined with a statistical precision much better than 1%, and systematic uncertainties of typically 2 - 3%, for both kinematics. The $Q^2$ evolution of the form factors will also be measured at additional kinematic points with the lightest target, $^{12}$C.