JLab Experiment 99-007

Measurement of G_{Ep}/G_{Mp} to $Q^2 = 5.6\ GeV^2$ by the Recoil Polarization Method

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The electric and magnetic elastic form factors of the nucleons are of highest importance in the understanding of the strong interaction. They fully characterize the charge and current distributions inside the nucleon.

In 1998 experiment E93-027 at JLab used the recoil polarization method to obtain the ratio G_{Ep}/G_{Mp} from $Q^2 = 0.5\ GeV^2$ to $Q^2 = 3.5\ GeV^2$, with statistical uncertainties ranging from 0.020 to 0.050, which was a great improvement over previous results for $Q^2 > 1\ GeV^2$[1]. The main feature of the results of E93-027 was an unexpected decrease of the G_{Ep}/G_{Mp} ratio as Q^2 increases. So it is of great interest to continue probing the proton structure to higher Q^2.

The elastic scattering of longitudinally polarized electrons on the proton results in a polarization of the recoil proton, with only two components: transverse, P_t, and longitudinal, P_ℓ, both in the reaction plane. As described in [2], measuring P_t and P_ℓ simultaneously in a polarimeter, allows one to obtain the ratio G_{Ep}/G_{Mp} directly from:

$$\frac{G_{Ep}}{G_{Mp}} = -\frac{P_t}{P_\ell}\frac{(E_e + E_{e'})}{2m}\tan\left(\frac{\theta_e}{2}\right)$$

In this experiment we will measure the ratio G_{Ep}/G_{Mp} at 4 kinematics shown in Table I by the same recoil polarization method. However, the high momemtum of the proton in this experiment requires two major changes of the current installation in Hall A. First, it has been observed that the analyzing power of the graphite used in the FPP dramatically falls-off with increasing proton momentum; in E99-007, the carbon analyzer will be replaced by CH_2. Second, the detector packages of the two spectrometers will be switched, to allow detection of the proton in what is currently the electron arm, because of the hadron arm momentum limitation of 3.2 GeV/c.

The experiment was approved by PAC15 for the four following points. A letter of intent to extend these measurements to a $Q^2 \sim 10\,GeV^2$ in Hall C was well received by PAC16.

Table I Kinematics of E99-007

Q^2	E_e	p_p	σ_{stat}	time
GeV^2	GeV	GeV/c	h=0.7, I=45 μA	hours
3.5	4.845	2.642	0.031	36
4.2	4.845	3.035	0.038	84
4.9	5.545	3.423	0.042	192
5.6	6.045	3.809	0.059	360
			Total time	672

References

[1] M.K. Jones et al., LANL e-print nucl-ex/9910005 and submitted to Phys. Rev. Lett.

[2] A.I. Akhiezer and M.P. Rekalo, Sov. J. Part. Nucl. **3**, 277 (1974); R. Arnold, C. Carlson and F. Gross, Phys. Rev. C **23**, 363 (1981).