JLab Proton Elastic Form Factor Measurements to a Q^2 of 5.6 GeV^2

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Polarization experiments have been important in the study of hadronic physics in the last 30 years. In experiments 93-027 (1998) and 99-007 (2000) at Jefferson Lab the ratio of the electromagnetic form factors of the proton was obtained by measuring P_t and P_ℓ the transverse and longitudinal recoil proton polarization in $\vec{e}p \rightarrow e'\vec{p}$, G_{Ep}/G_{Mp} is proportional to P_t/P_ℓ. Simultaneous measurement of P_t and P_ℓ provides good control of the systematic uncertainties.

An initial measurement of the G_{Ep}/G_{Mp} ratio was made in Hall A at Jlab to Q^2=3.5 GeV^2[1] with unprecedented accuracy. The results demonstrated unambiguously for the first time that the Q^2 dependence of G_{Ep} and G_{Mp} differ. The ratio $\mu G_{Ep}/G_{Mp}$ was found to decrease linearly with Q^2, down to a value of 0.6 at Q^2=3.5 GeV^2; in the dipole model the ratio would be 1.0 for all Q^2 values. The results of a second measurement of this ratio to Q^2=5.6 GeV^2[2], with similar accuracy, show that it decreases further to a value of 0.28 at Q^2 of 5.6 GeV^2. In the non-relativistic limit, the combined results of theses two experiments indicate that the spatial distributions of charge and magnetization current densities in the proton are different.

The two Jlab experiments contribute to the characterization of the structure of the nucleon, which is of fundamental importance to nuclear and particle physics. In fact, precise knowledge of the elastic form factors of the nucleon is a prerequisite for the test of any theory of strong interaction based on QCD.

[1] M.K. Jones et al., Phys. Rev. Lett. 84, 1398 (2000).
[2] O. Gayou et al., Phys. Rev. Lett. 88 092301 (2002).