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# Elastic Electron Scattering off $^3$He and $^4$He at Large Momentum Transfers

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The few-body form factors, along with the deuteron elastic structure functions, are the "observables of choice" [1] for testing the standard nucleon-meson description [2] of the nuclear interaction and the associated current operator. At large momentum transfers they may offer a unique opportunity to uncover a possible transition from meson-nucleon to quark-gluon degrees of freedom as predicted by quark dimensional scaling [3].

We plan to measure the electromagnetic form factors of $^3$He and $^4$He via elastic electron scattering from high-pressure helium targets. Scattered electrons and recoiling nuclei will be detected in coincidence in the two High Resolution Spectrometers (HRS) of Hall A. The charge and magnetic form factors of the spin 1/2 $^3$He nucleus will be separated via the Rosenbluth separation technique to the maximum momentum transfer possible. The charge form factor of the spin 0 $^4$He nucleus will be measured through forward angle cross section measurements. Coincidence elastic electron-proton measurements will be made to calibrate our method of cross section determination.

The existing data for the $^3$He charge and magnetic form factors extend to a momentum transfer $Q^2$ of approximately 30 fm$^{-2}$. This experiment will extend the measurement to around 90 fm$^{-2}$, more than doubling the existing range and extending our knowledge of the form factors down by more than an order of magnitude. The measured range of the charge form factor of $^4$He will be extended to about 75 fm$^{-2}$. These higher momentum transfers will allow access to a predicted second diffraction minimum for both $^3$He and $^4$He.

As the momentum transfer increases, the standard meson-nucleon models become increasingly sensitive to the details of the model and their predictions diverge. Our precision measurements in this range will be critical in establishing the parameters of the few-body standard model, testing our knowledge of the nucleon-nucleon potential, possible three-body force effects and the nature of meson-exchange currents. The measurements can also uncover a possible transition from the standard meson-nucleon description of the scattering process to a quark-gluon description, as predicted by quark dimensional scaling, if it occurs in the momentum transfer range accessible by this experiment.

[1] L.E. Marcucci, D.O. Riska and R. Schiavilla, Phys. Rev. **C58**, 3069 (1998).

[2] J. Carlson and R. Schiavilla, Rev. Mod. Phys. **70**, 743 (1998); and references therein.

[3] C.E. Carlson, J.R. Hiller, R.J. Holt, Ann. Rev. Nucl. Part. Sci. **47**, 395 (1997).