Some Necessary Background

EEFFs cross section described with Dirac ($\kappa$) and Pauli ($\tau$) form factors ($G_F$ and $G_M$).

\[
\frac{\varepsilon}{\varepsilon_{\text{det}}} = \frac{1}{\varepsilon(1+\gamma^2)} \left( G_L + \gamma G_T \right) + \frac{\varepsilon_{\text{det}}}{\varepsilon} \left( G_F + \tau G_T \right)
\]

Where Are We Now?

- $G_T$ reasonably well known over large $Q^2$ range.
- The ratio $G_L/G_S$ from recoil polarization measurements diverged from previous Rosenbluth separations.
- Two-photon exchange (TPE).
- Effect of radiative corrections.
- The neutron form factor ratio $G_T/G_M$ opens up flavor decomposition.
- Neutron magnetic FF $G_M$ still follows dipole.

Where Are We Going?

- Dyson-Schwinger Equations
  - Infinite set of coupled integral equations.
  - Inherently relativistic, and nonperturbative.
  - Connected to confinement, dynamical chiral symmetry breaking.
  - Proton form factor ratio sensitive to the shape of the dressed-quark mass function.

Flavor Decomposition

- With all four EEFFs we can unravel the contributions of the $u$ and $d$ quarks.

\[
G_U = 2 F_{2u} + F_{2d}
\]

The $u$ and $d$ quarks have different, unexplained $Q^2$ dependence - evidence of di-quarks?

How Are We Getting There? - Upgraded Accelerator

Continuous Electron Beam Accelerator Facility (CE-BAF)

- Superconducting Electron Accelerator (338 cavities)
- 100% duty cycle.
- $E_{\text{max}} = 11$ GeV (Halls A, B, and C) and 12 GeV (Hall D)
- $\Delta E/E = 2 \times 10^{-4}$, luminosity $\approx 90 \mu A$, $P_{\gamma} > 80%$.

How Are We Getting There? - New Detectors

Hall A - High Resolution Spectrometer (HRS) pair, SuperBigBite (SBS), neutron detector, and others.

Hall B - CLAS12 high luminosity, large acceptance spectrometer with forward and central detectors.

Hall C - Super High Momentum Spectrometer paired with existing High Momentum Spectrometer.

Hall D - New GlaucX detector will search for exotic states, but not for EEFFs.

The Measurements and Anticipated Results

JLab Program Advisory Committee (PAC) has approved six experiments to measure all four EEFFs (some twice) with 224 days of running.

Experiment E12-07-108 in Hall A (Arrington, Christy, Gilad, Silkovskiy, Wójcikowski) will make a precise measurement of $e^p$ elastic cross section and extract $G_L$.

Two experiments E12-07-104 (Gilfoyle, Hafidi, and Brooks) in Hall B and E12-09-019 (Annand, Gilman, Quinn, Wójcikowski) in Hall A will use the quasielastic $e^-/e^-$ inclusive ratio to extract a precision measurement of $G_D$.

Experiment E12-09-016 in Hall A (Cates, Wójcikowski, Riordan) will use the double Polarization Asymmetry $A_{\text{el}}$ from $^3\text{He}(e,e'\gamma)p$ to extract $G_L/G_S$.

Experiment E12-11-009 in Hall C (Arrington, Kohl, Sawadsky, Semenov) will use polarization transfer off $^1\text{H}(e,e'\gamma)p$ to measure $G_L/G_S$, complementary to the other $G_L/G_D$ in Hall A.

Schedule and Conclusions

- The proton magnetic form factor experiment ($G_M$) and form factor ratio ($G_L/G_S$) will run early.
- Remaining elastic form factor measurements will be made after 2018.
- Major changes in understanding of nucleon structure.
- Jefferson Lab will host a broadband campaign on the EEFFs and will significantly expand the physics reach of our understanding.
- Discovery potential in mapping out nucleon structure and understanding QCD.