Polarization transfer in $^4\text{He}(e^-, e^{'p^-})^3\text{H}$

Is the ratio $G_{Ep}/G_{Mp}$ modified in medium?

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work done in collaboration with

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Polarization transfer & nucleon form factors

- in $\vec{e} + p \rightarrow e + \vec{p}$

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\frac{G_E}{G_M} = -\frac{P'_x}{P'_z} \frac{E_e + E_{e'}}{2M} \tan \frac{\theta}{2}
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$P'_x$ and $P'_z$ transferred polarizations, transverse and longitudinal to the proton momentum, respectively
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- $A(\vec{e}, e'\vec{p})$ measurements may provide information on possible medium modifications of the proton form factors
Medium modifications of the nucleon

- A long-standing and controversial issue. Increase of nucleon size advocated to explain:
  - depletion of the nucleon structure functions measured in deep inelastic scattering (EMC effect)
  - quenching of the quasielastic longitudinal response (violation of the Coulomb sum rule)
- No compelling evidence of medium modifications
- Modifications strongly constrained by $y$-scaling analysis of inclusive data
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Experiments at Mainz and JLab have measured

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in the range \(0.4 \leq Q^2 \leq 2.6\) GeV²
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- Analysis inherently model dependent. Calculations carried out within different approaches, including correlations, two-body currents and full final state interactions (FSI), needed.
Summary of our theoretical approach

- realistic variational bound state wf’s (A18 + UIX Hamiltonian)

- final state written in the form

\[
\psi_{k\sigma;\sigma_3}^{(-)} = \frac{1}{\sqrt{4}} \sum_{\mathbf{P}} (-)^{\mathbf{P}} \left[ \eta_{k\sigma}^{(-)}(i; p)\phi_{\sigma_3}(jkl;^3\text{H}) + \eta_{k\sigma}^{(-)}(i; n)\phi_{\sigma_3}(jkl;^3\text{He}) \right]
\]

- \(\eta_{k\sigma}^{(-)}(i; \text{p/n})\) obtained from the optical potential

\[
v_{T}^{\text{opt}} = [v^c(r; E) + (4T-3)v^{c\tau}(r; E)] + [v^b(r; E) + (4T-3)v^{b\tau}(r; E)] \cdot \mathbf{s}
\]

determined by \(p + ^3\text{He} \to p + ^3\text{He}\) and \(p + ^3\text{H} \to n + ^3\text{He}\) data

- one- and two-body terms included in the em current operator

- matrix elements \(\langle \psi_{k\sigma;\sigma_3}^{(-)} | j^{\mu} | ^4\text{He} \rangle\) computed using Monte Carlo
Results

- $Q^2$-dependence of the super-ratio $R/R_{PWIA}$
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- $Q^2$-dependence of the induced polarization $P_y$
Summary

- The observed suppression of the super-ratio in $^4$He can be explained by FSI effects and two-body current contributions.
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- Within our model no in-medium modification of the proton electromagnetic form factors is needed to reproduce the experimental data.
- Our results support the conclusions of the analyses of the Coulomb sum rule in few-nucleon systems, showing that there is no missing longitudinal strength when the free-space proton form factor is used.