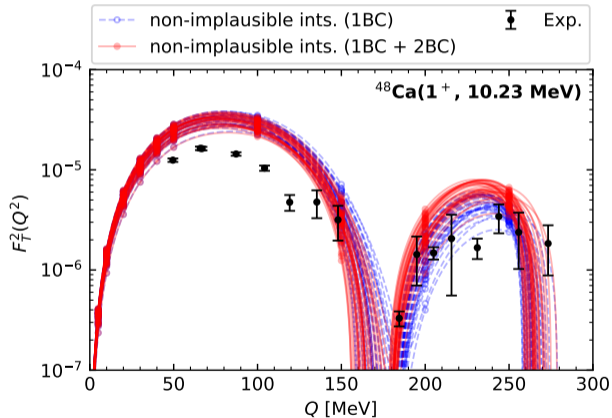


Two-body currents at finite momentum transfer and applications to M1 transition

in collaboration with:
T. Miyagi, J. Menéndez and A. Schwenk



Motivation: 2BCs at finite momentum transfer

- quenching for $0 \rightarrow 1$ decay [Menéndez, Gazit, and Schwenk, Phys. Rev. Lett. 107, 062501 \(2011\)](#)
- neutrinos scattering off nuclei [Hoferichter, Menéndez, and Schwenk, Phys. Rev. D 102, 074018 \(2020\)](#)
- weakly interacting massive particles scattering off nuclei
[Klos, Menéndez, Gazit, and Schwenk, Phys. Rev. D 88 \(2013\)](#)
- in medium-mass/heavy nuclei: only approximately included
[Menéndez, Gazit, and Schwenk, Phys. Rev. Lett. 107, 062501 \(2011\)](#)
- **multipole decomposition** for inclusion of two-body currents

[Hoferichter et al. Phys. Rev. D 102, 074018 \(2020\)](#)

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- [Hoferichter et al. Phys. Rev. D 102, 074018 \(2020\)](#)
- first applications to well studied **M1 transition in ⁴⁸Ca**
[Acharya et al., arXiv:2311.11438 \[nucl-th\] \(2023\)](#)
 - momentum transfer dependence of transition form factor
[Steffen et al., Nucl. Phys. A404, 413 \(1983\)](#)
 - $B(M1)$: experimental discrepancy between $(e; e^0)$ and $(\gamma; n)$
measurement [Steffen et al., Phys. Lett. B 95, 23 \(1980\)](#), [Tompkins et al., Phys. Rev. C 84, 044331 \(2011\)](#)

[Acharya et al. arXiv:2311.11438 \[nucl-th\] \(2023\)](#)

^{48}Ca many-body convergence

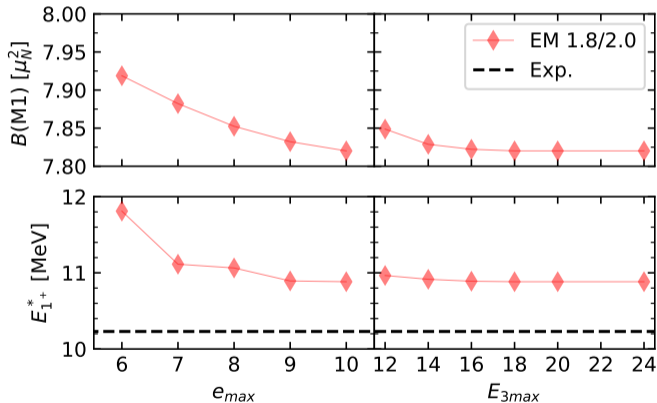
- VS-IMSRG convergence checked with EM 1.8/2.0 for $B(M1)$ and E_{1^+}

Miyagi, Eur. Phys. J. A 59, 150 (2023)

Stroberg, <https://github.com/ragnarstroberg/imsrg.git>

Hebeler et al., Phys.Rev.C 83 031301 (2011)

- $E_{3\text{max}} = 24$ for e_{max} variation
- $e_{\text{max}} = 10$ for $E_{3\text{max}}$ variation
- for further calculations:
 $e_{\text{max}} = 12$ and $E_{3\text{max}} = 24$



Multipole decomposed vector current

$$j(Q) = 4 \sum_{L=0}^{\infty} \left(T^{\text{el}}(Q) \tilde{Y}_{LM}(\hat{Q}) + T^{\text{mag}}(Q) \tilde{Y}_{L;L;M}(\hat{Q}) \right)$$

summing over rank L and its projection M using the following definitions

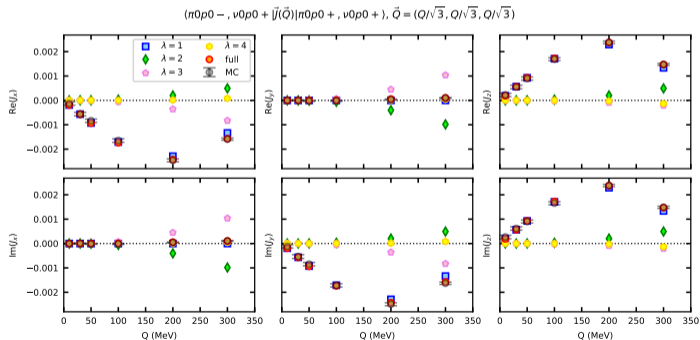
$$Y_{LM}(\hat{x}) = \hat{x} Y_{LM}(\hat{x}); \quad \tilde{Y}_{LM}(\hat{x}) = \frac{1}{L(L+1)} x^i Y_{LM}(\hat{x}); \quad \tilde{Y}_{L;L;M}(\hat{x}) = Y_{L;L;M}$$

$$\text{with } Y_{JLM}(\hat{x}) = \sum_{M_{\text{sum}}=L-1}^L Y_{L;M}(\hat{x}) C_{LM_{\text{sum}}}^{JM} e$$

Benchmark for vector 2BC at finite momentum transfer: seagull and pion-in-flight (sum in figure)

$$j(Q) = 4 \times \left(i \right) L(Q) Y(\hat{Q}) + T^{\text{el}}(Q) \sim (\hat{Q}) + T^{\text{mag}}(Q) \sim (\hat{Q})$$

multipole decomposed & Monte-Carlo integral results: agreement for all matrix elements studied



Transition for factor – Comparison to $(e; e')$ data

Steffen et al., Nucl. Phys. A404, 413 (1983)

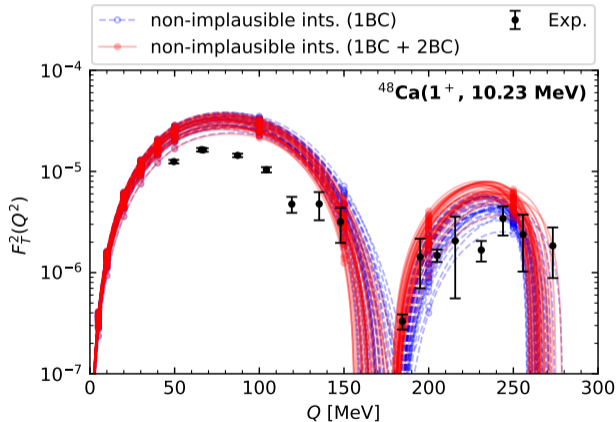
- non-implausible interactions using VS-IMSRG with 1BC and with 1BC+2BC

B. Hu et al., Nat. Phys. 18, 1196 (2022)

Miyagi, Eur. Phys. J. A 59, 150 (2023)

Stroberg, <https://github.com/ragnarstroberg/imsrg.git>

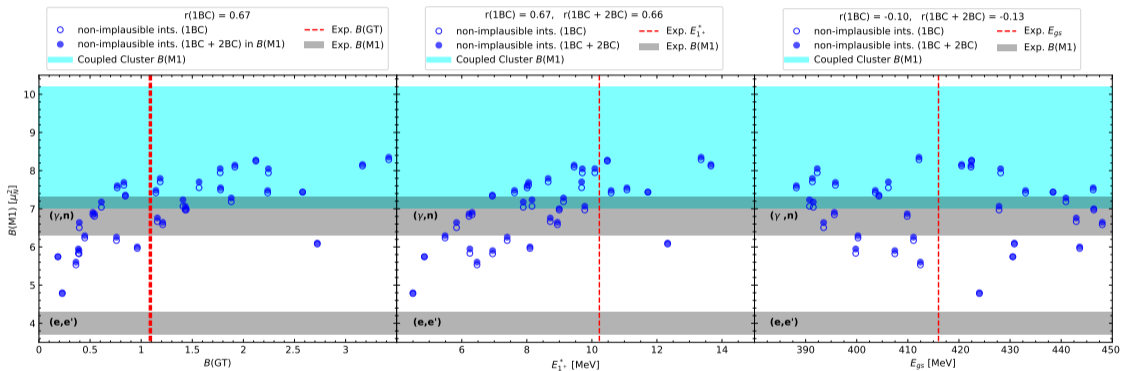
- small 2BC contribution
- similar to $B(M1)$
- $Q \rightarrow 0$ limit consistent with $B(M1)$



Correlations

Acharya et al., arXiv:2311.11438 [nucl-th] (2023), <https://www.nndc.bnl.gov/nudat3/>

Steffen et al., Phys. Lett. B 95, 23 (1980), Tompkins et al., Phys. Rev. C 84, 044331 (2011)



non-implausible interactions favor $B(M1)$ from (γ, n) exp. and show partial overlap with Coupled Cluster calculation

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I want to thank my
collaborators,
Takayuki, Javier and Achim.

Thank you for your attention
and check out my poster