Collective Excitations from Chiral NN+3N Interactions

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Random-Phase Approximation (RPA)

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- Motivation:
  - Description of ground states in medium-mass nuclei well established (CC, IM-SRG, SCGF, …)
  - Different class of observables: Collective excitations
- RPA:
  - Investigation of excited states and their transitions
  - Use same chiral interactions as in CC, …
  - Improvement through extensions (Second RPA)

RPA

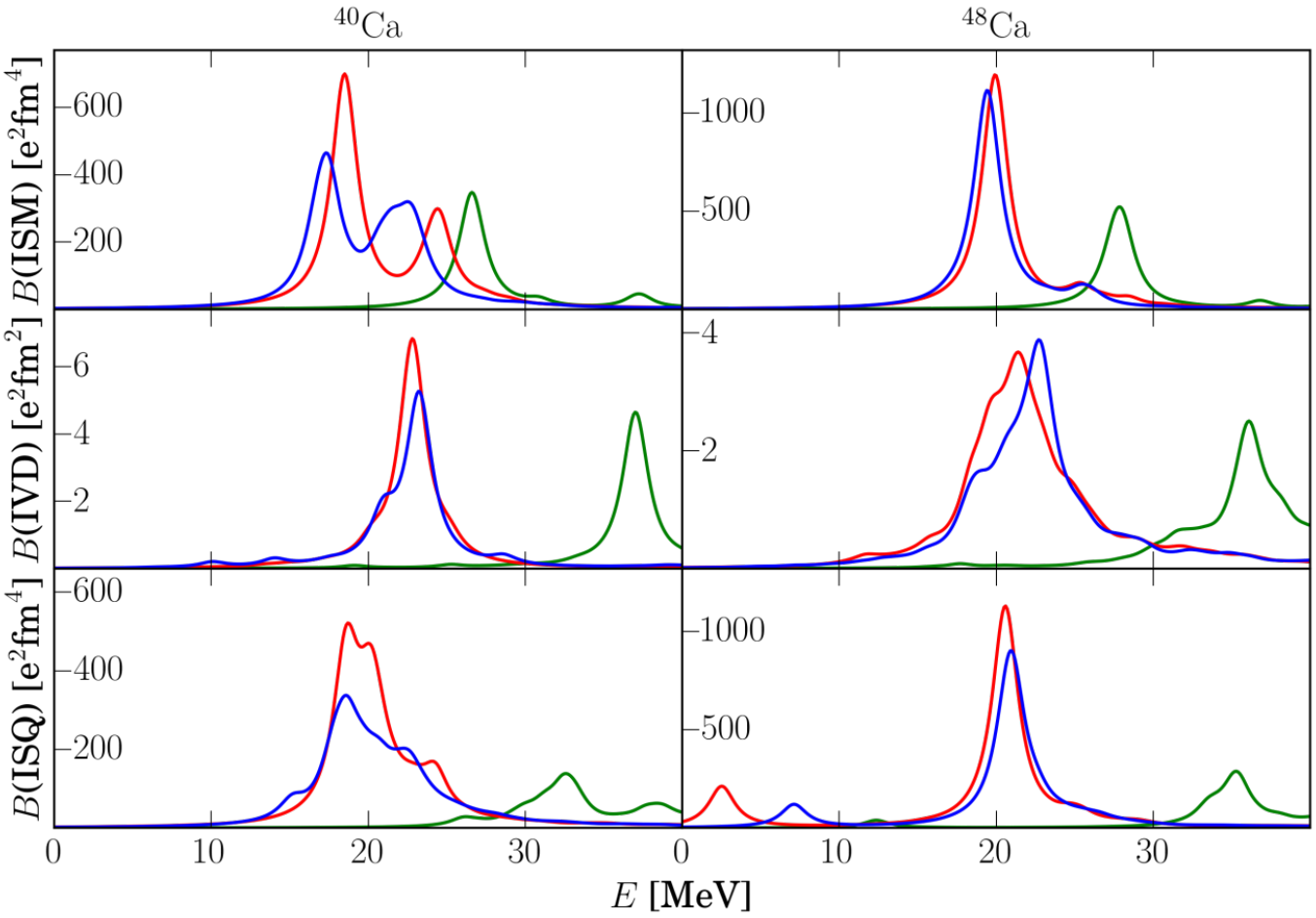
- Excitation Operator: (p: unocc., h: occ.)

$$\hat{Q}^{\dagger}_{\omega} = \sum_{p,h} \left(X^{\omega}_{ph} \hat{a}^{\dagger}_{p} \hat{a}_{h} - Y^{\omega}_{ph} \hat{a}^{\dagger}_{h} \hat{a}_{p} \right)$$

$\underbrace{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}_{\text{1p1h}}$

Standard RPA Second RPA (SRPA)

Interactions



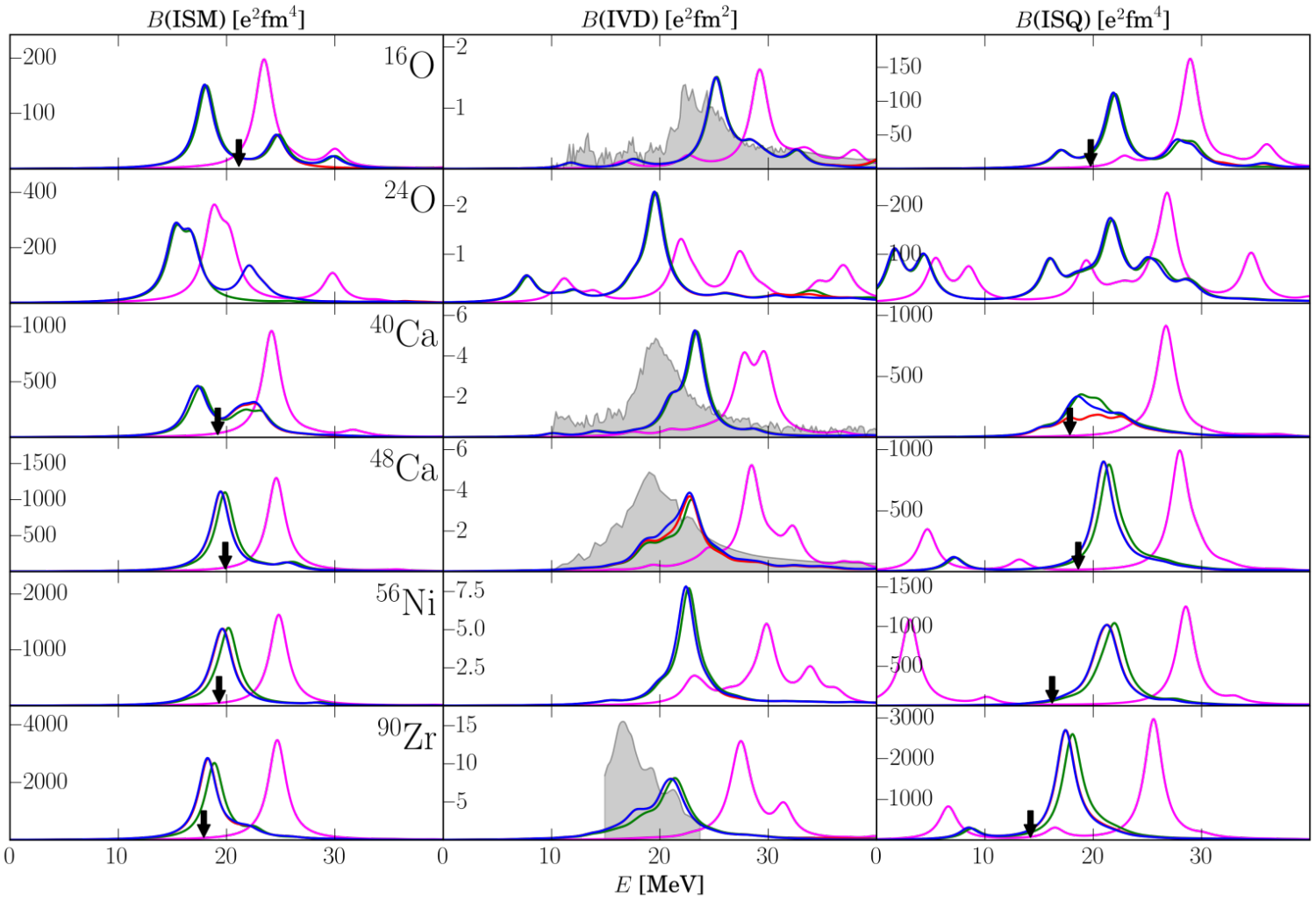
NN-only

NN+3N-ind

NN+3N$_{\text{full}}$

- SRG-induced 3N terms shift transitions to lower energies
- Chiral 3N terms less pronounced

Results



$E_{\text{2p2h-max}}$:

- 0≙RPA
- 200
- 300
- 400

- SRPA converged
- Shifts up to 10 MeV

Current Work & Outlook

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- Inclusion of ground-state correlations into RPA through use of:
  - In-Medium SRG transformed matrix-elements
  - Density formalism w/ ground-state densities from CI, CC, …

- Use of (IM-)SRG transformed multipole operators

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