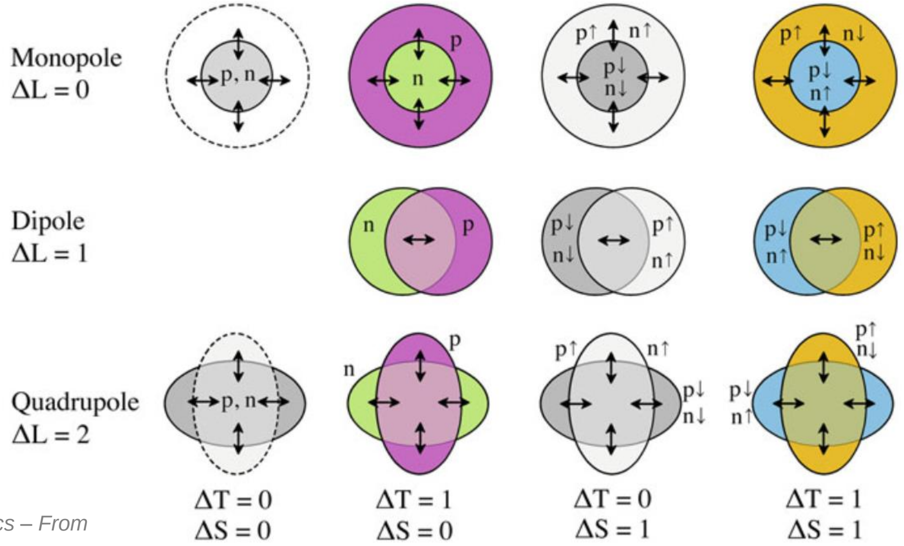
Consistent Description of Collective Excitations in the In-Medium (S)RPA

Michelle Müller



A. Obertelli and H. Sagawa. *Modern Nuclear Physics – From Fundamentals to Frontiers*. 2021.

(Second-Order) Random-Phase Approximation

- investigation of collective excitations
- exact ground state contains correlations

RPA	→	SRPA
excited states are given by 1p1h (de-)excitations of ground state		natural extension of RPA to 2p2h (de-)excitations

(S)RPA Transition Strengths

- main focus: calculation of **(S)RPA transition strengths**

- usually: application of one-body transition matrix elements

- extension of strength calculations to two-body contributions
  → possibility to involve *free-space* or *in-medium SRG evolved EM operator*

- calculation of SRPA transition strengths with two-body operator also leads to non-vanishing 2p2h contributions

Comparison of the Methods

HF-(S)RPA

- (S)RPA in Hartree-Fock basis
- ground-state correlations treated in (S)RPA formalism
- strength calculation usually via one-body matrix elements

Comparison of the Methods

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HF-(S)RPA	IM-(S)RPA
• (S)RPA in Hartree-Fock basis	• input: IM-SRG evolved Hamiltonian
• ground-state correlations treated in (S)RPA formalism	• ground-state correlations taken care of by IM-SRG
• strength calculation usually via one-body matrix elements	• strength calculation usually via one-body matrix elements

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Comparison of the Methods

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HF-(S)RPA

- (S)RPA in Hartree-Fock basis
- ground-state correlations treated in (S)RPA formalism
- strength calculation usually via one-body matrix elements

IM-(S)RPA

- input: IM-SRG evolved Hamiltonian
- ground-state correlations taken care of by IM-SRG
- strength calculation usually via one-body matrix elements

IM-(S)RPA+

- input: IM-SRG evolved Hamiltonian and IM-SRG evolved EM operator
- strength calculation via one- and two-body matrix elements
- consistent description

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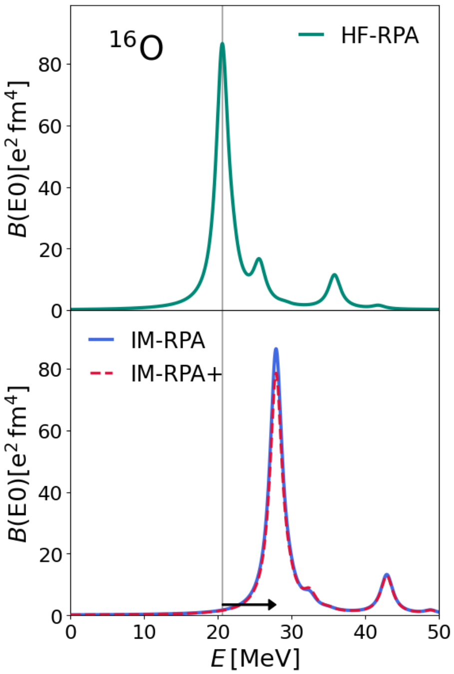
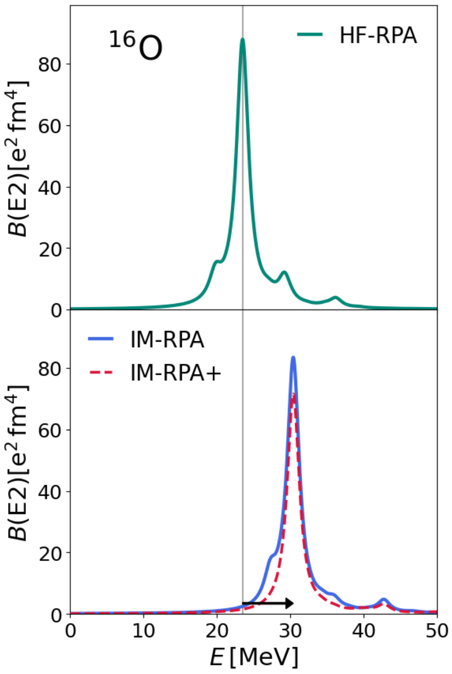
(S)RPA Transition Strengths

monopole **quadrupole**

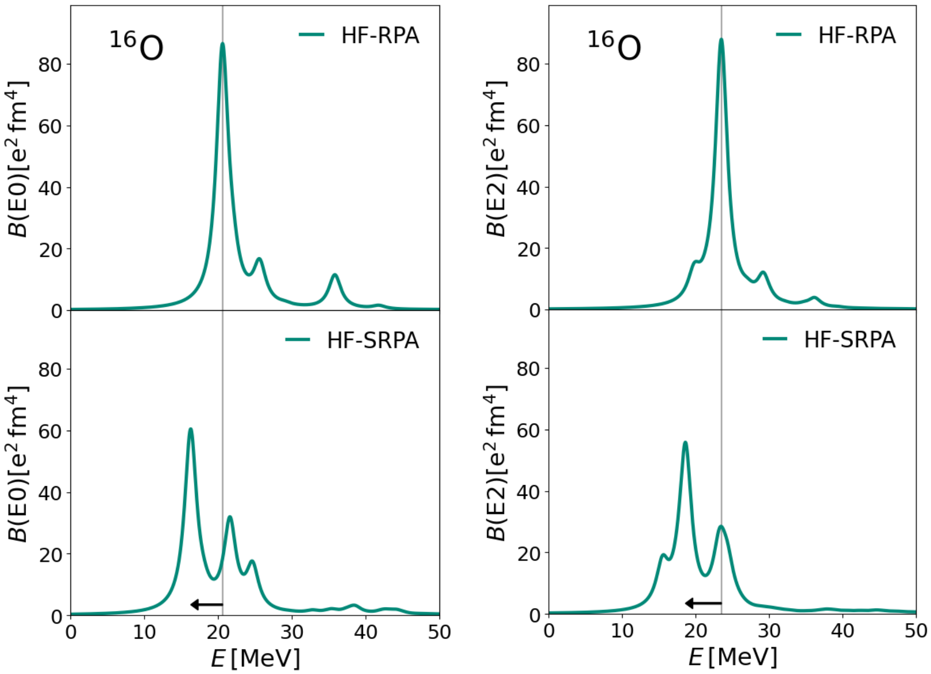




- **HF-RPA ➔ IM-RPA**: shift to higher energies
- **IM-RPA ➔ IM-RPA+**: small changes in strength, energies unaltered

(S)RPA Transition Strengths

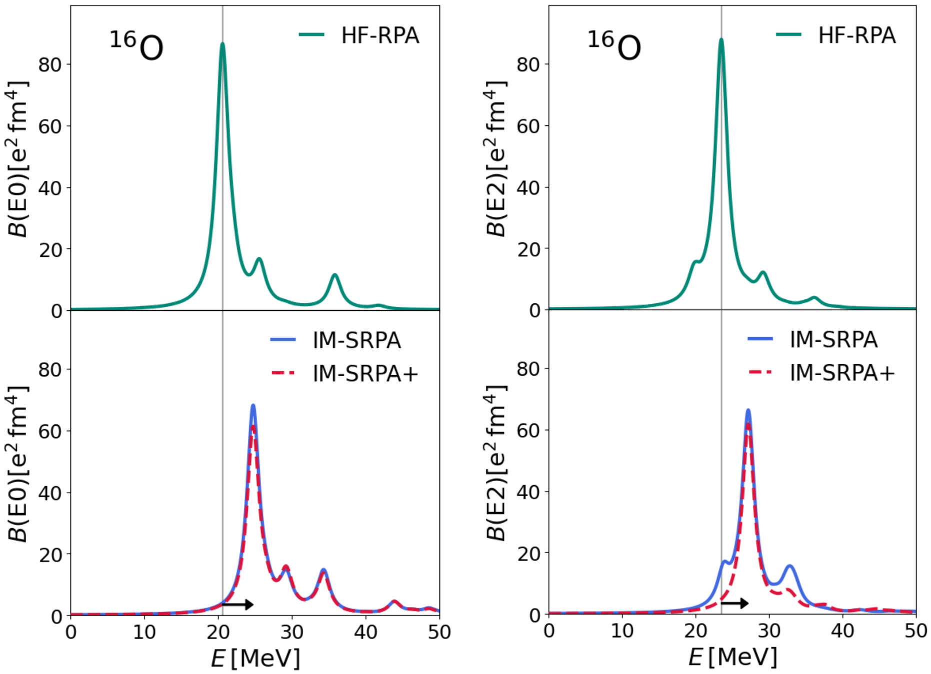
monopole quadrupole



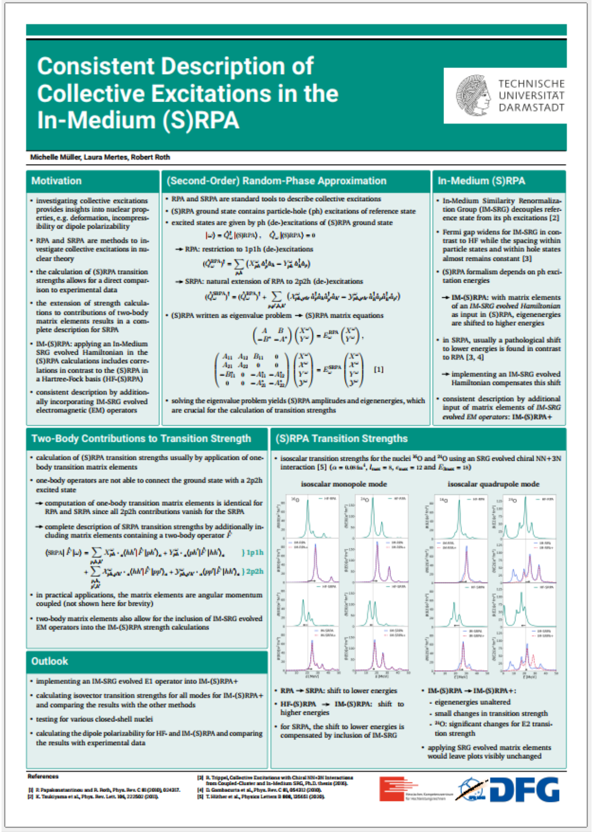
- **HF-RPA ➔ HF-SRPA**: shift to smaller energies

(S)RPA Transition Strengths

monopole **quadrupole**



- **HF-SRPA ➔ IM-SRPA**: compensation of shift to smaller energies
- **IM-SRPA ➔ IM-SRPA+**: small changes in strength, energies unaltered



Thank you for your attention!

→ more details on my poster