IMSRG with three-body operators

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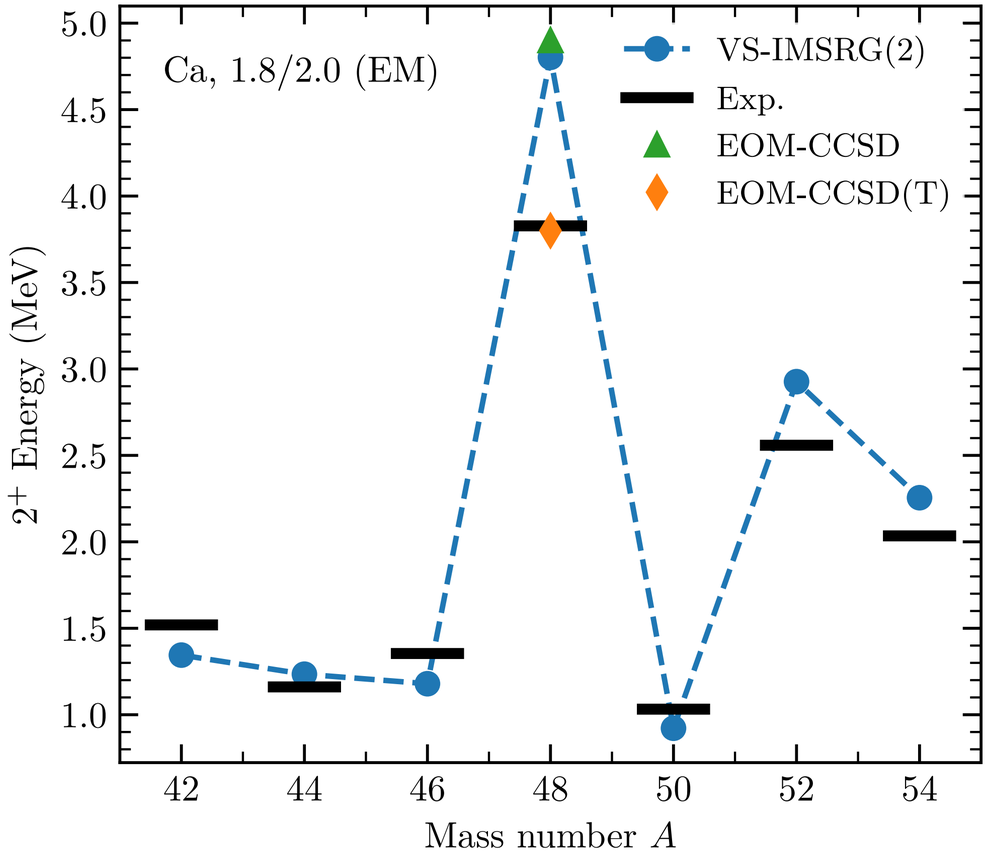
Why IMSRG(3)?



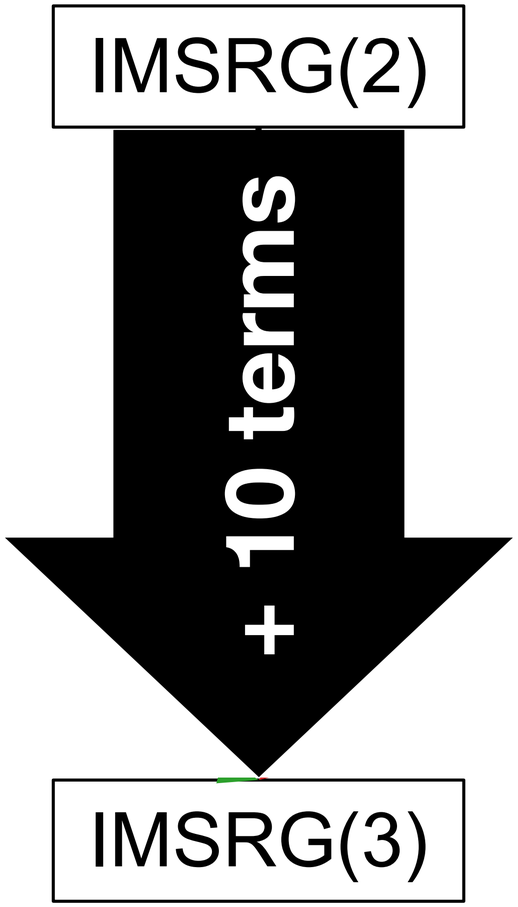
Hagen, Jansen, Papenbrock, PRL **117** (2016)

Simonis, Stroberg, Hebeler, Holt, Schwenk, PRC **96** (2017)

- IMSRG relies on many-body operator expansion
- **IMSRG(2)** = standard, successful truncation
- **IMSRG(3)** is more precise, but more expensive
- Benefits of IMSRG(3):
  - Known IMSRG(2) deficiencies in certain observables
  - Many-body uncertainty quantification within the IMSRG possible

IMSRG(3) benchmarks

- IMSRG(3) is too expensive
- What can we afford?
- What is actually important?



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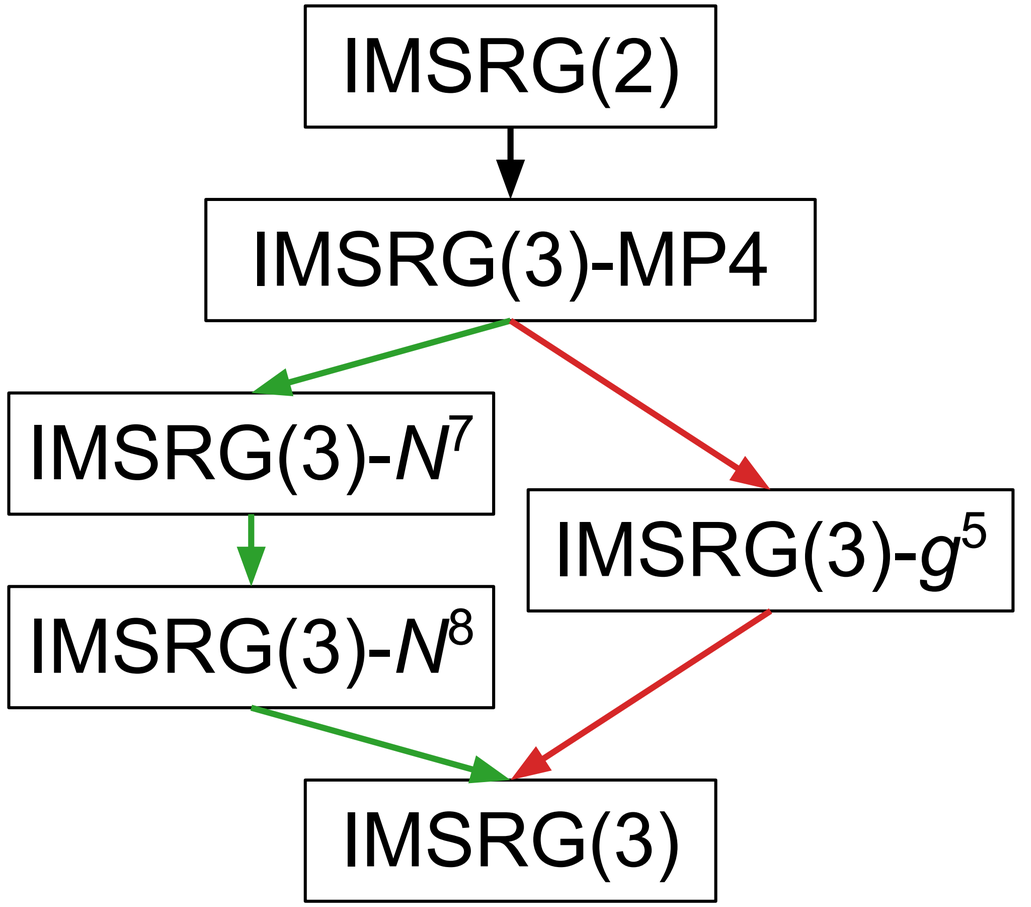

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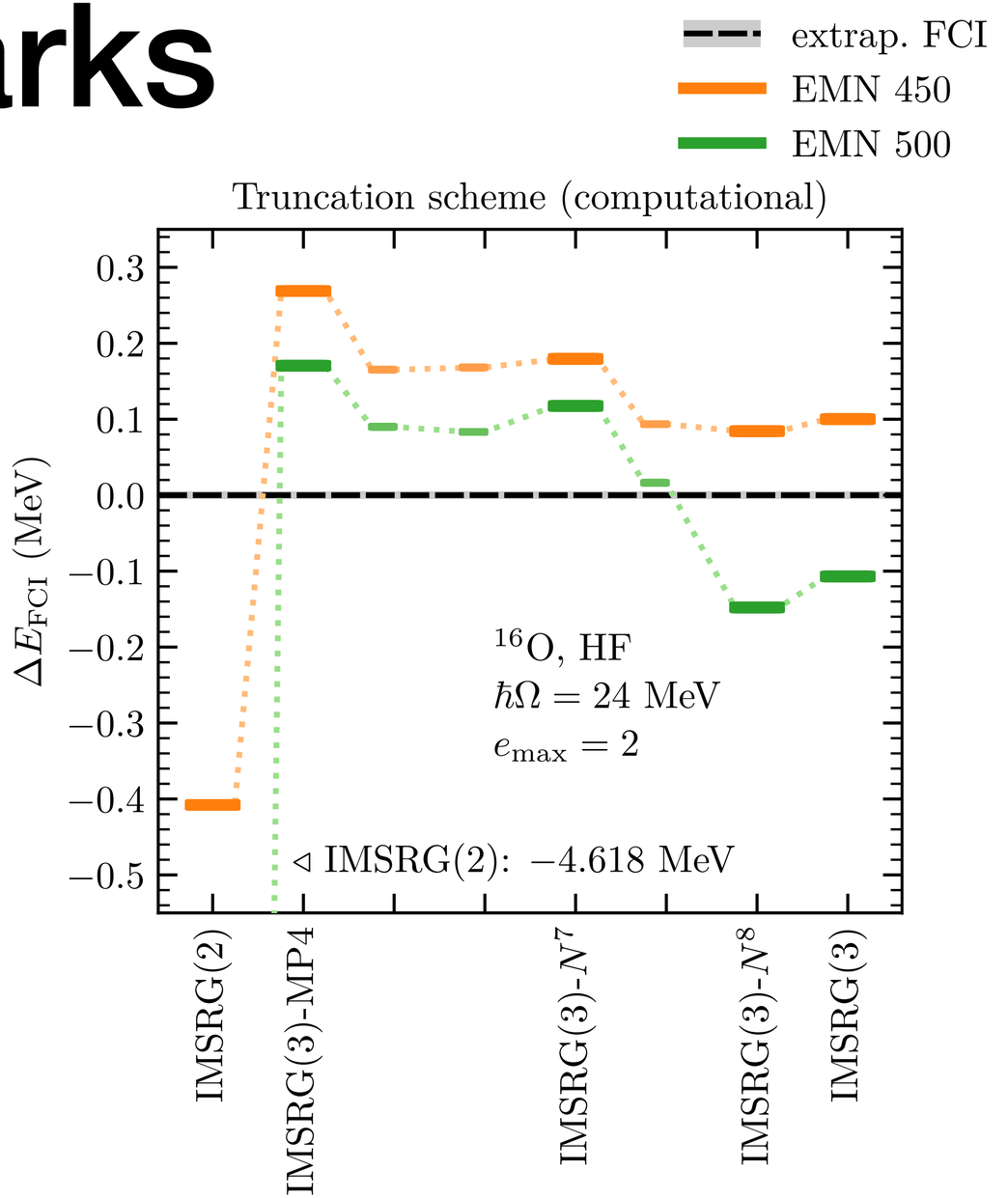
- Systematic study with comparison to exact results
- **IMSRG(3)** gives expected increase in precision
- ... also at lower computational cost



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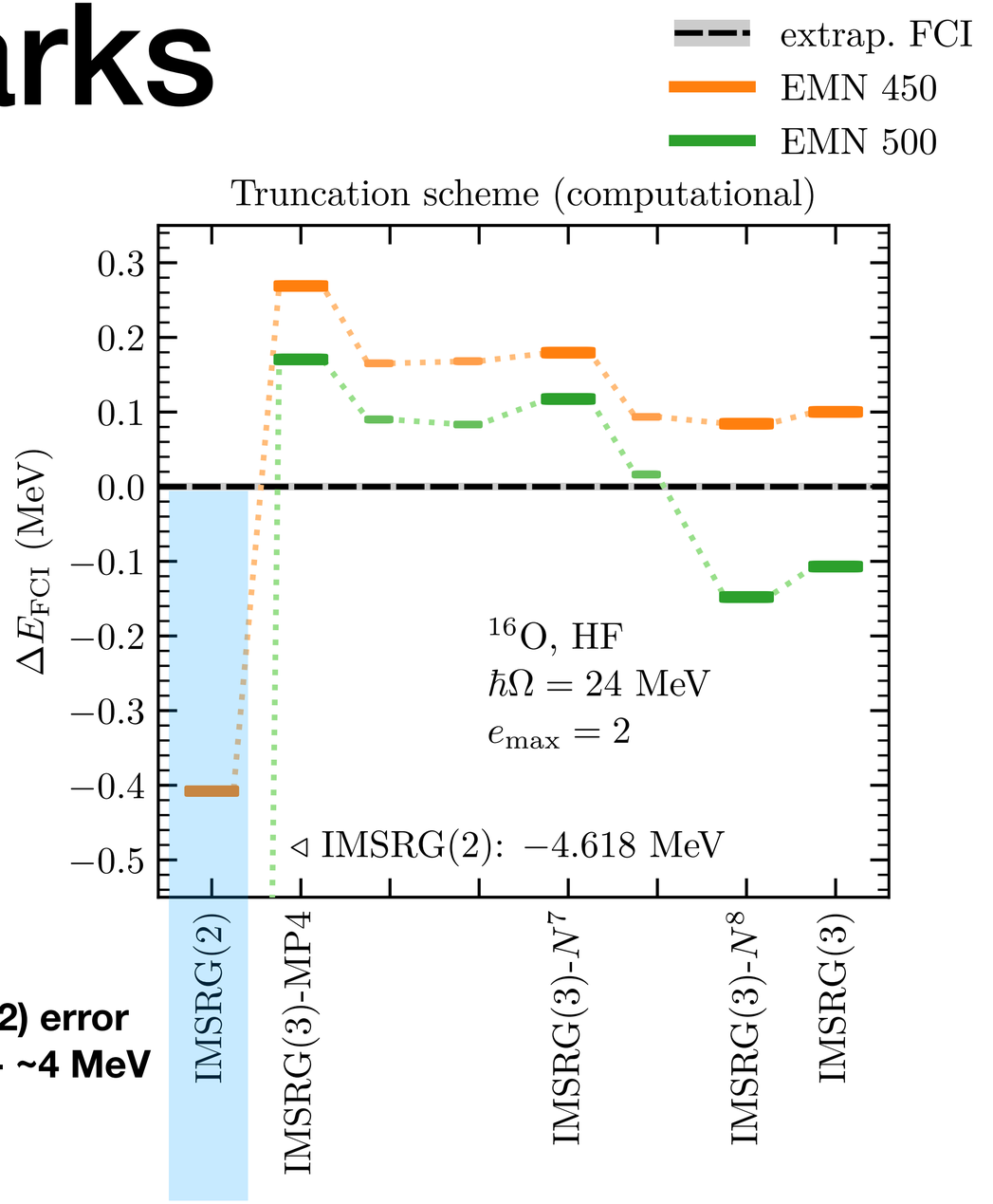

IMSRG(2) error
400 keV - ~4 MeV

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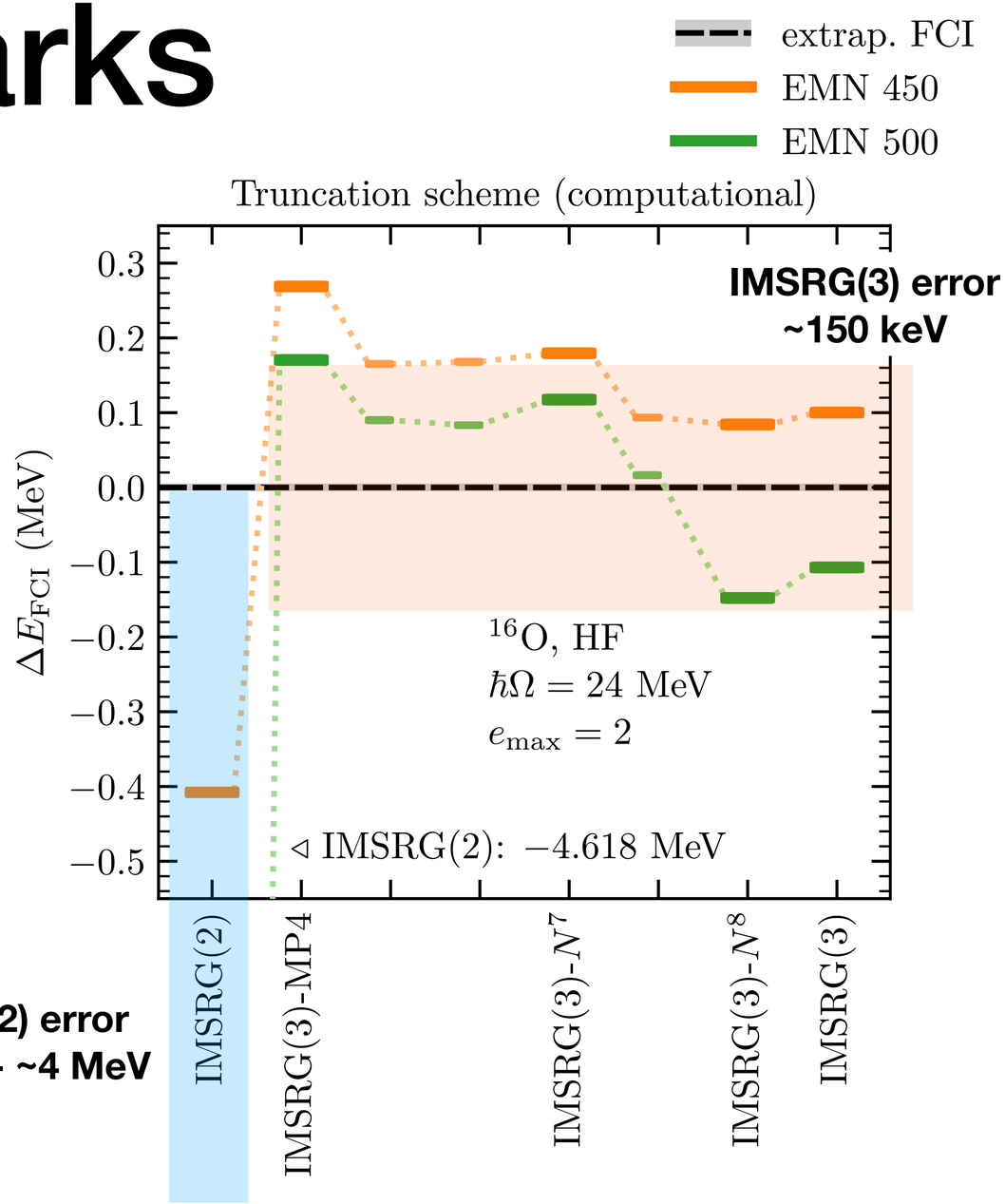
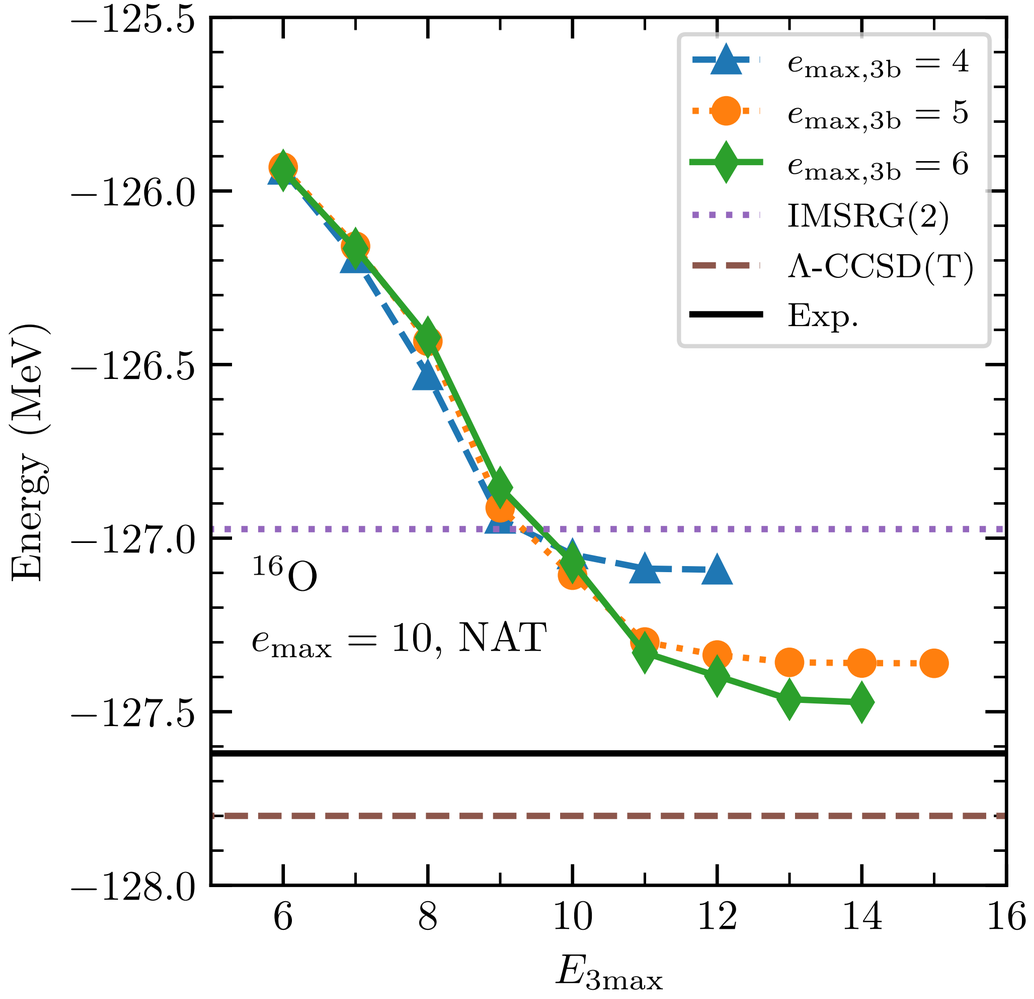


IMSRG(3) for medium-mass nuclei



- Investigate IMSRG(3) in ^{16}O, ^{48}Ca
- Truncations on 3B operator necessary for realistic calculations: $e_{\mathrm{max,3b}}$, $E_{3\mathrm{max}}$
- Nearly converged for ground-state energy

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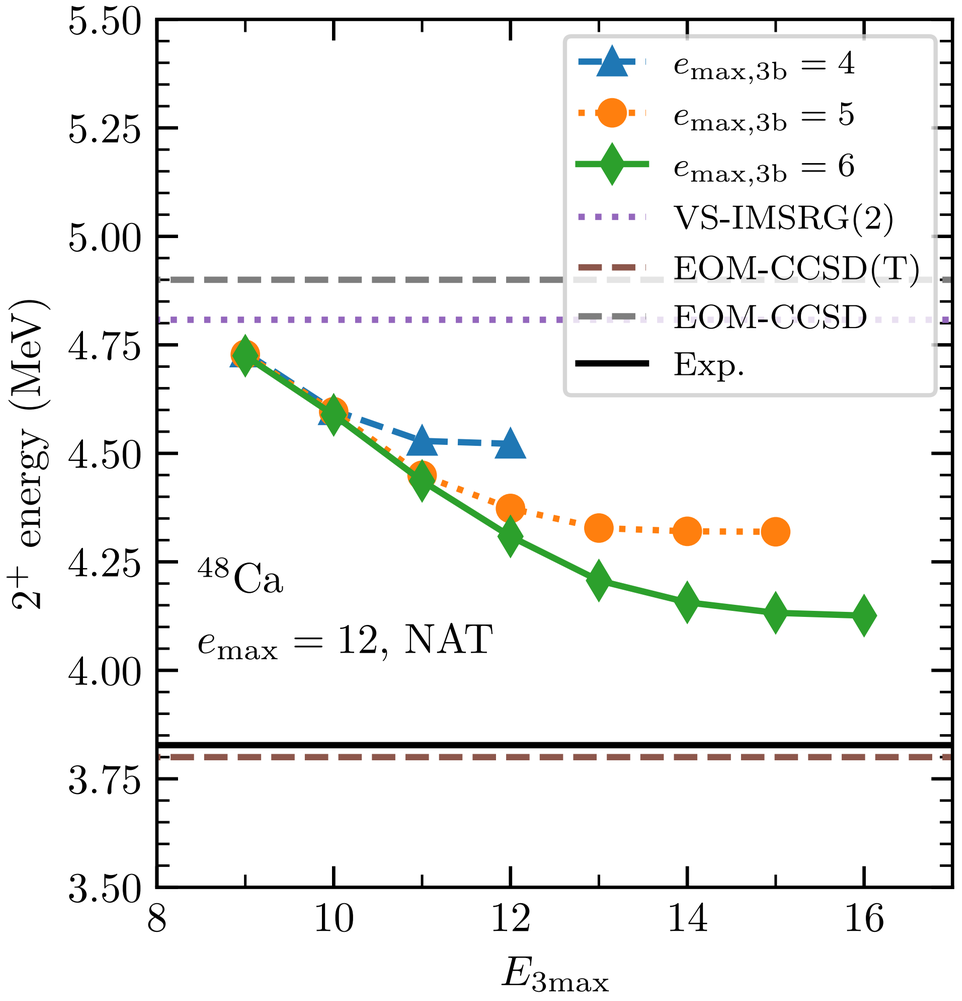
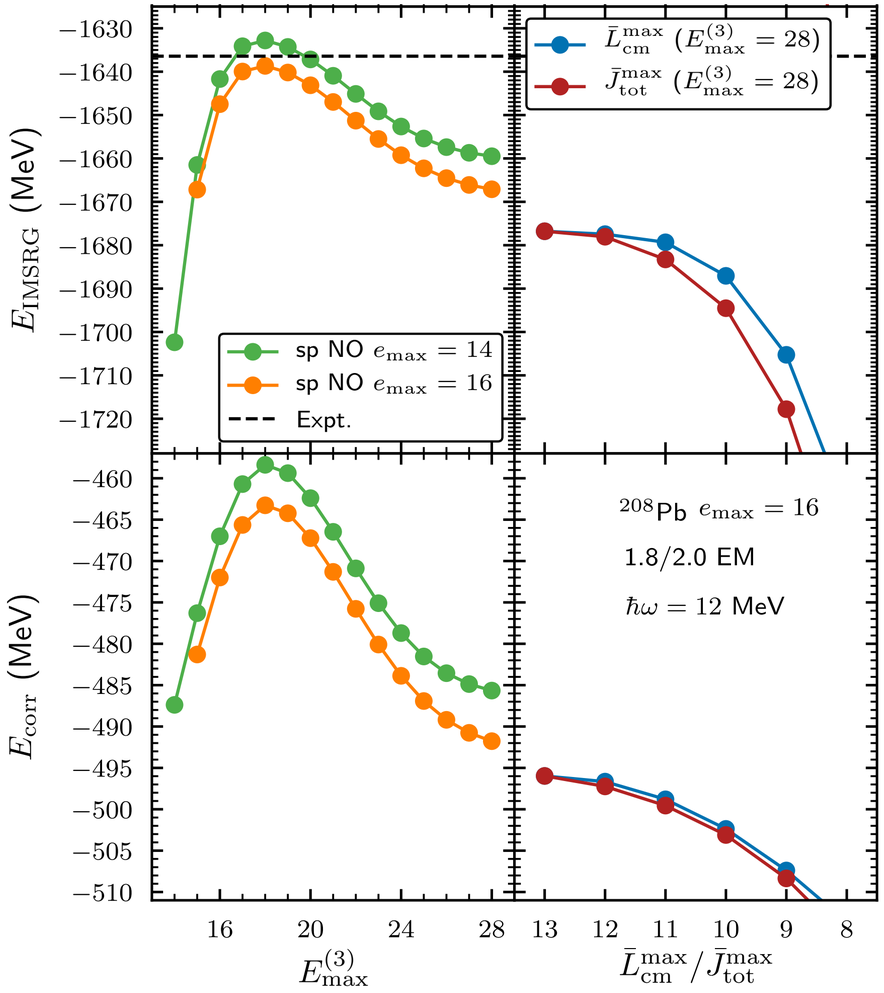


- Investigate IMSRG(3) in ^{16}O, ^{48}Ca
- Truncations on 3B operator necessary for realistic calculations: $e_{\mathrm{max,3b}}$, $E_{3\mathrm{max}}$
- Nearly converged for ground-state energy
- Convergence more challenging in Ca
- Substantial corrections to 2^+ energy
- Large model spaces needed for quantitative statements
- Overall qualitative consistency with CC

Aside: Jacobi normal ordering of 3N forces

Hebeler, Durant, Hoppe, **MH**, Schwenk, Simonis, Tichai, PRC **107** (2023)

- NO2B three-body force obtained in Jacobi basis
- No $E_{3,\max}$ truncation required
- Results consistent with Miyagi et al.
- Converged results for ^{208}Pb



Conclusions and outlook

- Approaching **realistic IMSRG(3) calculations** of medium-mass nuclei
- Small corrections for ground-state energies; **Larger corrections for 2^+ energies**

- Further **optimization** needed (basis, numerical implementation)
- Impact of IMSRG(3) in **neutron-rich isotopes**?

Thanks to:

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- ORNL Nuclear Theory

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- ... and all of you for your attention