In-Medium Similarity Renormalization Group

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Motivation

- great progress with ab initio many-body methods for medium-mass regime
- one very successful method: Coupled Cluster
- very promising "new" method: In-Medium Similarity Renormalization Group
- great advantage: flexibility of formulation
  - direct calculation of nuclear structure observables
  - construction of effective interactions for, e.g., shell-model calculations
  - excited states

Concept

- use efficient SRG flow equation approach

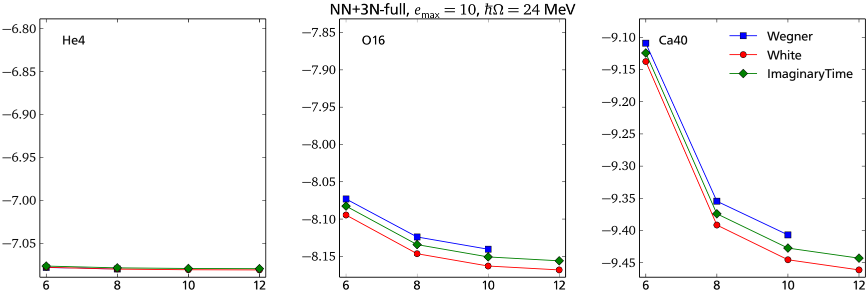
$$\frac{\mathrm{d}}{\mathrm{d}s}\hat{H}(s) = \left[\hat{\eta}(s), \hat{H}(s)\right]$$

- use normal-ordered form of operators throughout the evolution, e.g.

$$\hat{H}(s) = E(s) + \sum_{pq} f^p_q(s) \left\{\hat{p}^\dagger \hat{q}\right\} + \frac{1}{4}\sum_{pqrs} \Gamma^{pq}_{rs}(s) \left\{\hat{p}^\dagger \hat{q}^\dagger \hat{s} \hat{r}\right\} + \ldots$$

- cut off at normal-ordered two-body part (NO2B)
- derive flow equations for $E(s)$, $f^p_q(s)$ and $\Gamma^{pq}_{rs}(s)$
- choice for generator $\longleftrightarrow$ desired behavior

IM-SRG Energy: Generator Comparison

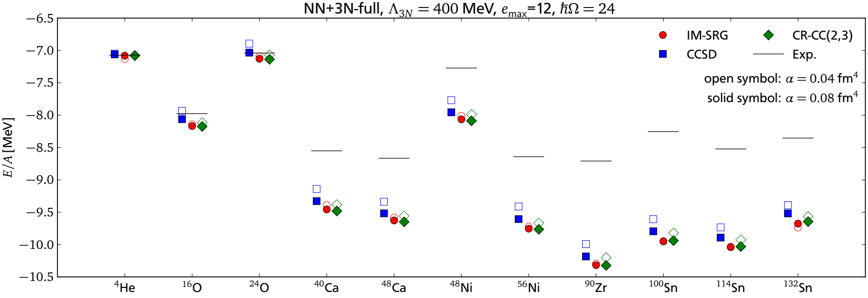


- largest deviation:
  0.4 % for ^{40}Ca between Wegner and White

- largest deviation between White and Imaginary-Time:
  0.2 % for ^{40}Ca

- good agreement
  → generally use White, fallback: Imaginary-Time

IM-SRG and Coupled Cluster



- good agreement IM-SRG and CR-CC(2,3), improves with increasing α
- CCSD consistently underbinds w.r.t. IM-SRG
- CPU hour comparison for ^{40}Ca at $e_{max} = 12$:
  ~ 60 (IM-SRG) vs. ~ 120 (CR-CC(2,3))