Many-Body Perturbation Theory and *Ab Initio* Nuclear Structure

Alexander Tichai, Bastian Dörig and Robert Roth

Institut für Kernphysik

TECHNISCHE UNIVERSITÄT DARMSTADT

Many-Body Perturbation Theory

Motivation

- access nuclear observables in the **medium-mass regime**
- methods like coupled cluster and in-medium SRG have been successfully applied
- alternative: use a conceptual simple approach

$\Rightarrow$ **many-body perturbation theory**

Concept

- definition of **unperturbed basis**

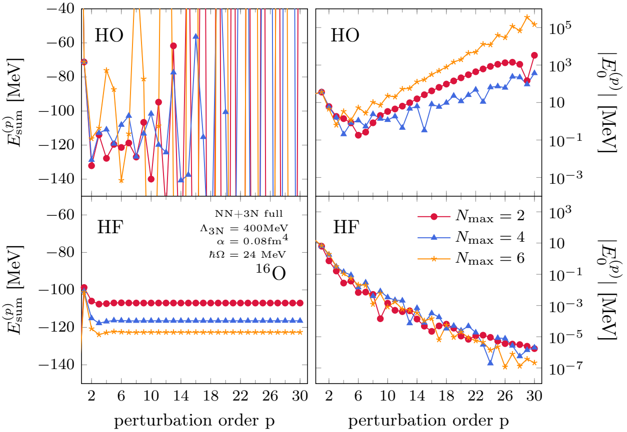
$$\hat{H} = \hat{H}_0 + \lambda \hat{H}_1 \qquad \hat{H}_0 |\Phi_n\rangle = E_n |\Phi_n\rangle$$

- **power-series expansion**

$$E_n(\lambda) = \sum_{p=0}^{\infty} E_n^{(p)} \lambda^p$$

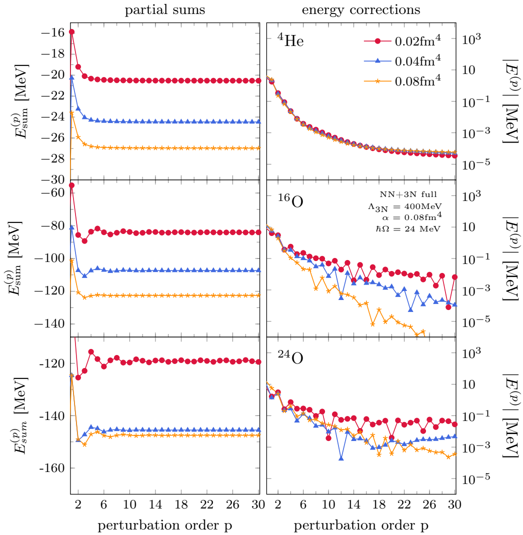
- determine expansion coefficients order by order
- problem: need to control the **convergence behaviour**

Perturbation Theory for ^{16}O



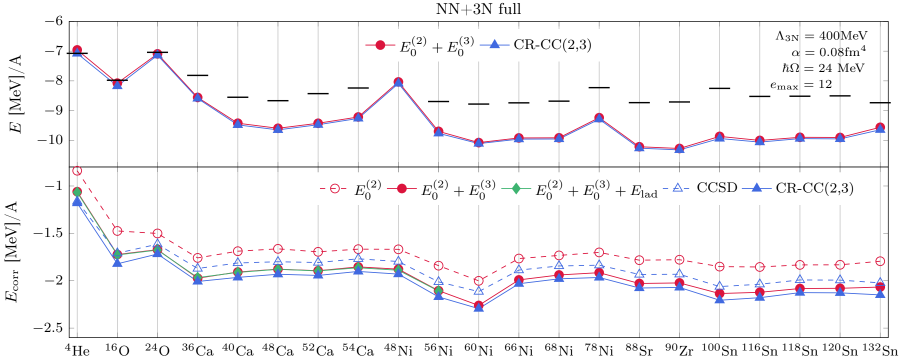
- HO perturbation series are **exponentially divergent**
- Energy corrections in HF-MBPT are **exponentially suppressed**
- Partitioning heavily affects convergence properties

Impact of SRG Evolution for



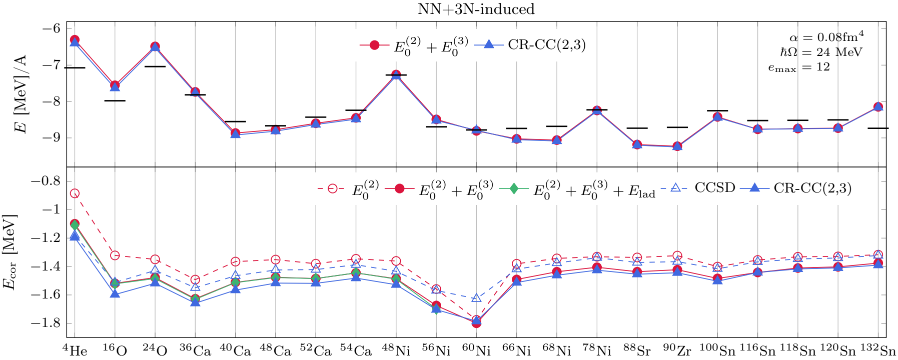
- Perturbation series also robust for harder interactions
- Increasing the flow parameter yields **stronger suppression** of high-order energy corrections
- convergent power series motivate use of **low-order partial sums**

Binding Energy - NN+3N-full



- Very good agreement of HF-MBPT and CR-CC(2,3)
- Third-order contribution is **sizeable** (≈ 0.2MeV/A)
- Ladder-summation yields **intrinsic error estimates**

Binding Energy - NN+3N-induced



- Very good agreement of HF-MBPT and CR-CC(2,3)
- Third-order contribution is **sizeable** (≈ 0.2MeV/A)
- Ladder-summation yields **intrinsic error estimates**