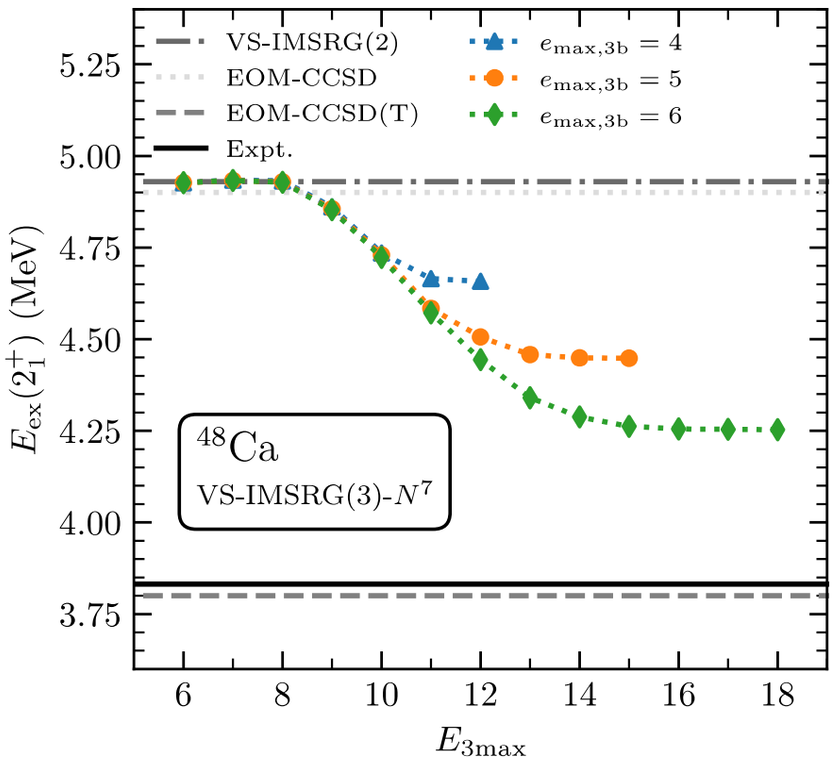
Improved structure of calcium isotopes from ab initio calculations

U.S. DEPARTMENT OF ENERGY | Office of Science

NUCLEI Nuclear Computational Low-Energy Initiative

Objectives

- Predict structure of ground states and low-lying excited states of calcium isotopes using first-principles computations of nuclei
- Explore the impact of improved many-body truncations in the in-medium similarity renormalization group method , specifically the IMSRG(3) approximation, on various observables



Improved calculations of ^{48}Ca reduced the predicted first excitation energy of the isotope, a key signature of its doubly-magic structure. The new predicted 2^+ energy is in substantially better agreement with experiment, meaning that improved simulations are necessary to properly capture this emergent structure of nuclei.

Impact (as of now)

- The IMSRG(3) improves the prediction of the first 2^+ energy of calcium-48, related to its closed-shell structure
- The IMSRG(3) does not significantly impact the charge difference between calcium-48 and calcium-52, which remains a challenge for ab initio calculations
- We provide estimates for the size of IMSRG(3) corrections to ground state energies, radii, and neutron skins, applicable to other systems based on the size extensive nature of the in-medium similarity renormalization group method. These estimates will be valuable for other researchers using this method and as a basis for future studies.

Accomplishments (as of now)

- Publication: Heinz, Miyagi, Stroberg, Tichai, Hebeler, Schwenk, Phys. Rev. C **111** 034311 (2025)