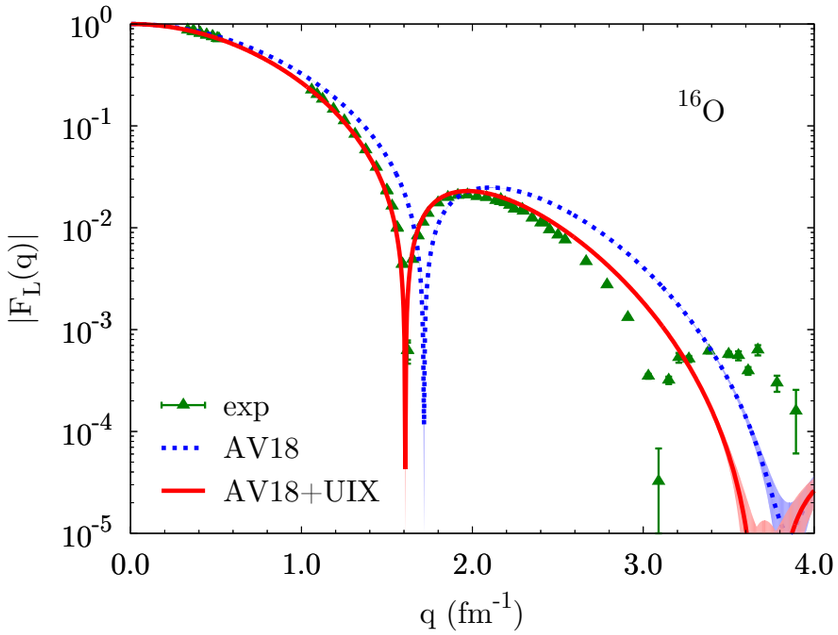
Variational calculation of closed-shell nuclei up to A = 40

Objectives

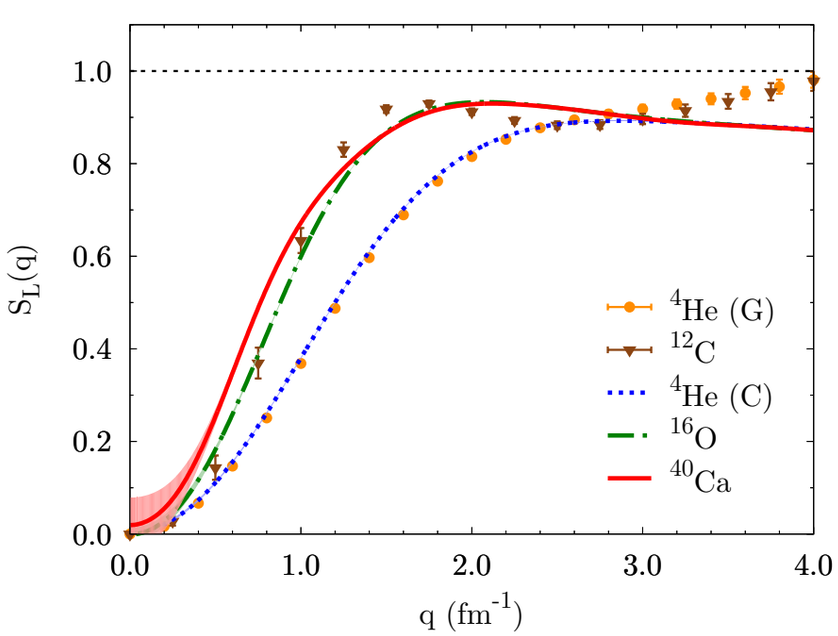
- Compute ground state properties of closed-shell nuclei up to A = 40 with quantum Monte Carlo.
- Analyze the behavior of phenomenological Hamiltonians in medium-heavy nuclei.
- Study the high-momentum components of the nuclear wave function and potential in-medium modifications of the nucleon form factors.

Impact

- Observe a change in the behavior of the UIX 3-body force — from attractive to repulsive — already in relatively small nuclear systems, such as ^{16}O.
- Confirm the universality of the tail of the momentum distribution for a given class of Hamiltonians.
- Show very little A dependence of the Coulomb sum rule for A ≥ 12: no evidence of in-medium modification of the nucleon form factor.



Longitudinal elastic form factor in ^{16}O for different phenomenological Hamiltonians. The UIX 3-body force combined with the AV18 potential provides a good description of the structure of the nucleus.



Coulomb sum rules for A ≤ 40. Symbols with error bars show GFMC calculations employing the AV18+IL7 potential. The curves show CVMC results for AV18+UIX.

Accomplishments

- Development of a cluster variational Monte Carlo approach (CVMC) to study the properties of medium-heavy nuclei employing realistic nuclear interactions.
- Analysis of binding energies, charge radii, one- and two-body densities, one-body momentum distributions, charge form factors, and Coulomb sum rules for A = 4, 16, 40.

LA-UR-21-21790

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References: Phys. Rev. C 96, 024326 (2017)

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