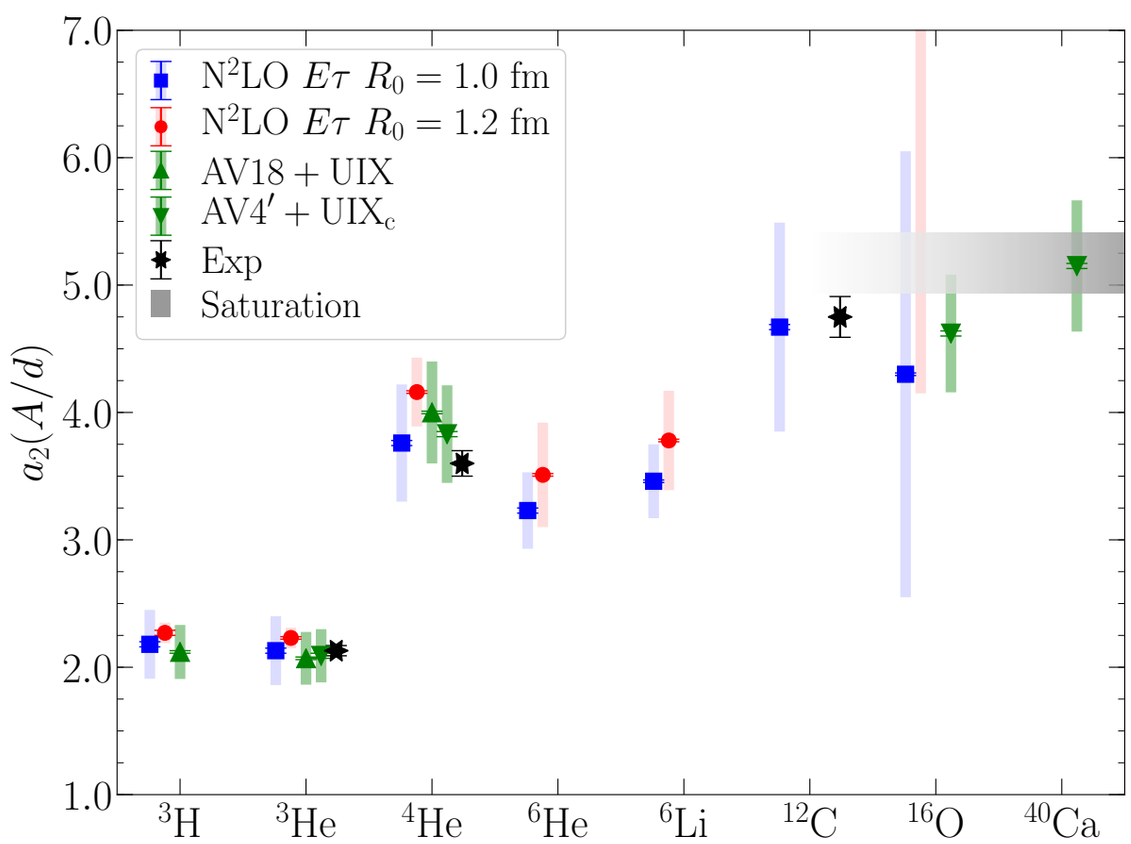
Ab initio short-range-correlation scaling factors in nuclei up to A=40

U.S. DEPARTMENT OF ENERGY | Office of Science

NUCLEI Nuclear Computational Low-Energy Initiative

Objectives

- We use quantum Monte Carlo methods to calculate the short-range-correlation scaling factor a_2 in nuclei up to ^{40}Ca as ratio of two-nucleon coordinate-space densities in the limit of short interparticle distance.
- We employ both phenomenological potentials and local chiral interactions up to next-to-next-to-leading (N^{2}LO) order for different values of the cutoff R_0.



Short-range-correlation scaling factors for selected nuclei up to A=40. Available experimental data are also shown.

Impact

- The short-range-correlation (SRC) scaling factor for a nucleus A relative to the deuteron $a_2(A/\mathrm{d})$ and relative to ^{3}He $a_2(A/^3\mathrm{He})$ is calculated from ab initio low-energy nuclear theory in light and medium-mass nuclei, with the first predictions for ^{6}He, ^{6}Li, ^{16}O, and ^{40}Ca.
- Results are largely scheme and scale independent, *i.e.*, they do not depend on the specific nuclear potential, even though the two-nucleon densities from which a_2 is extracted are manifestly scheme and scale dependent.
- The quantum Monte Carlo estimates of a_2 agree with the available experimental information in the mass range investigated, even for a simplified phenomenological interaction that does not include the tensor force.
- The employed framework further predicts that the EMC effect and SRC scaling factors have minimal or negligible nuclear isovector corrections.
- Using the the empirical linear relationship between the slope of the EMC effect and SRC scaling factors, the slope of the EMC effect is estimated for ^{6}He, ^{6}Li, ^{16}O, and ^{40}Ca.

Accomplishments

J.E. Lynn, D. Lonardoni, J. Carlson, J.-W. Chen, W. Detmold, S. Gandolfi, and A. Schwenk, J. Phys. G: Nucl. Part. Phys. 47, 045109 (2020)