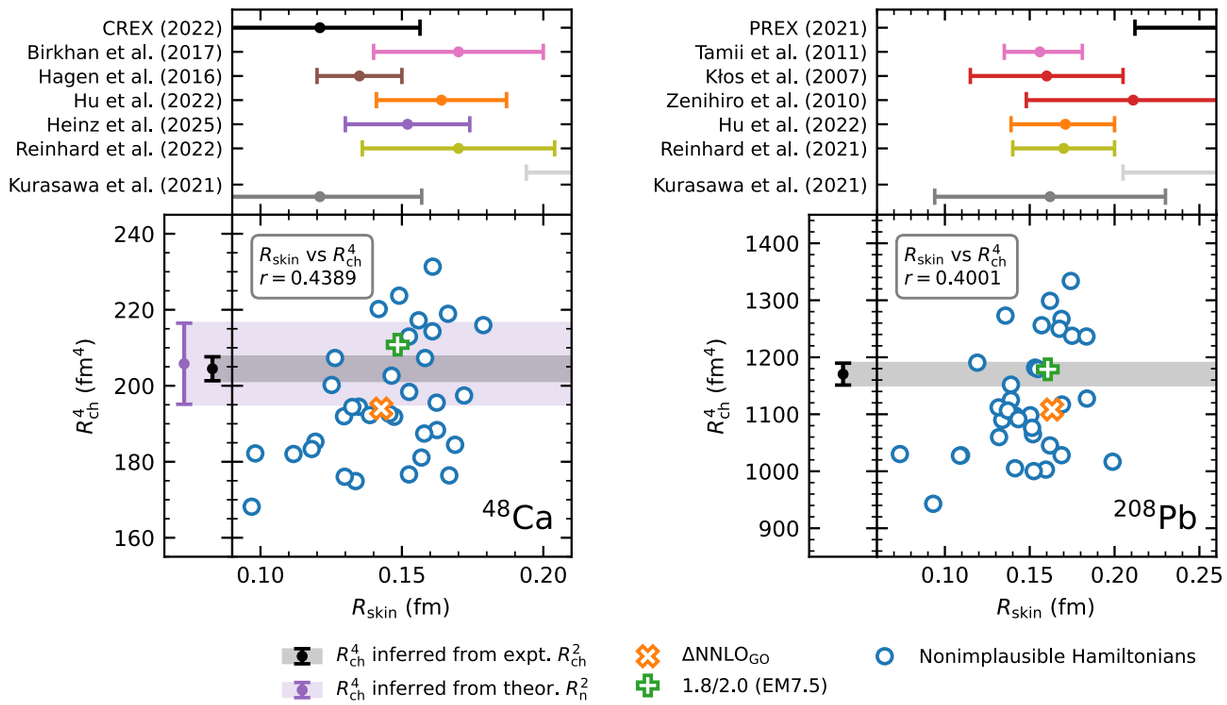
Ab initio computations of the fourth-order charge density moments of ^{48}Ca and ^{208}Pb

U.S. DEPARTMENT OF ENERGY | Office of Science

NUCLEI Nuclear Computational Low-Energy Initiative

Objectives

- Predict moments of charge density of nuclei
- Investigate sensitivity of higher-order charge density moments, to be measured in electron scattering experiments, to the neutron density
- Explore possible correlation between higher moments and neutron skins



Ab initio calculations of the fourth-order charge density moments R_{ch}^4 reveal weak correlation with neutron skins of ^{48}Ca and ^{208}Pb, indicating that measuring this observable will not lead to a model independent determination of the neutron skin. Constraints from theoretical predictions of R_{ch}^4 are compatible with past determinations of neutron skins in both systems.

Impact (as of now)

- We present first ab initio predictions of higher moments of the charge density.
- We find that these higher order moments are closely connected with charge and neutron densities via a correlation analysis.
- We find that these strong correlations between the fourth-order charge density moments and charge and neutron radii does not extend to neutron skins, which are only weakly correlated with these higher order moments.
- This limits the ability of high-precision electron scattering to constrain the neutron skin thickness in a model-independent way.

Accomplishments (as of now)

- Preprint: Miyagi, Heinz, Schwenk, arXiv:2508.10767