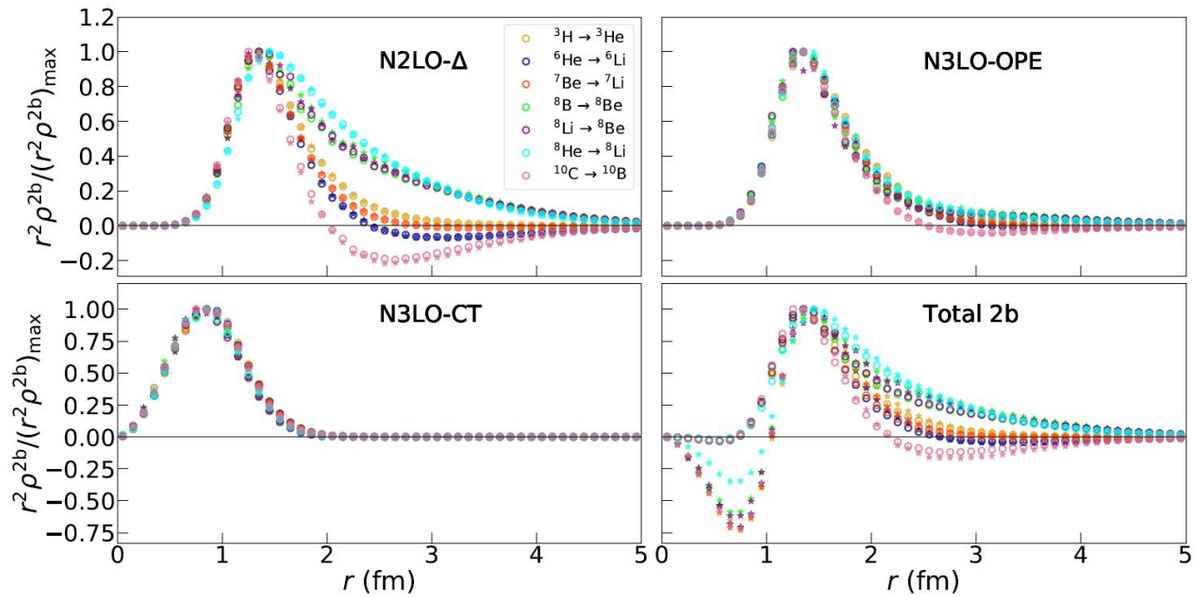
Ab initio calculation of Gamow-Teller matrix elements

U.S. DEPARTMENT OF ENERGY | Office of Science

NUCLEI Nuclear Computational Low-Energy Initiative

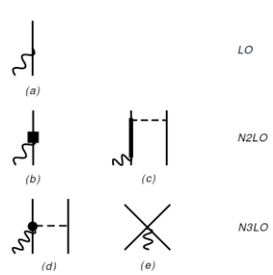
Objectives

- Searches for beyond Standard Model physics rely on nuclear beta decay and require an accurate understanding of the underlying nuclear dynamics
- We performed a systematic study of Gamow-Teller matrix elements relevant for nuclear beta decay with several chiral effective field theory models
- We illuminate important dynamics, such as the nature of two-body contributions to axial transitions



Two-body Gamow-Teller transition densities evaluated in variational Monte Carlo for several transitions. Different colors indicate different transitions, while open circles and filled stars indicate different models. The densities exhibit a universal short-range scaling with model dependent strength and a long-range, transition dependent behavior.

$$M_{\mathrm{GT}}^{2b} = \int dr_{ij} 4\pi r_{ij}^2 \rho^{2\mathrm{b}}(r_{ij})$$



Impact

- Two-body contributions to most Gamow-Teller matrix elements are small (2%-3%) and additive corrections to the leading order
- Short-range two-body transition densities exhibit a universal scaling and model dependent strength
- The long-range behavior of two-body transition densities is dependent on the overlap of nuclear wave functions
- Combination of long-range transition dependence and short-range model dependence can explain why the A=10 two-body correction changes sign in some models

Accomplishments

- G. B. King, L. Andreoli, S. Pastore, M. Piarulli, R. Schiavilla, R. B. Wiringa, J. Carlson, and S. Gandolfi, Phys. Rev. C 102, 025501 (2020).
- Editors' Suggestion