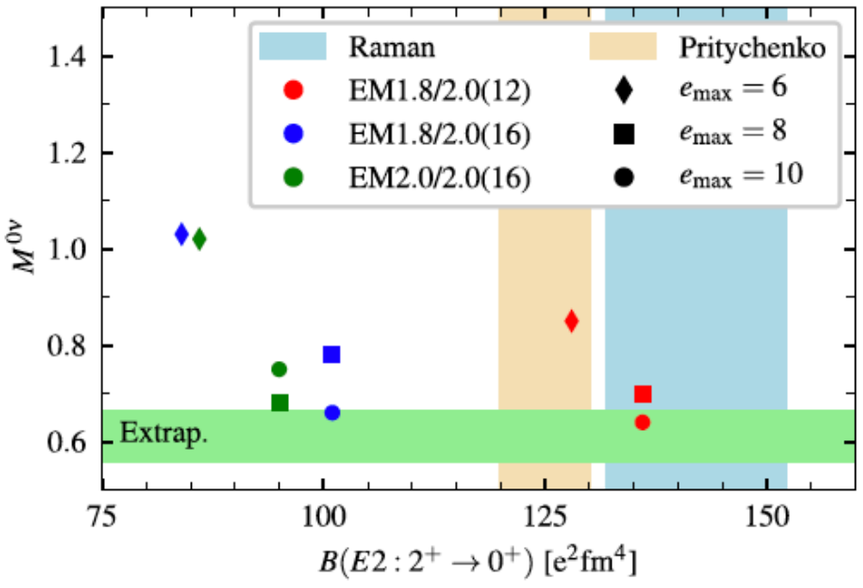
Ab initio calculation of neutrinoless double beta decay

U.S. DEPARTMENT OF ENERGY | Office of Science

NUCLEI Nuclear Computational Low-Energy Initiative

Objectives

- Develop an *ab initio* In-Medium Generator-Coordinate Method (IM-GCM) that merges the In-Medium Similarity Renormalization Group (IMSRG) and the GCM to treat both dynamic and static (collective) nuclear correlations.
- Apply the method to compute the nuclear matrix element (NME) governing the neutrinoless double beta decay of ^{48}Ca to ^{48}Ti, starting from chiral NN+3N interactions.
- Use a novel ensemble normal ordering of the correlated ground states in ^{48}Ca and ^{48}Ti as a reference for the IMSRG evolution.



The NME for the neutrinoless double-beta decay of ^{48}Ca versus the calculated B(E2) value in ^{48}Ti, with different interactions, oscillator frequencies, and cutoffs.

Impact

- A good *ab initio* reproduction of both the spectrum and electric quadrupole transition rates in the deformed nucleus ^{48}Ti — a first in a nucleus this heavy. A proper description of deformation is crucial for an accurate prediction of the NME.
- A computed NME of 0.61, below the predictions of most phenomenological methods.
- A major step towards a first-principles computation of NMEs for the decay of ^{76}Ge, ^{130}Te, and ^{136}Xe. These will greatly facilitate the interpretation of upcoming experiments, the extraction from them of unknown neutrino properties, and the discovery of new physics, with important implications for cosmology and the source of the matter-antimatter asymmetry in the universe.

Accomplishments

Publication: J. M. Yao, B. Bally, J. Engel, R. Wirth, T. R. Rodríguez, and H. Hergert, Phys. Rev. Lett. 124, 232501 (2020)

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