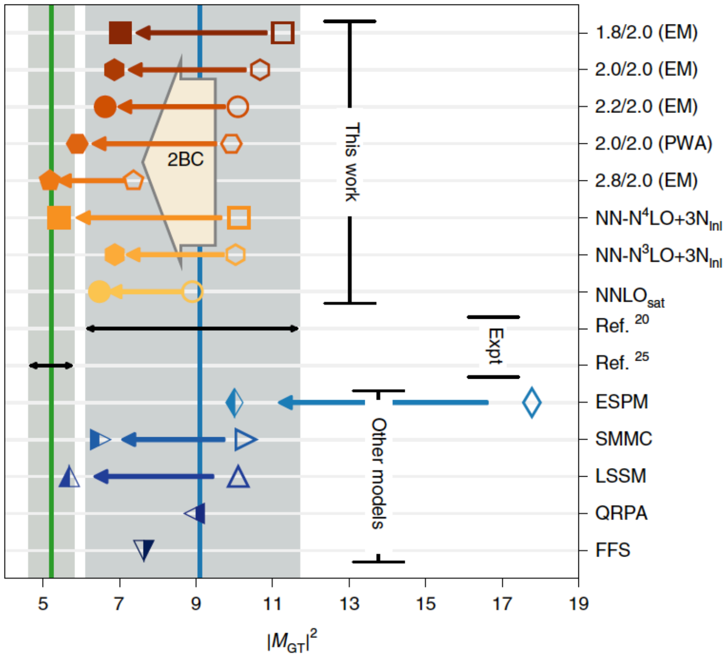
50-year-old puzzle about β-decay rates resolved from first principles

Objectives

- Address the long-standing puzzle of why computations of β-decay rates in atomic nuclei are faster than what's expected from the β-decay of the free neutron
- Utilize state-of-the-art interactions from chiral effective-field-theory and computational methods to address the puzzle
- Explore the role of the coupling of the weak force to two nucleons and of strong correlations in the nucleus

Impact

- β-decay is the dominant decay mode of atomic nuclei
- β-decay rates enter models of heavy element synthesis in neutron star mergers and supernovae explosions
- Understanding β-decay relevant for neutrino-less double-β-decay, to reduce the uncertainty in extracting the neutrino mass scale



Accomplishments

- Resolved the long-standing discrepancy between experimental and theoretical β-decay rates from first principles.
- The coupling of the weak force to two nucleons and a proper treatment of strong correlations in the nucleus are necessary to correctly describe β-decay rates from light nuclei to the heavy nucleus ^{100}Sn

Caption: Gamow–Teller strength in ^{100}Sn. Comparison of the Gamow–Teller strength $|M_{GT}|^2$ for the β-decay of ^{100}Sn calculated in this work compared to experiment (Expt), and other models. Open symbols represent results obtained with the standard Gamow–Teller operator, filled symbols include two-body currents (2BCs) and partially filled symbols show values following from the multiplication of the computed Gamow–Teller strength by a phenomenological quenching factor.

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