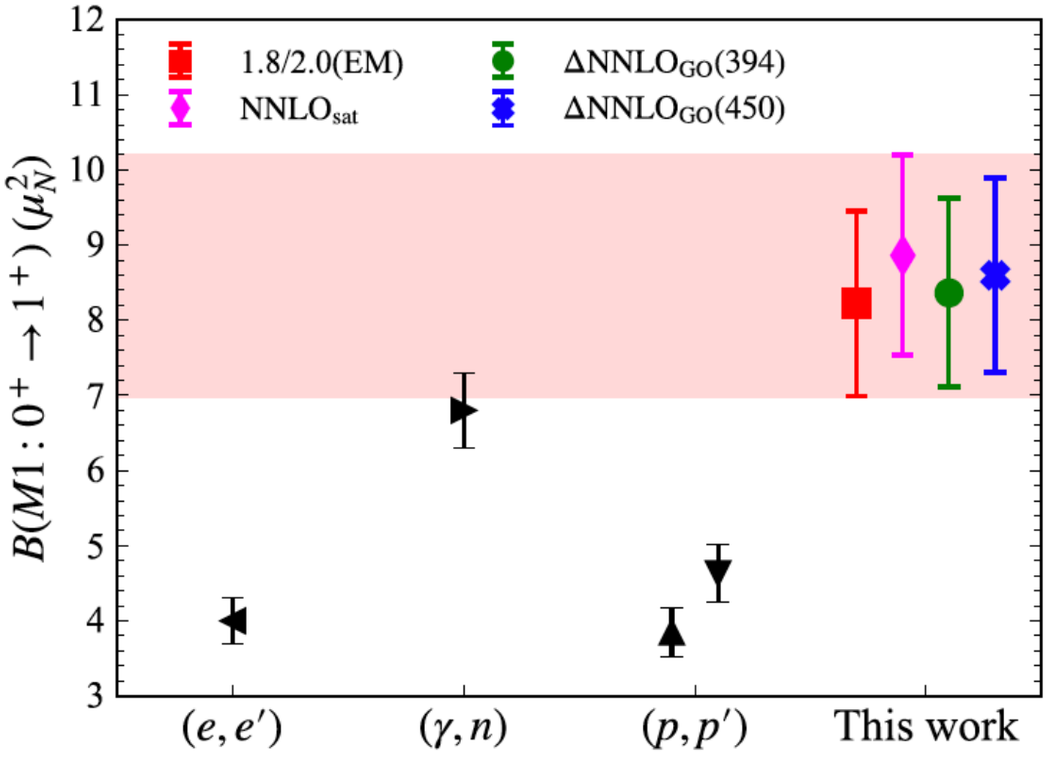
Magnetic excitations of the nucleus ^{48}Ca: theory input to an experimental controversy

U.S. DEPARTMENT OF ENERGY | Office of Science

NUCLEI Nuclear Computational Low-Energy Initiative

Objectives

- There is an experimental controversy regarding the magnetic dipole transition in the nucleus ^{48}Ca. This makes it interesting to see what first principles computations would reveal.
- Resolving the controversy is important because our understanding of magnetic dipole transitions also impacts how physicists model hard-to-pin-down neutrino-nucleus interactions that happen in exploding stars.



The magnetic dipole strength carried by the 1^+ state at 10.23 MeV in ^{48}Ca. Data from electron scattering (e,e'), photon scattering (γ, n) and proton scattering (p,p') experiments are compared to the calculations of this work.

Impact

- Within uncertainties, computations are consistent with the photon scattering (γ, n) experiment.
- Two-body currents, i.e. magnetic transitions that happen while two nucleons interact, do not yield a reduction in the magnetic strength. This is a somewhat unexpected result because similar two-body currents reduce the rates of beta decays.
- The results from the calculations cast some doubts on earlier approaches to neutrino-nucleus scattering that built on the (e,e') scattering data (which saw much smaller magnetic transition strengths).
- The computations put the ball back into the experimenters' court. It is important that the experimental disagreement gets clarified.

Accomplishments

- B. Acharya, B.S. Hu, S. Bacca, G. Hagen, P. Navrátil , T. Papenbrock, Phys. Rev. Lett. 132, 232504 (2024)