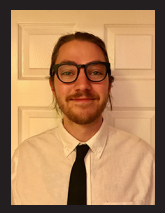
Ab Initio Calculations of Gamow-Teller Strength Functions



The nucleus is an important laboratory for many tests of fundamental physics, but current experimental capabilities are limited. Ab initio nuclear theory seeks to further predictive capability by describing many-body systems starting with nucleon-nucleon scattering data. Prediction of many-body properties, including beta-decay rates, is useful for medical physics, reactor physics, and astrophysical models. Light nuclei provide a proving ground for ab initio calculations.

Recent developments in nuclear theory have made large-scale ab initio calculations possible. Rather than being tuned to phenomenological many-body data, the ab initio framework starts from two-body data to parameterize nucleon-nucleon interactions, and thus boasts a more robust description of many-body physics. Because ab initio calculations can be very costly, we want to be able to predict convergence of our results.

In this work, we compute Gamow-Teller transition strengths (a type of beta-decay probability) using Chiral Effective interactions, a systematic approach to ab initio interactions. Calculations are done in a no-core shell model framework using a configuration-interaction code on HPC machines. With respect to Nmax, the model-space parameter, we explore convergence behavior of GT strengths compared to ground state energies for light nuclei (A < 16). Results indicate that, for nuclei with certain properties, convergence rates may be estimated.

Jordan Fox *and Calvin Johnson*

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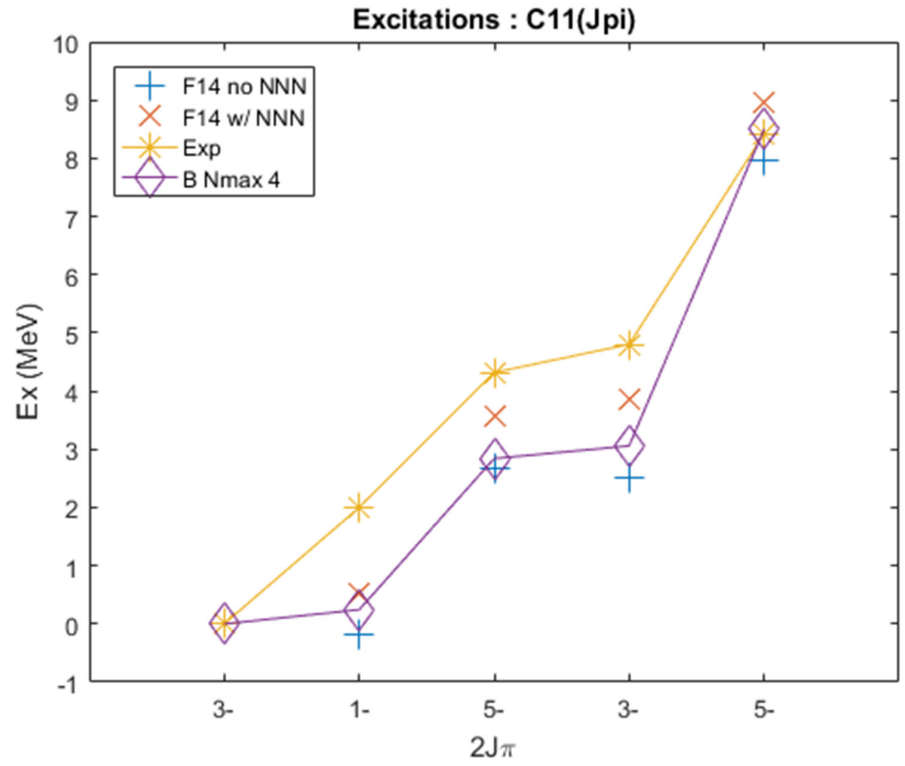
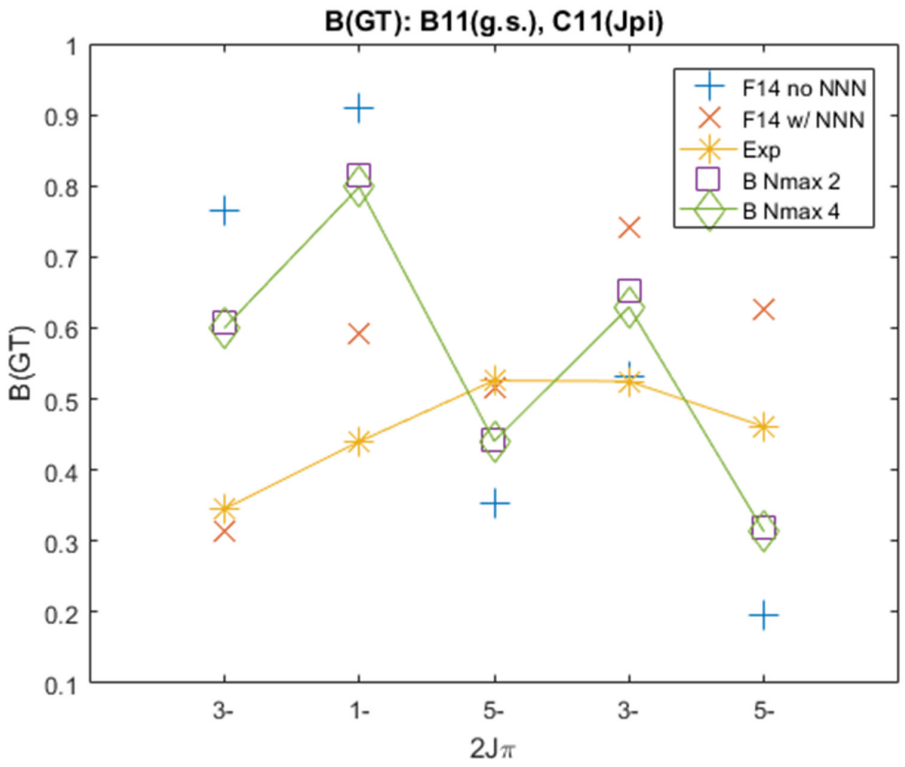


Excitations in Carbon-11 organized by total angular momentum J. My results are labeled ‘B Nmax 4’. ‘F14’ and ‘Exp’ refer to refer to the prediction of other researchers and experiment respectively. NNN refers to the inclusion of a 3-body force, which my calculations do not. This plot confirms I am in the right ballpark for solutions with no NNN component.



Gamow-Teller B-values for the transition Boron-11 to Carbon-11, organized by total angular momentum J of the daughter nucleus. B-values are closely related to probability of the transition to occur. While this plot indicates NNN components are important for predicting B values, my calculations are consistently closer to experiment than other work done using no NNN forces.