SYMPLECTIC NO-CORE CONFIGURATION INTERACTION CALCULATIONS FOR *P*-SHELL NUCLEI

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A long-standing goal of nuclear physics is to quantitatively predict the structure of nuclei and understand their excitation modes *ab initio*, i.e., directly from realistic nucleon-nucleon interactions. However, the nucleus is a complex quantum many-body system governed by strong, short-range interactions. Short-range correlations, tightly-bound alpha clusters and nuclear deformations induce dynamics over differing length and energy scales within the same nucleus. These multi-scale dynamics must be simultaneously described within the framework of the many-body calculation. Consequently, the dimension of the traditional many-body basis (harmonic oscillator basis) in which *ab initio* calculations are carried out explodes as the number of nucleons and their degrees of freedom increases.

To obtain quantitative predictions for nuclei with more than just a few nucleons, we turn to physically adapted bases, to reduce the size of the basis necessary to obtain accurate results. Specifically, we use the symplectic no-core configuration interaction (Sp-NCCI) basis, which encodes the approximate Sp(3,R) symmetry of the nucleus.

In the Sp-NCCI basis, the states are linear combinations of harmonic oscillator configurations over many shells, characterized by Sp(3,R) symmetry. The overwhelming dimension of the traditional basis arises, in large part, because the kinetic energy term in the nuclear Hamiltonian induces a strong coupling between low and high excitation configurations. However, the kinetic energy conserves Sp(3,R) symmetry. Consequently, the contribution induced by the kinetic energy can be captured within a relatively small Sp-NCCI basis.

We present results for *p*-shell nuclei obtained within the Sp-NCCI framework.