Computing the structure of the lightest tin isotopes

**Objectives**

- Determine the structure of the supposedly doubly magic nucleus $^{100}\text{Sn}$ consisting of 50 protons and 50 neutrons and its neighbors
- Tying the structure of this heavy nucleus to nuclear interactions that are constrained only in very light nuclei.
- Compute the $2_1^+$ state in $^{100}\text{Sn}$ as a key indicator for the structure of this nucleus.
- Compute the structure of neighboring isotopes $^{101-105}\text{Sn}$ to lay the ground work for understanding many more short-lived nuclei beyond $^{100}\text{Sn}$

**Impact**

- Doubly magic nuclei such as $^{100}\text{Sn}$ have a simple structure and are the cornerstones for entire regions of the nuclear chart.
- Our results confirm that $^{100}\text{Sn}$ is doubly magic, and the predicted low-lying states of $^{100,101}\text{Sn}$ open the way for shell-model studies of many more rare isotopes.
- Separation energies enter models of nucleosynthesis.

**Accomplishments**

- Prediction that the energy of the $2_1^+$ state in neutron-deficient $^{100}\text{Sn}$ is significantly higher than for neighboring nuclei.
- Finding that $^{100}\text{Sn}$ with charge $Z=50$ and neutron number $N=50$ is a doubly magic nucleus.
- Understanding of the structure of neighboring nuclei opens the way to compute many more isotopes beyond $^{100}\text{Sn}$.
- Validation of nuclear interactions constrained in the lightest nuclei enables predictions for more heavy nuclei.

Caption: Low-lying states in $^{100}\text{Sn}$ computed with the chiral interaction 1.8/2.0(EM) in the EOM-CCSD and EOM-CCSD(T) approximations and compared to LSSM calculations based on phenomenological interactions. The excitation gap of about 4 MeV identifies $^{100}\text{Sn}$ as a doubly magic nucleus, which is more strongly bound than its neighbors.


Contact: T. Morris, morristd@ornl.gov