Spring 2025 Physics Colloquium

Friday, January 24th

3:00 PM

PAS 201 or Zoom

(https://arizona.zoom.us/j/81283840289)

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Ab initio nuclear theory for heavy nuclei and physics beyond the Standard Model

Abstract: Recent breakthroughs in the treatment of the many-body problem in strongly interacting systems, along with an innovative understanding of nuclear forces rooted in Quantum Chromodynamics (QCQ), have led to an "ab initio revolution" in nuclear theory. This paradigm shift allows us to address some of the most exciting questions in nuclear structure, nuclear astrophysics and the frontiers of physics beyond the Standard Model (BSM), starting from only underlying nuclear and weak forces, such as the properties of neutron stars and dense nuclear matter, the origin of the elements in the Cosmos, and the nature of dark matter.

In this talk, I will give a brief conceptual introduction to effective field theory and state-of-the-art quantum many-body approaches, including the in-medium similarity renormalization group and the coupled cluster theory. I will show how recent advances allow us to reach heavy nuclear systems composed of more than 200 strongly interacting particles, where I will highlight the first ab initio predictions of the 208Pb neutron skin and how it links to properties of nuclear matter, and thus neutron stars. I will then focus on recent advances in ab initio calculations of nuclear responses for dark matter direct detection and coherent elastic neutrino-nucleus scattering.

Given their wide-ranging applicability, these methods can also be broadly extended to other many-body problems, such as condensed matter and atomic systems.

**** Refreshments served in PAS 218 at 2:30 PM – 3:00 PM ****

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