

Fall 2023 Colloquium

Department of Physics & Astronomy

Texas A&M University-Commerce

Nov 9, Thursday, 4-5 PM in Science Building 127

(coffee and cookies will be served at 3:50 PM)

Nuclear Physics

Frontiers in ab-initio computations of atomic nuclei

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Dr. Hagen earned BS (1997), MS (2001) degrees in Physics, and a Ph.D. degree (2005) in Physics at the University of Bergen, Norway. His Ph.D. research topic was on theoretical nuclear physics. He started his career at Oak Ridge National Laboratory from 2005. More information about Dr. Hagen and his research can be found at

<https://www.ornl.gov/staff-profile/gaute-hagen>

Abstract

Atomic nuclei exhibit multiple energy scales ranging from hundreds of MeV in binding energies to fractions of an MeV for low-lying collective excitations. Describing these different energy scales within an ab-initio framework is a long-standing challenge. In this talk I will show how we overcome this challenge by using high-performance computing, many-body methods with polynomial scaling, and ideas from effective-field-theory. This progress enables us to address fundamental questions related to the how nucleons organize themselves in shell away from the valley of beta-stability, nuclear deformation and the limits of the nuclear chart, the role of meson-exchange currents and strong correlations in Gamow-Teller transitions, and the nature of the neutrino from computations of neutrino-less double beta decay and lepton-nucleus scattering on relevant nuclei. New ways to make quantified predictions are now possible by the development of accurate emulators of ab-initio calculations. These emulators reduce the computational cost by many orders of magnitude. This allows us to perform global sensitivity analysis, and use novel statistical tools to make quantified predictions for the neutron skin in ^{208}Pb , the binding energy of exotic ^{280} , and what drives deformation in neon and magnesium isotopes. With this talk I hope to convey that the accurate computation of multiscale nuclear physics demonstrates the predictive power of modern ab initio methods.