

Understanding of nuclear structure and stellar processes through nuclear reactions

Remarkable progress has been achieved in nuclear theory over the last 15 years. Development of modern theoretical approaches capable of predicting properties of nuclear systems from first principles, bare nucleon-nucleon interactions, is a paramount step forward. Strong predictive power of advanced theoretical tools, such as Large Basis No Core Shell Model, Greens Function Monte Carlo, Coupled Clusters and Lattice Effective Field theories have been demonstrated for some nuclear systems. However, it is clear that we are only at the beginning of this road and guidance from accurate experimental data is key for further developments. I will discuss how nuclear reactions can provide detailed experimental data on the nuclear structure (focusing on light nuclei with less than 20 nucleons) and serve as a stringent test for the state-of-the-art theoretical calculations.

The role of nuclear reactions in various stellar processes has been recognized since very early days of nuclear physics. However, measuring the reaction rates at energies relevant for stellar environment (where cross section is extremely low) has been notoriously difficult. Additional complication is encountered if the reaction rate of interest involves radioactive nuclide, which is common for explosive processes, such as X-ray bursts or supernova explosions. Development of beams of rare isotopes and new direct and indirect experimental methods allow for significant progress toward understanding of crucial nuclear reaction rates and constraining the astrophysical models.