Abstract for an Invited Paper
for the NWS09 Meeting of
The American Physical Society

Frontiers in Nuclear Theory: From Light Nuclei to Astrophysics

SONIA BACCA, TRIUMF

Nuclear theory today aims at a comprehensive understanding of properties of nuclides in the whole nuclear chart. A number of challenges are encountered by theorists along the road of accomplishing this goal. Recent progresses in many fronts lead to a renaissance of nuclear physics. Advances in effective field theory provide us with a tool to derive nuclear forces starting from the fundamental theory of Quantum-Chromo-Dynamics: two- and three-body forces among nucleons arise naturally and consistently with each other. This complex nature of the nuclear force generates a broad diversity of phenomena, especially in nuclei far from stability. A fascinating example is the arising of halo nuclear structures leading to extremely large radial extensions. Owing to their short lifetimes, most of these nuclei do not naturally exist on Earth. To be studied they must be synthesized in the laboratory, at the so-called radioactive beam facilities, like TRIUMF. Measurements provide a test of the predictive power of theoretical models. Nowadays, thanks to the advent of high performance computing, new ab-initio methods for the solution of the quantum many-body problem become available. Exotic properties of nuclei can be derived directly from the interaction among protons and neutrons. Furthermore, the investigation of astrophysical implications of nuclear processes, e.g. in the nucleosynthesis of elements is another key aspect in nuclear theory. This synergy between nuclear physics and astrophysics makes the scenario even more exciting. I will discuss some advances in the field with emphasis on future perspective.