Physics Colloquium
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Dr. Rituparna Kanungo
Department of Astronomy and Physics, Saint Mary’s University

Unveiling a new era in nuclear science with reaction spectroscopy of rare isotopes

Our Universe has a wide variety of visible matter at the heart of which lie nuclear isotopes that embody the beauty of nature’s strong force combining protons and neutrons into complex systems. While much has been understood about the stable and very long-lived nuclei, the neutron-proton asymmetric, short-lived nuclei, i.e. the rare isotopes, bring a wealth of new information. The reactions and decays of these isotopes drive the creation of majority of the heavy elements in our Universe and are the powerhouse of exotic cosmic phenomena. These short-lived rare isotopes can be produced and energized at selected accelerator facilities and are termed as radioactive ion (RI) beams.

The presentation will outline how reactions with the RI beams are allowing us to uncover the unknown properties of rare isotopes and leading to revelation of unconventional forms of nuclei such as, nuclear halo and skin, their exotic excitation phenomena, and fundamental changes of nuclear shells that break the bounds of our traditional knowledge. The new features in the rare isotopes challenge our understanding of the nuclear force bringing new insight. The presentation will show how experimental observables of rare isotopes are exhibiting sensitivity to the variations from different prescriptions attempting to describe the nuclear force.

The discovery of unconventional features of the rare isotopes forms the guidance to build the true global model of nuclei that will lead to an understanding of the behavior of matter under extreme neutron-rich conditions in our Universe. An outlook will be presented on some future prospects at new generation RI beam facilities that will extend our reach further for accessing rare isotopes in colliding and exploding stars.