Unveiling new features in rare isotopes with direct reactions

Rituparna Kanungo[1,2]*
[1]*Astronomy and Physics Department, Saint Mary's University, Halifax, Canada*
[2]*TRIUMF, Vancouver, Canada*
** email: ritu@triumf.ca*

Abstract

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. Rare isotopes are short-lived nuclei, many of them with highly asymmetric ratios of protons and neutrons that lie far from the line of stability. While much has been understood about the stable and very long-lived nuclei, the rare isotopes, bring a wealth of new information. They bring new insight into the evolution nuclear structure. 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. The unusual features in these isotopes our understanding of the nuclear strong interaction.

These short-lived rare isotopes can be produced and accelerated and are termed as radioactive ion (RI) beams. The presentation will outline how direct reactions with radioactive ion 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 structures and fundamental changes of nuclear shells.

The discussion will describe recent experiments using the low-energy re-accelerated beams at TRIUMF. It will be shown that low-energy inelastic scattering in inverse kinematics provide evidences on resonance states and their charateristics in the Borromean nuclei [1,2]. The finding of deformation in a doubly closed-subshell nucleus at the drip-line will be presented [3]. It will be discussed how the rare isotope studies have shown strong sensitivity to constrain the nuclear force [4].

Explorations to find and characterize the nuclear skin and halos and associated shell changes from measurements of nuclear radii of light nuclei using intermediate and high-energy beams at the in-flight facilities will be presented as well [4-7]. The measurement of interaction cross section yielding the matter radii using the fragment separator at RIKEN will be described to discuss observation to the heaviest Borromean two-neutron halo [7].

References

[1] R. Kanungo et al., Phys. Rev. Lett. 114, 192502 (2015).
[2] J.S. Randhawa et al., Phys. Rev. C 99, 021301(R) (2019).
[3] M. Holl et al. Phys. Lett. B 822, 136710 (2021).
[4] A. Kumar et al., Phys. Rev. Lett. 118, 262502 (2017).
[5] A. Estradé et al., Phys. Rev. Lett. 113, 132501 (2014).
[6] R. Kanungo et al., Phys. Rev. Lett. 117, 102501 (2016).
[7] S. Bagchi et al., Phys.Lett. B 790, 251 (2019).
[8] S. Bagchi et al., Phys. Rev. Lett. 124, 222504 (2020).