



Contribution ID: 701

Type: **Invited Talk for Parallel Sessions (Invitation Only)**

## Exploring new features in rare isotopes through direct reactions

*Thursday, 29 May 2025 16:30 (25 minutes)*

The rare isotopes have ushered a new era in nuclear science unveiling structural features that challenge conventional knowledge. The emergence of exotic features like the neutron halo and neutron skin in neutron-rich nuclei are tied to mutations of the nuclear shell closures that are well established from our knowledge of stable nuclei. This raises questions on our complete understanding of the strong nuclear force of nature that binds visible matter. The properties of these exotic nuclei guide our understanding on the state of matter in extreme neutron-rich systems in our Universe. The reactions and decays of these isotopes drive the creation of majority of the heavy elements in our Universe .

The presentation will outline how reactions with rare isotope beams at different energy scales are allowing us to unveil unexpected new features in rare isotopes. This is 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 characterization of low-energy excited states in neutron-rich nuclei with nucleon transfer reactions and inelastic scattering using a solid H<sub>2</sub>/D<sub>2</sub> target at TRIUMF will be presented. The exploration of radii around  $N = 14 - 16$  in neutron-rich isotopes at RIKEN-RIBF will be presented showing the appearance of exotic structures and their relation to shell evolution.

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**Session Classification:** Parallel Session

**Track Classification:** Nuclear Reactions