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Spectroscopy of rare isotopes with direct reactions

Rare Isotopes located far from the valley of stability bring new insight into the evolution nuclear structure. Our knowledge on the properties of neutronand proton-rich nuclei guide our understanding of the state of matter in extreme neutron-rich systems such as neutron stars and supernovae and heavy element synthesis. The presentation will outline how radioactive (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 structures and fundamental changes of nuclear shells that break the bounds of our traditional knowledge. The discussion will show examples of how low-energy re-accelerated RI beams from the Isotope Separator Online (ISOL) facility at TRIUMF are used to study Borromean nuclei at the drip-lines to uncover features of soft dipole resonance in the halo nucleus, 11Li and unbound excited states in other light Borromean nuclei.

The new features of the rare isotopes challenge our understanding of the nuclear force bringing new insight. It has been a century-long challenge to understand the nuclear force between protons and neutrons forming manybody nuclei, from the fundamental basis of quantum chromodynamics (QCD). The formulation of the chiral effective field theory has paved the closest link with QCD making it possible to predict some observable properties of many-body nuclei. The presentation will show selected examples from recent achievements of how observations with rare isotopes compare with ab initio theoretical predictions with chiral forces demonstrating high sensitivity to refine our understanding of the nuclear interaction.

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