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Exotic nuclei explored at in-flight separators

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Abstract

In-flight separators have played a significant role in the physics of exotic nuclei. In the last decade, in particular, this field has expanded rapidly with the advent of the new-generation (3rd-generation) in-flight-separator facility, the RI-beam Factory (RIBF) at RIKEN that was commissioned in 2007. In addition, new experimental methods, techniques and state-of-the-art detectors at in-flight separators have developed rapidly, which has contributed considerably to this progress. One can now reach very far from the stable nuclei towards the drip lines, and even beyond in some cases. Hundreds of new isotopes have been identified, and new exotic isomers have been observed. β decays and relevant γ decays, including isomeric states, have clarified many new aspects of nuclear structures. A variety of direct reactions, making the best use of in-flight rare isotope (RI) beams at intermediate/high energies, have been applied for a wide range of rare isotopes. New experimental results using these methods have shown that one needs a new framework to understand structures and dynamics of exotic nuclei, such as new or lost magic numbers, novel neutron halo/skin structures and relevant reactions/excitations. A wide range of reactions associated with nucleo-synthesis in the Universe and the equation of state (EoS) of neutron-rich nuclear matter have also been studied through experiments using rare isotopes available at in-flight separators. This review article focuses its attention on how recent experimental techniques have been developed and applied to exotic nuclei at in-flight separators. We also make remarks on prospects for the near future: in the era when the 3rd-generation RI-beam facilities based on in-flight separators are being completed world-wide.

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