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Spectroscopy of Neutron-Rich Nuclei Produced in Multinucleon Transfer Reactions at KISS

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Multinucleon transfer (MNT) reactions have recently gained renewed interest as they provide access to heavy neutron-rich (n-rich) nuclei, particularly around N = 126 and actinides, which are relevant to r-process nucleosynthesis [1]. They produce a wide variety of nuclides around both the projectile and the target, with a wide distribution of angles and energies, requiring the development of experimental techniques to collect, separate, and identify the reaction products of interest. In particular, exotic nuclei far from the projectile or target are produced so infrequently that they can get buried among more abundant reaction products. Furthermore, for short-lived nuclei of less than a few minutes, rapid separation becomes important.

We are developing the KEK Isotope Separation System (KISS) at the RIKEN Nishina Center, which focuses on the extraction of MNT reaction products [2]. It is an argon-gas-cell-based laser-ion-source coupled with an isotope separator on-line system. The MNT reaction products are thermalized and neutralized in argon gas, element-selectively ionized, and mass-separated by a magnetic field. We perform decay, mass, and laser spectroscopy of n-rich nuclei of refractory elements around the N = 126 region. A multi-reflection time-of-flight mass spectrograph is used for high-precision mass measurements and unique identification of isobars. Recently, research has been extended to mass spectroscopy of n-rich actinides by using a 238U beam.

We will report on the experimental methods and results of KISS, as well as our next plan for further n-rich regions.
[1] Y.X. Watanabe et al., PRL 115, 172503 (2015).
[2] Y. Hirayama et al., NIM B 353, 4 (2015).

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