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Production and Identification of Neutron-Rich Isotopes Beyond N=126 Using 238U Projectile Fragmentation at the RIBF BigRIPS Separator

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Next-generation in-flight radioactive isotope (RI) beam facilities, including the RIKEN Radioactive Isotope Beam Factory (RIBF), the Facility for Rare Isotope Beams (FRIB), and the upcoming Facility for Antiproton and Ion Research (FAIR), primarily use two reaction mechanisms: in-flight fission for medium-mass neutron-rich isotopes and projectile fragmentation for high-purity RI beams near the projectile. The BigRIPS superconducting in-flight separator [1] at RIBF has become a global leader in RI-beam production, combining high-intensity heavy-ion beams with outstanding separation capabilities, resulting in the discovery of nearly 200 new isotopes.

Producing heavy neutron-rich isotopes around and beyond the neutron magic number N=126 remains challenging due to high atomic numbers, multiple charge states, and low production cross sections. To overcome this, we recently produced neutron-rich isotopes with Z=80–90 via projectile fragmentation of a 345 MeV/u U beam on a beryllium target, supported by advanced detectors and detailed simulations. For in-flight separation, the – method was used, where is the magnetic rigidity and is the energy loss in degraders. Angular slits effectively suppressed fission fragments by exploiting their broader angular distributions. Careful charge-state selection before and after BigRIPS focal planes ensured high transport efficiency and purity.

Particle identification was performed using the TOF– method [2], where TOF is time-of-flight. A newly developed xenon-filled ionization chamber [3] enabled precise measurements and accurate identification in the heavy mass region. As a result, neutron-rich isotopes in the Z=80–90 region were successfully produced, separated, and identified, providing essential data for future studies of nuclei beyond N=126. This presentation will highlight these results and the optimized separation and identification techniques developed with BigRIPS.

[1] T. Kubo, Nucl. Instr. Meth. B 204, 97 (2003).
[2] N. Fukuda et al., Nucl. Instr. Meth. B 317, 323 (2013).
[3] M. Yoshimoto et al., Prog. Theor. Exp. Phys. ptaf063, 2025.

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