Physics with Heavy Neutron−Rich RIBs at the HRIBF*

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We have performed an experiment using neutron−rich radioactive ion beams from the HRIBF facility, together with the CLARION Ge detector array and the HyBall CsI charged−particle detector array. A foil−plus−multichannel−plate detector was also placed at the achromatic focus of the Recoil Mass Spectrometer [1] and used to detect recoiling reaction products.

A beam of ^{118}Ag ($T_{1/2}$ ~2 s for ^{118m}Ag, $T_{1/2}$ ~4 s for ^{118g}Ag) was produced by proton−induced fission of ^{238}U, and accelerated to 455 and 500 MeV in the tandem accelerator. These energies required the use of the second stripping foil in the high−energy beam tube, but beam intensities on target of approximately10^6 ^{118}Ag ions per second were obtained. The data collected consisted of γ−HyBall coincidences, together with γ−γ−recoil coincidences where the recoil was detected in the multichannel−plate detector. The overall efficiency for detecting such products was about 40%.

Two different reactions were used. Firstly, a target of 0.6 mg/cm^2 ^{12}C was bombarded at 500 MeV. Fusion−evaporation reactions leading to the known nuclides ^{125,126}I [1] (5n and 4n evaporation) and ^{126}Te (p3n) were observed, together with α3n evaporation to previously unobserved states in ^{123}Sb. Also observed were inelastic scattering events, where a scattered ^{12}C from the target was detected with HyBall in coincidence with a γ ray detected in CLARION. Inelastic excitation of the first 2^+ state of ^{118}Sn, from a weak (approx. 5%) isobaric contamination of the beam can be clearly identified in the carbon−gated spectrum, suggesting an excellent means of performing Coulomb−excitation B(E2) measurements of RIBs in future experiments. In the γ−γ−recoil events, levels up to the known [2] $31/2^-$ state of ^{125}I were observed.

Secondly, a target of 1.25 mg/cm^2 ^{9}Be was bombarded at a beam energy of 455 MeV in an attempt to observe new levels in the 4n−evaporation product, ^{123}Sb. The γ−γ spectrum observed in coincidence with recoils was virtually identical to the α−gated γ−ray spectrum from the C target, confirming the assignment of the peaks to ^{123}Sb. With the Be target, a large number of α particles from incomplete fusion were also observed in the HyBall array.

Results from this test experiment, and plans for future measurements with Sn and Te neutron−rich radioactive beams, will be presented.

[1] C.J. Gross *et al.,* Nuclear Instrum. and Methods, **A450** (2000) 12.
[2] D.J. Hartley *et al.*, private communication.

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