Search for Borromean halo structure in the *Island of Inversion*

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With large neutron-to-proton ratios far from the line of stability, nuclei develop exotic structures such as neutron skin and halo. Halo nuclei show unexpected behaviour, such as, large interaction cross section which in turn, points to large matter radius [1] and narrow momentum distribution of the valence neutrons. In this context, nuclei with two neutron halo are interesting systems to understand the correlation between the two halo neutrons and the core. Borromean nuclei are such systems where the nucleus is bound with two halo nucleons but the combination of core and one halo nucleon is unbound. Two-neutron halos in Borromean nuclei have been identified along the dripline in the *p-sd* shell in ^{6}He, ^{11}Li, ^{14}Be, ^{17,19}B and ^{22}C but its occurrence in the region beyond the *sd*-shell has not been fully investigated. In the *Island of Inversion* region where the breakdown of N=20 shell closure occurs, one-neutron halo was found in ^{31}Ne [2].

We performed an experiment using the BigRIPS fragment separator [3] and the ZeroDegree Spectrometer (ZDS) at the RIKEN facility in Tokyo, Japan to explore the structure of the Borromean N=20 nucleus ^{29}F. A beam of ^{29}F was produced from the fragmentation of primary ^{48}Ca beam with a Be production target. The primary beam energy was about 345 MeV/u. The BigRIPS fragment separator and particle detectors were used to separate ^{29}F from the contaminants. We have identified ^{29}F on an event-by-event basis and the particle identification plot before the reaction target is shown in Fig. 1a. A carbon

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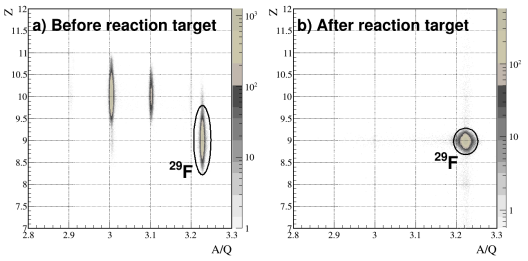

FIG. 1: a) Particle identification spectrum before the reaction target at focal plane F8 of BigRIPS. b) Particle identification spectrum after the reaction target at the final focus F11 of the ZDS. This spectrum is obtained with the gate on ^{29}F before the reaction target. Particle identification was performed using Bρ-ToF-ΔE measurement.

reaction target having thickness of 2.01 g/cm^2 was placed at the F8 focal plane to measure the interaction cross section.

The ZDS was used to transport and identify the unreacted ^{29}F and other fragments at the final achromatic focus F11. At the F11 focal plane, there was another carbon target (2.5 g/cm^2 thick) which was used to measure the charge-changing cross section to obtain the root-mean-square radius of the proton distribution. The proton radii have been derived from charge-changing cross sections, measured previously for B [4], C [5], and N [6] isotopes at GSI, Germany.

The matter radius can be obtained from the measured interaction cross section. The radii are obtained from the cross sections through finite range Glauber model analysis of the reaction. From the combined values of matter and proton radii one can evaluate the neutron-skin thickness for neutron-rich nuclei. Details of the experimental setup, analysis procedures and new preliminary results for the ^{29}F isotope will be presented.

References

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