In-beam γ-ray spectroscopy of ^{100}Sn

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The heaviest self-conjugate nucleus, ^{100}Sn, has long attracted attention due to its unique nucleon numbers for protons and neutrons on the proton drip-line and the path of the astrophysical rapid proton capture process. Investigating the magicity of ^{100}Sn and the single-particle structure of its neighboring nuclei is crucial for advancing our understanding of nuclear forces and nucleosynthesis. Currently, ^{100}Sn is best reached at in-flight separation facilities through the fragmentation of a ^{124}Xe beam. The decay properties of the ^{100}Sn have been studied in detail at GSI, NSCL, and RIBF.[1–3] To further explore its excited states and mass properties, experiment NP2112-RIBF211, designed for simultaneous in-beam γ-ray and mass spectroscopy of ^{100}Sn, was conducted in June 2024. In this report, the in-beam γ-ray spectroscopy part of the experiment will be briefly introduced.

In the experiment, a ^{124}Xe primary beam at 345 MeV/nucleon was provided by SRC with an average intensity of 120 particle nA. The primary beam was directed onto a 4-mm-thick ^{9}Be target, producing neutron-deficient tin isotopes. The BigRIPS separator was tuned to center on ^{101}Sn, while simultaneously accepting ^{102}Sn. At the F8 focal plane, the average beam intensities of ^{101}Sn and ^{102}Sn were approximately 1.6 pps and 35 pps, respectively. The layout of the in-beam setup at F8 is shown in Fig. 1. A 35-mm-thick CRYPTA liquid hydrogen target[4] was employed to induce the 1n- and 2n-removal reactions from ^{101}Sn and ^{102}Sn. The beam energies before and after the target were approximately 210 MeV/nucleon and 140 MeV/nucleon, respectively. The γ rays emitted in-flight from the reaction products were detected using the high-efficiency DALI2^{+} array.[5] The beam particles and reaction residues were identified in BigRIPS and ZeroDegree spectrometers on an event-by-event basis via the Bρ-ToF-ΔE method.

The particle identification (PID) of BigRIPS and ZeroDegree is shown in Fig. 2. The ZeroDegree PID was obtained after selecting ^{101}Sn and ^{102}Sn in BigRIPS (without DALI2^{+} γ-ray gate). Over the 205 hours of data acquisition, around 1000 ^{100}Sn nuclei were identified from the ^{101}Sn$(p,pn)^{100}$Sn and ^{102}Sn$(p,p2n)^{100}$Sn knockout reactions. Detailed analyses of γ-ray spectroscopy and cross sections are still on-going.

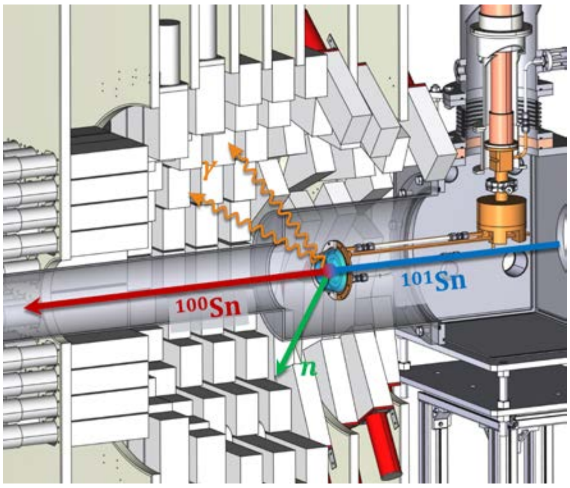

Fig. 1. Layout of the setup for in-beam γ-ray spectroscopy at F8 with a diagram of the ^{101}Sn$(p,pn)^{100}$Sn reaction in the liquid hydrogen target.

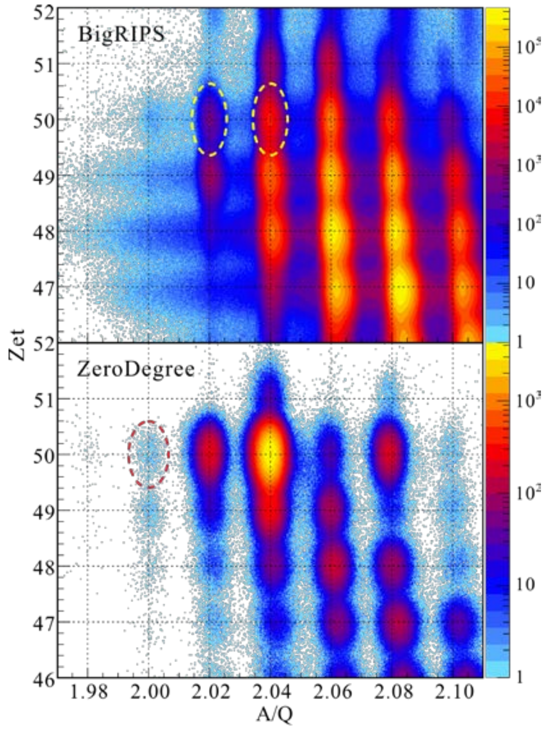

Fig. 2. Particle identification (PID) of BigRIPS (top) and ZeroDegree (bottom). ^{101,102}Sn in BigRIPS and ^{100}Sn in ZeroDegree are circled by dotted lines.

References
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