

Beta-decay studies of neutron-deficient Sn isotopes

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Studies of nuclei in the ¹⁰⁰Sn region offer the possibility to test nuclear models describing structure and decay properties of nuclei in which protons and neutrons occupy identical orbitals near a double shell closure. An insight into the structure of nuclei close to ¹⁰⁰Sn can be gained by studying their β decay which is dominated by $\pi g_{9/2} \rightarrow \nu g_{7/2}$ Gamow-Teller (GT) transitions. An attractive feature of such nuclei is that most of the GT strength lies within the Q_{EC} -value window. Such a concentration of strength has recently been observed in a series of light indium and silver isotopes (see [1] and references therein). ¹⁰⁰Sn has been predicted to decay by one GT transition to a single 1^+ 1p-1h state in ¹⁰⁰In at an excitation energy of about 1.8 MeV, while the closest even-even neighbours of ¹⁰⁰Sn, ⁹⁸Cd and ¹⁰²Sn, show a spreading of the GT strength over a number of 1^+ states in the daughter nucleus.

In the recent experiments at the GSI-ISOL facility we used the FEBIAD-B3C ion sources with the addition of CS₂ [2] for the mass separation of SnS⁺ ions. In this way routinely about 60% of the intensity of the Sn⁺ beam was shifted to the SnS⁺ molecular side-band, where the strong suppression of contaminants [2] cleaned the beams from In, Cd, and Pd isobars. Only the strongly produced activities of Ag were traced in on-line experiments, the suppression of which was 4-5 times lower than the anticipated value of 10⁴ found in off-line studies. The latter effect may be due to an operation of the ion source at lower temperature compared to the off-line measurement, which was made to enhance the SnS⁺ intensity. We measured β - γ - γ decay properties of ^{101–105}Sn with two complementary set-ups, namely (i) the Total Absorption Spectrometer (TAS) for the measurement of GT strength distributions and (ii) an array of germanium detectors (including a FZR-Cluster and two GSI-Clover detectors) operated in coincidence with silicon β -detectors. β -delayed protons of ¹⁰¹Sn were measured by using ΔE -E silicon telescopes. The intensities of the mass-separated ^{101–105}Sn beams were obtained from the experimental decay properties. By using a 40 particle-nA ⁵⁸Ni beam, a 3 mg/cm² ⁵⁰Cr target, and a catcher of ZrO₂ fibers inside the FEBIAD source, we reached secondary beam intensities given in Table 1. These values are about one to two orders of magnitude higher than those obtained by a previous FRS experiment [3].

The data on the ¹⁰²Sn decay collected with the high resolution set-up (ii) as well as spectra obtained by the small germanium detector in the TAS confirm the main features of the ¹⁰²Sn decay scheme proposed by Stolz [3] on the basis of an FRS experiment. The main difference is that we do not confirm the 53 keV transition (see Fig. 1), which was previously [3] placed at the very bot-

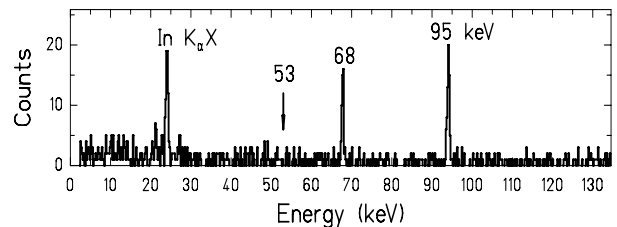


Figure 1: Low energy γ -ray spectrum obtained for mass 102. An arrow shows the expected position of the 53 keV line which remained unobserved in this experiment.

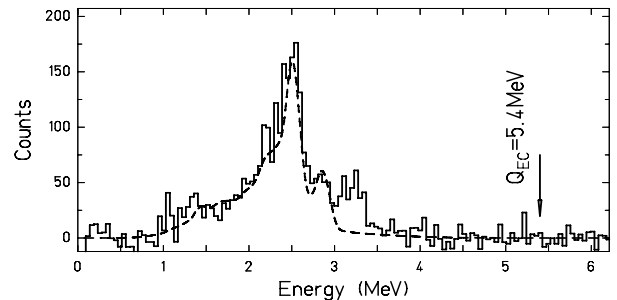


Figure 2: Beta-gated TAS spectrum of ¹⁰²Sn from the experiment (solid line) and from a GEANT simulation based on the modified level scheme of Ref. [3] (dashed line).

tom of the ¹⁰²In level scheme. Removing this transition from the decay scheme may affect the spin assignment of the ground state of ¹⁰²In. Figure 2 presents the β -gated TAS spectrum of ¹⁰²Sn after subtraction of contributions from daughter activities which were determined in separate measurements. The maximum occurring at a recorded TAS-energy of about 2.5 MeV is interpreted as being due to the $\pi g_{9/2} \rightarrow \nu g_{7/2}$ GT resonance at a ¹⁰²In excitation energy of about 1.5 MeV.

In summary, the development of SnS⁺ beams at the GSI ISOL allowed us to study in detail the β -decay properties of ^{101–105}Sn. These data, in particular those on β - γ - γ coincidences, are under evaluation. An extrapolation of the experimental beam intensities, yields 8 atoms/h for ¹⁰⁰Sn indicating that the measurement of β -delayed γ rays of this nucleus will indeed be a very challenging task.

References

- [1] C. Plettner *et al.*, Phys. Rev. **C66**, 044319 (2002)
- [2] R. Kirchner, Nucl. Instr. and Meth. B, in print, and www.gsi.de/annrep2001 (page 211)
- [3] A. Stolz, Ph.D. Thesis, TU München (2001)

Table 1: Measured ISOL rates of the ^{101–105}Sn isotopes.

Isotope	¹⁰¹ Sn	¹⁰² Sn	¹⁰³ Sn	¹⁰⁴ Sn	¹⁰⁵ Sn
atoms/min	2.4	31	$1.4 \cdot 10^3$	$3.0 \cdot 10^4$	$2.0 \cdot 10^5$