# Beta decay of $^{103}$Sn

O. Kavatsyuk[1,2], M. Kavatsyuk[1,2], J. Döring[1], L. Batist[3], A. Banu[1], F. Becker[1], A. Blazhev[1,4], W. Brüchle[1], T. Faestermann[5], M. Górska[1], H. Grawe[1], Z. Janas[6], A. Jungclaus[7], M. Karny[6], R. Kirchner[1], M. La Commara[8], S. Mandal[1], C. Mazzocchi[1], I. Mukha[1], C. Plettner[1], A. Płochocki[4], E. Roeckl[1], M. Romoli[8], M. Schädel[1], R. Schwengner[9] and J. Żylicz[6]

[1]GSI, Darmstadt, Germany; [2]Kiev National University, Ukraine; [3]St. Petersburg Nuclear Physics Institute, Russia; [4]University of Sofia, Bulgaria; [5]Technische Universität München, Germany; [6]University of Warsaw, Poland; [7]Instituto Estructura de la Materia, CSIC, and Departamento de Fisica Teórica, UAM Madrid, Spain; [8]Universitá di Napoli, Italy; [9]Forschungszentrum Rossendorf, Germany

Doubly closed-shell nuclei and neighbouring isotopes/isotones provide a sensitive test ground for the nuclear shell model. $^{100}$Sn is the heaviest doubly-magic N=Z nucleus, located at the proton drip line, where protons and neutrons occupy identical shell-model orbitals. The overlap of their wave functions is large, which further causes a strong proton-neutron interaction to be expected. Beta decay in this region is dominated by an allowed Gamow-Teller (GT) transformation $\pi g_{9/2} \rightarrow \nu g_{7/2}$, which in the decay of an even-even nucleus populates the $I^{\pi} = 1^{+}$ GT resonance. For an odd-neutron parent nucleus the coupling of this resonance to the unpaired nucleon can be studied. This provides a test of the residual interaction via the $\beta$-delayed $\gamma$-ray spectroscopy.

Measurements of $\beta$-delayed $\gamma$-rays and protons were performed at the GSI-ISOL facility for $^{101,103,105}$Sn. It was essential for this experiment to efficiently suppress the isobaric indium, cadmium, silver and palladium contaminants by using the novel sulphurisation technique [1]. The $\beta$-delayed $\gamma$-ray spectra were measured with an array of high-resolution germanium detectors (17 crystals) in grow-in mode as well as with the Total Absorption Spectrometer (TAS) in decay mode. Moreover, $\Delta$E-E telescope was used to record $\beta$-delayed protons [2, 3]. Further experimental details are given in refs. [1-3].

We report on the new data for the $\beta$ decay of $^{103}$Sn. In Fig. 1 the $\beta$-gated $\gamma$-ray spectrum for $^{103}$Sn, taken at mass A=103+32 with the germanium array, is shown. The 720, 726 and 740 keV lines are known to belong to the decay of the $^{103}$In daughter activity [4]. The 1077 keV line has been identified by in-beam spectroscopy [5] to represent the $11/2^{+} \rightarrow 9/2^{+}$ transition in $^{103}$In. The data shown in Fig. 1 yield the first evidence for $\beta$-delayed $\gamma$-rays of 643, 821, 1077, 1356, 1397 and 1428 keV, which are preliminarily assigned to the decay of $^{103}$Sn. The TAS spectrum gated by protons is shown in Fig. 2. The 776 and 776+1022 keV lines correspond to the $2^{+}$ state in $^{102}$Cd fed by $\beta$-delayed protons after a $EC$ and $\beta^{+}$-decay of $^{103}$Sn, respectively. Based on these data, a $\beta^{+}/EC$ ratio of 0.06 for the proton emission to the $2^{+}$ state in $^{102}$Cd was estimated. A corresponding ratio of 0.6 for the proton emission to the ground state in $^{102}$Cd was obtained using a proton-$\gamma$ anti-coincidence condition. The $Q_{EC}$ value of $^{103}$Sn was preliminarily determined from these $\beta^{+}/EC$ ratios and the average energy of $\beta$-delayed protons [6] to be 7.5±0.5 MeV.

The half-life of $^{103}$Sn, obtained from the $\beta$-delayed proton time distribution, is shown in the inset of Fig. 2. The result of the fit being $T_{1/2} = 7.0 \pm 0.6$ s is in agreement with the previously measured values of 7±3 s [6], 7.5±1.5 s [7] and in disagreement with 8.7±0.6 s [8] by two standard deviations.

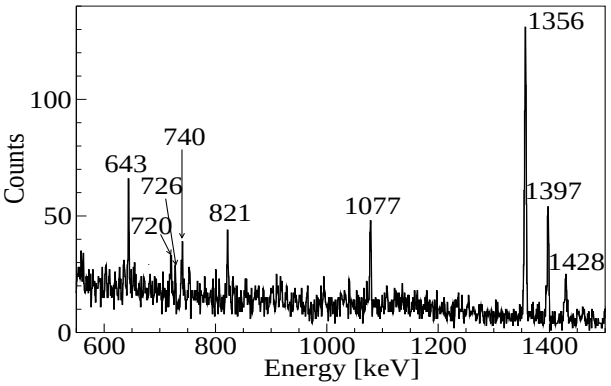


Figure 1: Gamma-ray spectrum obtained for mass A=103+32 in coincidence with positrons. The strongest lines are marked by their energies in keV.

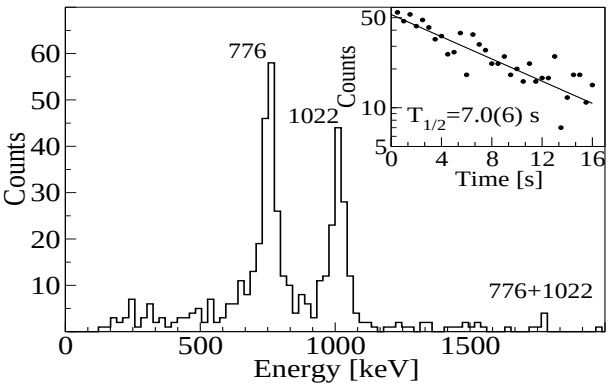


Figure 2: TAS spectrum taken in coincidence with $\beta$-delayed protons from the $^{103}$Sn decay. The inset shows the time characteristic of $\beta$-delayed protons.

## References

[1] R. Kirchner, Proc. Conf. to EMIS-14, NIM A, in print
[2] M. Karny *et al.,* contr. GSI Sci. Rep. 2002
[3] I. Mukha *et al.,* contr. GSI Sci. Rep. 2002
[4] J. Szerypo *et al.,* Z. Phys. A 359 (1997) 117
[5] J. Kownacki *et al.,* Nucl. Phys. A627 (1997) 239
[6] P. Tidemand-Petersson *et al.,* Z. Phys. A 302 (1981) 343
[7] K. Rykaczewski, Report GSI-95-09, 1995
[8] A. Stolz, Ph.D. Thesis, TU München (2001)