BETA DECAY OF EXOTIC NUCLEI CLOSE TO ^{100}Sn: ^{94}Ag AND ^{100}In*

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(Received December 2, 2002)

The β decay of the proton-rich nuclei ^{94}Ag and ^{100}In was investigated at the GSI on-line mass separator by using different arrays of Ge and Si detectors, as well as a total absorption spectrometer (TAS). The preliminary analysis of the $\beta\gamma\gamma$ coincidences in case of ^{94}Ag confirms the existence of all γ rays observed in a previous measurement and forms the basis for an improved decay scheme. In the case of ^{100}In, the population of states up to the 8^+ yrast state in ^{100}Cd has been identified from $\beta\gamma\gamma$ coincidences. The experimental β feeding measured in the TAS is compared to predictions of large-scale shell-model calculations, which favour a spin and parity of 6^+ for the ^{100}In ground state.

PACS numbers: 21.10.Tg, 23.20.Lv, 23.40.–s, 21.60.Cs

1. Introduction

Exploring nuclei in the upper proton $g_{9/2}$ shell close to ^{100}Sn gives the opportunity to observe the phenomena generated by the residual hole–hole proton–neutron interaction, resulting in the occurrence of spin-gap isomers (*e.g.* ^{95}Pd, $J^\pi = 21/2^+$ [1] and tentatively ^{94}Ag, $J^\pi = 21^+$) [2]. Beta decay is a powerful tool to investigate these structural phenomena, and ^{94}Ag and ^{100}In nuclei, although very exotic, are still accessible to detailed $\beta\gamma\gamma$ spectroscopy in connection with the ISOL technique.

* Presented at the XXXVII Zakopane School of Physics "Trends in Nuclear Physics", Zakopane, Poland, September 3–10, 2002.

2. ^{94}Ag

The ^{58}Ni(^{40}Ca,1p3n) reaction was used to produce ^{94}Ag nuclei. The 4.78 MeV/u ^{40}Ca beam was delivered by the UNILAC accelerator of GSI Darmstadt. The reaction recoils were stopped inside a catcher of a FEBIAD B3C ion source, which possesses excellent release properties for silver while palladium is strongly suppressed by trapping in the two cold pockets [3]. After ionisation and extraction from the ion source, the $A = 94$ secondary beam was implanted into a tape which moved every 9.6 s. The implantation point was surrounded by an array of Si detectors [4], with a β efficiency of 65% and an array of Ge detectors, comprising a Cluster, two Clovers and two single Ge crystals, with a photopeak efficiency of 3.3% for a γ-ray energy of 1.33 MeV. The segmentation of the β detector will allow us in the offline analysis to reject such events where positrons and γ rays hit the same Ge detector, and thus to improve the peak to background ratio. Furthermore, the Si detectors can be used for detecting β-delayed protons which are expected in this case within an energy window of 10 MeV [5]. Thus, the use of this detector represents a considerable improvement with respect to the previous experiment [2]. The total measuring time amounted to a total counting time of 80 h.

Events with $\beta\gamma$ and $\beta\gamma\gamma$ coincidences were sorted and partially analysed. The sum spectrum of 16 Ge crystals (one crystal was not used in the present analysis) in coincidence with positrons is shown in Fig. 1. The positron

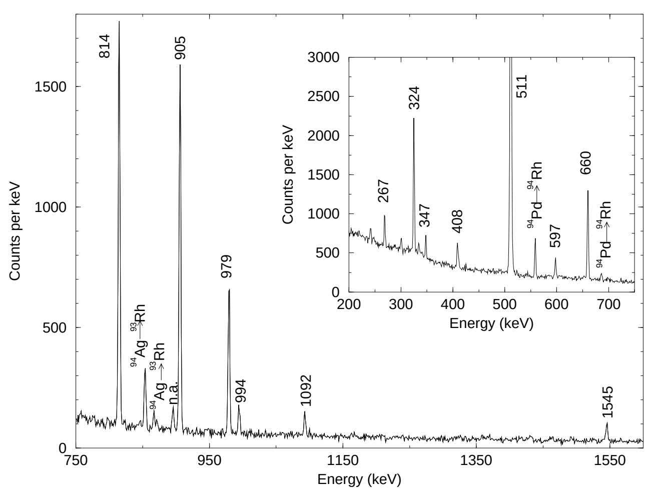

Fig. 1. Beta-gated γ spectrum measured at mass 94. The transitions labelled with their energy in keV belong to the daughter nucleus ^{94}Pd. The line marked by “n.a.” has not yet been assigned.

energy-loss condition was set in the range of 320 to 6080 keV. We improved the statistics in the $\beta\gamma\gamma$ matrix by a factor of 3 with respect to the previous experiment [2]. All the γ rays reported in [2] could be confirmed, including the weak 597 and 1545 keV transitions, which makes the existence of the tentative 21^+ isomer still plausible. As seen in Fig. 1, two transitions were observed at 853 and 866 keV which have been assigned to ^{93}Rh from previous in-beam experiments [6]. These transitions are present also in the projection of the $\beta\gamma\gamma$ matrix and could be associated with the β-delayed proton decay of ^{94}Ag, but clear evidence is awaited from the proton analysis. The data analysis is in progress.

3. ^{100}In

^{100}In was produced via the ^{50}Cr(^{58}Ni,$\alpha p3n$) reaction. The reaction recoils were stopped inside a graphite catcher of a thermal ion source which guarantees sufficient selectivity for indium [7]. After ionisation and extraction from the ion source, the beam delivered by the GSI mass separator was directed to the Ge high-resolution setup (similar to that discussed in the previous section) or to the total-absorption spectrometer (TAS) [8]. The high-resolution setup comprised 12 Ge crystals having a photopeak efficiency of 2.7%. The experimental details have already been described in [9]. By inspecting $\beta\gamma\gamma$ data originating from the high-resolution experiment, we could observe the population of states of 8^+ ($E = 2548$ keV) and 6^+ ($E = 2096$ keV, 2458 keV) in the daughter ^{100}Cd nucleus. The issue is how to correlate this information with the spin and parity of the parent state. If the γ-ray balance deduced from the high-resolution experiment were used, the resulting "apparent feeding" would be ambiguous, since it includes β feeding and unobserved γ feeding as well. A more reliable and complementary way to inspect the β feeding is to measure the ^{100}In activity in TAS. The procedure of deriving the β-intensity distribution from the experimental spectra is described in [10]. The β-intensity distribution deduced from TAS is shown in the upper panel of Fig. 2. It is seen from the figure, that for low ^{100}Cd excitation energies, where the Ge setup is sensitive, the TAS spectrum is empty. The main part of the distribution is characterized by a Gamow–Teller resonance occurring at excitation energies above 4 MeV, peaking at 6.4 MeV and having a full width at half-maximum of 1 MeV. In order to make some predictions with respect to the spin and parity of the ^{100}In ground state, a comparison with theory is needed. Shell-model calculations were performed [9] and the results are presented in the lower panels of Fig. 2. Assuming a spin and parity of 7^+ for the decaying state, a substantial feeding (10 %) of the 2548 keV 8^+ level is obtained, in contradiction with the experimental data, which indicate no direct population of the 8^+ level. A very small feeding of the 6^+ level at 2096 keV is seen in the middle panel of Fig. 2, which might correspond to the same feeding which we observe in the experimental TAS spectrum. Thus, a more likely value for the spin and parity of the ^{100}In ground state is 6^+.

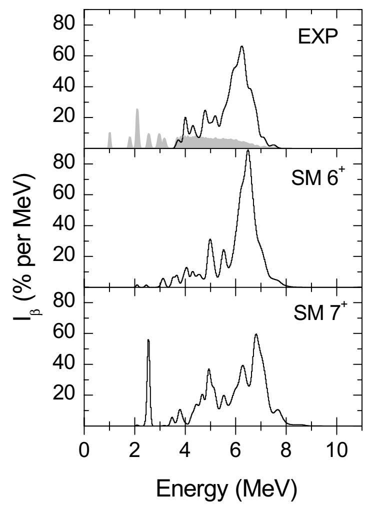

Fig. 2. Beta-intensity distribution deduced from the TAS experiment (upper panel), and from shell-model (SM) predictions, assuming spin and parities of 6^+ and 7^+, respectively, for the ground state of ^{100}In (lower panels). The experimental uncertainties are indicated as a shadowed area in the upper panel.

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