

The β^+ /EC decay of ^{100}In and the ^{100}Sn shell model

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The nucleus ^{100}In , the neutron-proton particle-hole (ph) neighbour of the doubly magic ^{100}Sn , is the closest lying neighbour which can be studied today in β^+ /EC decay with rates allowing detailed $\beta\gamma\gamma$ spectroscopy, while still having a simple ph shell-model structure. Its ground state is expected to be the $I_{max} - 1 = 6^+$ respectively 7^+ member of the $[\pi g_{9/2}^{-1}\nu d_{5/2}]_{2-7}$ or $[\pi g_{9/2}^{-1}\nu g_{7/2}]_{1-8}$ multiplets (Fig. 1). Their centroids are predicted to be nearly degenerate [1, 2]. The Gamow-Teller (GT) decay of a $\pi g_{9/2}$ proton in ^{100}In to a $\nu g_{7/2}$ neutron in ^{100}Cd will preferably populate either the $I^\pi = (5 - 7)^+$ members of the two-quasiparticle configurations $\nu d_{5/2}g_{7/2}$ or $\nu g_{7/2}^2$ or the four-quasiparticle GT resonance, where these configurations are coupled to an unpaired $\pi g_{9/2}^{-2}$ proton state. The two-quasiparticle $I^\pi = (5 - 7)^+$ states in the daughter nucleus ^{100}Cd have simple configurations, which are easily accessible to shell-model interpretation [3, 4]. They are lying well below the GT resonance in a region of low level density, so that their GT feeding and γ decay can be used to assign configurations to parent and daughter states.



Figure 1: States from the $\pi g_{9/2}^{-1}\nu g_{7/2}$ and $\pi g_{9/2}^{-1}\nu d_{5/2}$ multiplets as predicted by the shell model

We have performed a study of the ^{100}In β^+ /EC decay at the GSI on-line mass separator. The reaction $^{50}\text{Cr}(^{58}\text{Ni},\alpha p3n)$ at 6.15-A MeV energy and 45 particle-nA intensity of the ^{58}Ni beam was used to produce mass separated ^{100}In at an average rate of 5 atoms/s from a TIS ion source [5]. The ^{100}In samples were collected and measured in grow-in mode in cycles of 16 s on a movable tape and then removed to suppress long-lived daughter activity. The collection point was surrounded by a plastic scintillator to detect positrons with 70 % efficiency. Two composite HPGe detectors, a cluster of the EUROBALL type and a superclover from the VEGA array, a large volume single HPGe and a LEPS detector served for γ -ray detection with a total detection efficiency of 3.7 % for a 1.33 MeV γ ray.

A γ -coincidence spectrum gated by positrons and the $2^+ \rightarrow 0^+$ γ transition in the daughter ^{100}Cd is shown

in Fig. 2. This nucleus has been well studied in in-beam spectroscopy up to high spin [3, 4]. A strong apparent GT feeding of the known $I^\pi=6^+$ and 8^+ states is clearly observed. From the preliminary analysis of the feeding pattern a spin and parity assignment of $I^\pi=(7^+)$ is inferred for the parent state in ^{100}In . A half-life analysis of the strong 297, 795 and 1005 keV γ lines yields a value of 5.1(5) s in agreement with the adopted average of previous results 6.1(7) s [6].

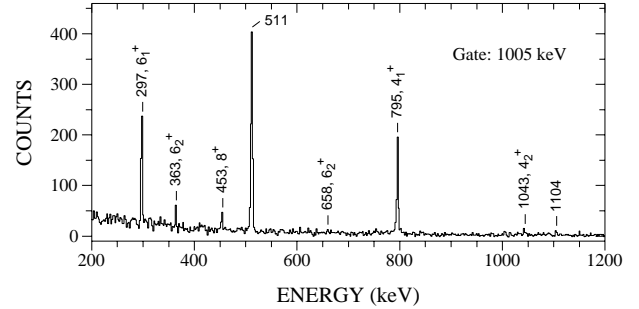


Figure 2: Partial β -gated $\gamma\gamma$ spectrum of the ^{100}In decay gated on the $2^+ \rightarrow 0^+$ transition in the daughter ^{100}Cd

The spin and parity assigned to the parent state, which could be the ground state or an isomer, is clearly at variance with the shell-model prediction shown in Fig. 1 [1]. The residual interactions used in shell-model calculations favour $I^\pi=6^+$ [1, 7, 8] in agreement with tentative assignments to the odd-odd In isotopes and N=51 isotones. The ph nature of the interaction requires that the two assignments belong to different configurations (Fig. 1). This excludes a trivial solution to the problem by shifting the centroids of the multiplets, as the configuration mixing would counteract, and would rather indicate a revision of the realistic interaction used in the shell model.

References

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