High-spin β decay of ^{94}Ag

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The structure of the $N = Z$ nucleus ^{94}Ag, presumably the lightest proton-bound silver isotope, provides information about the proton-neutron interaction in identical orbitals and on possible high-spin isomers if the nucleons couple in stretched configurations. An analogous case is known in ^{52}Fe, one major shell lower than ^{94}Ag, where a 12^+ state originating from the maximum aligned $\pi(1f_{7/2})^{-2}\nu(1f_{7/2})^{-2}$ configuration receives an extra-binding energy which makes it isomeric and thus undergoing β and E4 decay [1].

^{94}Ag has previously been studied at the GSI ISOL by Schmidt et al. [2], who measured a half-life of 0.42(5) s for a β-delayed proton activity. This was assigned to a low-lying isomer. The tentative $J^\pi = (7-9)^+$ assignment for this isomer is one of the topics addressed in the present study. Following the fusion-evaporation reaction

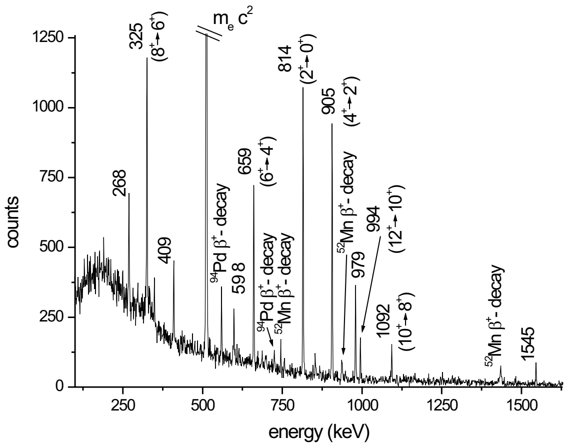

Figure 1: Gamma-ray spectrum in coincidence with positrons at mass $A = 94$. The ^{52}Mn lines represent a contaminant from a previous experiment. The γ rays assigned to the ^{94}Ag decay are marked by transition energies.

^{58}Ni(^{40}Ca,p3n)^{94}Ag, the reaction products were stopped in the hot graphite catcher inside the GSI ISOL ion source. The ^{94}Ag activity was implanted into a tape at rest which moved every 2.4 s. The implantation position was viewed by a $\beta\gamma$ detector set-up. The β-delayed γ rays were registered by a high-resolution Ge array comprising a Super-Clover, a Cluster and a single-crystal Ge detector, yielding a photopeak efficiency of 3.5 % at 1.3 MeV γ-ray energy. To detect β radiation, a plastic scintillator with an efficiency of 85 % was employed. The total measuring time was 14 hours. The intensity of the ^{94}Ag secondary beam at the collection point was estimated to be about 2 atoms/s.

The β-gated γ spectrum is presented in Fig. 1. One can clearly see feeding of the medium spin $J^\pi = (6-8)^+$ states in the daughter ^{94}Pd from the known $J^\pi = (7-9)^+$ isomer. From the strong apparent feeding of the (6^+) and (8^+) states in ^{94}Pd, we assign the parent spin of the β decaying state to be (7^+). The surprising feature of the $\beta\gamma$ spectrum is, however, that states with spins higher than 8^+ were observed. On the basis of $\beta\gamma\gamma$ coincidences we were able to extend the known level scheme of the daughter ^{94}Pd. In addition, half-life information has been deduced by fitting a single-component exponential grow-in function to the data. From the time analysis of all the $\beta\gamma$ lines observed, an average half-life of 0.36(3) s was obtained. This is assigned to ^{94}Ag and is in good agreement with the previous result of 0.42(5) s. If only γ rays deexciting states with $J^\pi \geq 8$ are considered, i.e. transitions possibly originating from the second isomer decay, an average of 0.3(2) s is determined [3]. This is not significantly different from the value of 0.36(3) s, but improved measurements of this type may allow us to identify the higher-lying high-spin isomer.

To understand the microscopic structure of ^{94}Pd, shell-model calculations have been performed in the $1p_{1/2}, 0g_{9/2}$ model space using an empirical interaction. The resulting predictions are compared with the experimental data in Fig. 2. The spin-parity assignment of the potential ^{94}Ag isomer with $J^\pi \geq 15$, not predicted by the shell-model calculations, is the subject of future experiments at ISOL.

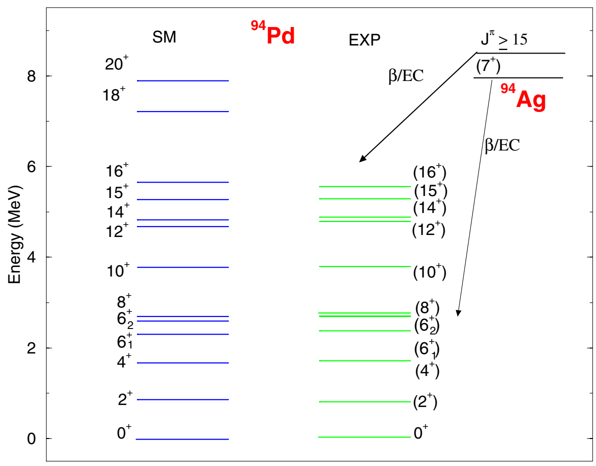

Figure 2: Shell-model calculations for excited ^{94}Pd states in comparison with the corresponding experimental data. The isomeric parent states in ^{94}Ag are also indicated.

References

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