

Beta-delayed proton decay of a high-spin isomer of ^{94}Ag

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In the β^+ /EC decay of the $N=Z$ nucleus ^{94}Ag , preliminary evidence for a long-lived ($T_{1/2}=0.3(2)$ s), high-spin ($I\geq 17$) isomer in ^{94}Ag , in addition to the known (7^+) isomer, was obtained in a previous GSI-ISOL experiment [1]. The two ^{94}Ag levels were studied by measuring $\beta-\gamma$ coincidences, which yielded also information about excited states in the daughter nucleus ^{94}Pd .

The existence of the ($I\geq 17$) isomer has been confirmed in a recent GSI-ISOL experiment, where both β -delayed γ rays [2] and protons were detected. The ^{94}Ag nuclei were produced by using the fusion-evaporation reaction $^{58}\text{Ni}(^{40}\text{Ca},p3n)$. The β^+ /EC-delayed proton decay of ^{94}Ag was measured by recording β -p, p- γ , β -p- γ and p- γ - γ coincidences with high-granularity arrays of germanium and silicon detectors [3].

The spectrum of γ rays measured in coincidence with protons is displayed in Fig. 1. This spectrum shows more

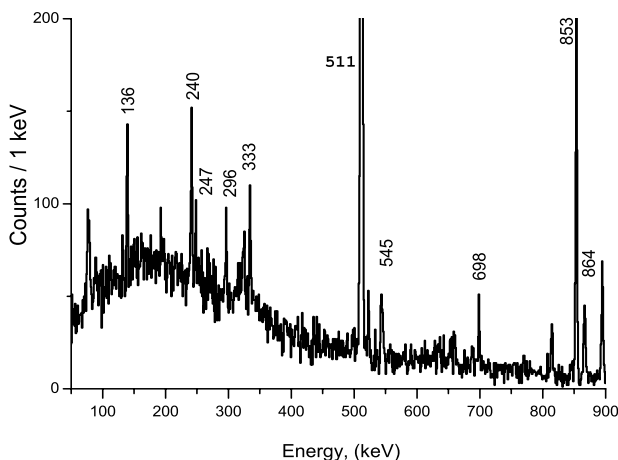


Figure 1: Energy spectrum of γ rays from ^{94}Ag measured in coincidence with protons. Energies of known transitions in ^{93}Rh are indicated in keV.

than 20 peaks matching the γ de-excitation pattern of high-spin states in ^{93}Rh , which are known from in-beam γ -spectroscopy [4]. Thus we have observed the feeding of high-spin states in ^{93}Rh , populated by proton emission from excited states of ^{94}Pd . This gives further evidence for the β decay of a spin-gap isomer in ^{94}Ag with $I\geq 17$ and $T_{1/2}=0.5(1)$ s, with the latter result being deduced from the time distribution of the p- γ data.

The proton energy spectrum measured in coincidence with the known 698 keV γ -transition in ^{93}Rh is shown in Fig. 2. It has a maximum at an energy around 3 MeV, with the low-energy bump corresponding to β particles. As the 698 keV γ -transition (see Fig. 1) indicates a population of the 5.69 MeV, $33/2^-$ state in ^{93}Rh (thus discriminating against p- γ events from the decay of the (7^+) isomer),

and the proton separation energy in ^{94}Pd amounts to 4.47 MeV, the end-point of the proton spectrum of about 5 MeV gives an estimate of at least 15 MeV for the highest excitation energy of ^{94}Pd states fed in β decay of the ^{94}Ag isomer ($I^\pi\geq 17^+$). As can be seen from the comparatively modest intensity of the β component in Fig. 2, the dominant β -decay mechanism leading to proton emission is electron-capture, which apparently holds for the decay of both ^{94}Ag isomers. A remarkable feature of the observed decay pattern is a preferred feeding of negative-parity states at high excitation energies in ^{93}Rh , which points to odd orbital momenta of the emitted protons assuming even parity for the parent states [1].

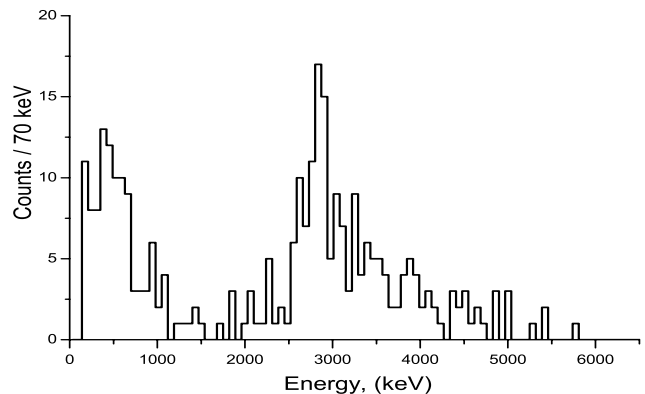


Figure 2: Protons measured in coincidence with the 698 keV γ -transition in ^{93}Rh which stems from a 5.69 MeV level in this nucleus.

All in all, we have obtained experimental evidence for a $I\geq 17$, $T_{1/2}=0.5(1)$ s isomer in ^{94}Ag , whose β -decay energy is at least 15 MeV. This state is characterized by the highest spin ever observed for β -decaying nuclei. Shell-model calculations have predicted numerous spin-gap isomers in the proton-neutron ($p_{1/2}, g_{9/2}$) model space [5], but so far only the $I^\pi=(21/2^+)$ state in ^{95}Pd was observed [6]. These calculations fail to predict a high-spin isomer for ^{94}Ag , with the closest candidate 21^+ , which represents the highest spin in the model space [1]. Only inclusion of excitations up to $3p-3h$ of the ^{100}Sn core can reproduce this type of isomerism [7].

References

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