Long-lived isomer in $^{126}$Pd$^\dagger$

H. Watanabe$^{*,1,2}$ for the RIBF60&62R1 Collaboration

Spectroscopic studies of $^{126}$Pd have been performed at the RIBF facility. Neutron-rich nuclei below $^{132}$Sn were produced using in-flight fission of a $^{238}$U$^{196+}$ beam at 345 MeV/nucleon with the intensity ranging from 7 to 12 pNA, impinging on a beryllium target with a thickness of 3 mm. The nuclei of interest were separated and identified through the BigRIPS separator and the following ZeroDegree spectrometer. A total of 5.3 × 10$^4$ $^{126}$Pd fragments were implanted into a highly segmented active stopper, named WAS3ABi, which consisted of eight double-sided silicon-strip detectors (DSSSD) stacked compactly. The DSSSDs also served as detectors for electrons following $\beta$-decay and internal conversion (IC) processes. Gamma rays were detected by the EURICA array that consisted of twelve Cluster-type detectors.

The decay schemes of the isomeric states in $^{126}$Pd are exhibited in Fig. 1. For $^{126}$Pd, the $J^\pi = (5^-)$ and $(7^-)$ isomers at 2023 and 2110 keV, respectively, were reported in Ref. 1). In the present work, the $\gamma$ rays below these isomers, except for the 86-keV line, have been observed in coincidence with electrons that were associated with the prior implantation of $^{126}$Pd, as demonstrated in Fig. 2(a). With gates on these $\gamma$ rays, a prominent peak can be found in an electron spectrum [marked with "I" in the inset of Fig. 2(b)]; this corresponds to the conversion electrons for the 86-keV, $E2$ transition ($\alpha_T = 2.374$). In Fig. 2(b), a $\gamma$-ray at 297 keV is clearly visible in addition to the $\gamma$ rays below the $(5^-)$ isomer by gating on the 86-keV IC peak. The appearance of the 297-keV peak is emphasized by taking a $\gamma$-ray time condition earlier than electron events, as is evident from the inset of Fig. 2(a), suggesting that this new $\gamma$ ray precedes the highly converted 86-keV transition. Furthermore, the 297-keV $\gamma$ ray is observed in coincidence with the other $\gamma$ rays in $^{126}$Pd [see Fig. 2(c) as an example]. Thus, the long-lived isomer can be identified at an excitation energy of 2406 keV. A peak marked with "II" in the inset of Fig. 2(b) is expected to arise from the conversion electrons for the 297-keV transition, being most likely of an $E3$ character ($\alpha_T = 0.1197$).

The half-life ($T_{1/2}$) derived from the time distribution of the 297-keV $\gamma$ ray is in agreement with that of the 693-keV line within experimental errors, as illustrated in the insets of Fig. 2(c). Similar half-lives have been observed for six other $\gamma$ rays; these transitions are expected to belong to high-spin states in $^{126}$Ag which are populated through the $\beta$ decay of the long-lived isomer in $^{126}$Pd. Therefore, the half-life is determined to be 23.0(8) ms by taking a weighted average of the respective values. Based on the observed mutual coincidence [see Fig. 2(d)] and $\gamma$-ray intensities, we propose the decay scheme from the long-lived isomer in $^{126}$Pd to the high-spin states in $^{126}$Ag as shown in Fig. 1.

![Fig. 1. Decay schemes of the $J^\pi = (10^+)$ isomer in $^{126}$Pd.](image1)

![Fig. 2. Gamma-ray spectra measured with various gate conditions within 50 ms after the $^{126}$Pd implantation.](image2)

References

---

$^\dagger$ Condensed from the article in Phys. Rev. Lett. 113, 042502 (2014)

$^*$ RIKEN Nishina Center

$^1$ IRCNP, School of Physics and Nuclear Energy Engineering, Beihang University