Long-lived isomer in ^{126}Pd†

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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 $^{238}U^{86+}$ 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 β-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 γ rays below these isomers, except for the 86-keV line, have been also 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 γ 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 γ-ray at 297 keV is clearly visible in addition to the γ 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 γ-ray time condition earlier than electron events, as is evident from the inset of Fig. 2(a), suggesting that this new γ ray precedes the highly converted 86-keV transition. Furthermore, the 297-keV γ ray is observed in coincidence with the other γ 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 γ ray is in agreement with that of the 693-keV one within experimental errors, as illustrated in the insets of Fig. 2(c). Similar half-lives have been observed for six other γ rays; these transitions are expected to belong to high-spin states in ^{126}Ag which are populated through the β 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 γ-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.

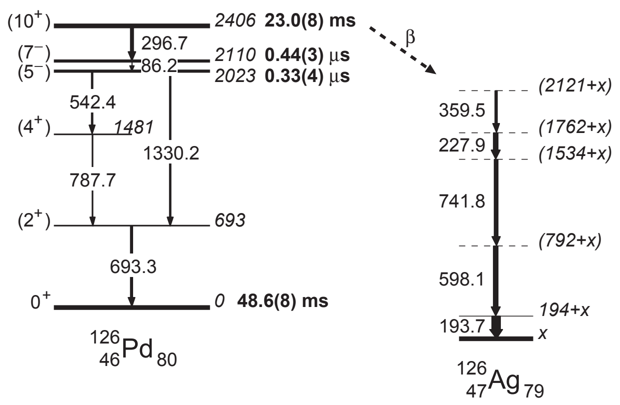

Fig. 1. Decay schemes of the $J^\pi = (10^+)$ isomer in ^{126}Pd.

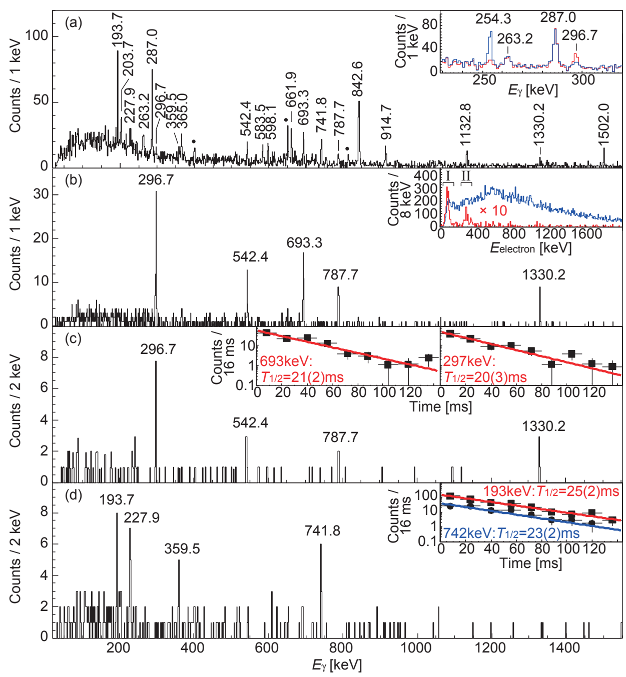

Fig. 2. Gamma-ray spectra measured with various gate conditions within 50 ms after the ^{126}Pd implantation.

References

1) H. Watanabe et al.: Phys. Rev. Lett. **111**, 152501 (2013).

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