Seniority isomer in ^{128}Pd[†]

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The level structure of the very neutron-rich nucleus ^{128}Pd has been studied for the first time. Neutron-rich nuclei below ^{132}Sn were produced using in-flight fission of a $^{238}U^{86+}$ beam at 345 MeV/nucleon impinging on a 3-mm-thick beryllium target. The primary beam intensity ranged from 7 to 12 pnA during the experiments. The nuclei of interest were separated by the BigRIPS separator and the following ZeroDegree spectrometer. The identified particles were implanted into a highly segmented active stopper named WAS3ABi[1)], which consisted of eight double-sided silicon-strip detectors (DSSSD) stacked compactly. Each DSSSD had a thickness of 1 mm with an active area segmented into sixty and forty strips (1-mm pitch) on each side in the horizontal and vertical directions, respectively. The DSSSDs also served as detectors for electrons following β-decay and internal conversion processes. Gamma rays were detected by the EURICA spectrometer[2)], which consisted of twelve Cluster-type detectors, each of which contained closely packed seven HPGe crystals.

Figure 1 shows a γ-ray energy spectrum measured in delayed coincidence with ^{128}Pd ions. Four γ rays at energies of 75, 260, 504, and 1311 keV have been unambiguously observed. These γ rays are found to be in mutual coincidence and exhibit consistent time behavior. Therefore, we conclude that they proceed through a single cascade originating from one isomeric state. A least-squares fit of the summed gated time spectra of the isomeric-decay transitions yields $T_{1/2} = 5.8(8)$ μs half-life, as shown in Fig. 1. The relative intensities of these isomeric γ rays are in agreement within experimental errors, except for the 75-keV transition that is expected to be highly converted. The total internal conversion coefficient for the 75-keV transition derived from a comparison with the 1311-keV γ-ray intensity is 2.6(17), which is consistent with the theoretical value of 3.88 for an $E2$ multipolarity.

On the basis of the above arguments on the observed γ transitions, the level scheme of ^{128}Pd is proposed as displayed in Fig. 1, where the spin and parity of the 5.8-μs isomeric state at 2151 keV is assigned as $J^\pi = 8^+$. The spin-parity assignment for the levels and the ordering of the transitions between the isomer and the ground state are based on a close resemblance to the yrast level energies below the analogous 8^+ isomers in ^{130}Cd[3)] and ^{96}Pd ($N = 50$)[4)]. A transition strength of $B(E2; 8^+ \rightarrow 6^+) = 0.22(3)$ W.u. can be obtained from the measured half-life of the 2151-keV isomeric state.

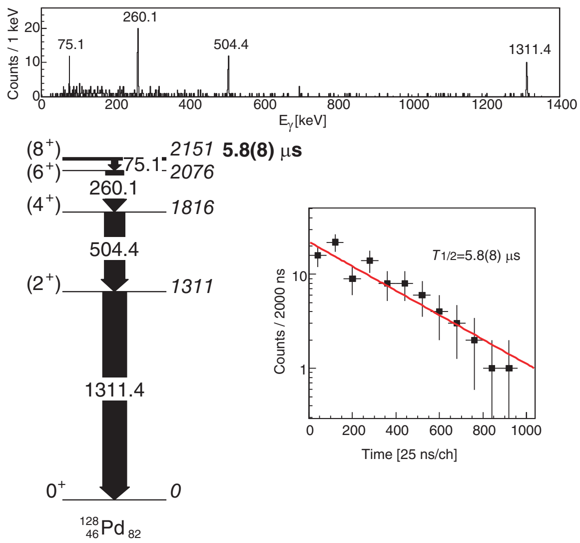

Fig. 1. Gamma-ray spectrum measured in coincidence with ^{128}Pd ions within $0.15 - 25$ μs (top), level scheme of ^{128}Pd (bottom left), and sum of time distributions of the 260-, 504-, and 1311-keV γ rays in ^{128}Pd (bottom right).

The excitation energies of the $J^\pi = 2^+ - 8^+$ states in ^{128}Pd are comparable to those in ^{130}Cd[3)]. The constancy of level energies is characteristic of the seniority scheme, where seniority υ counts the number of nucleons that are not in pairs coupled to spin zero. In the case of an n-particle (or n-hole) system in a single-j shell, the level energies with identical J^π and υ are independent of n. Such energy properties are also visible for the even $N = 50$ isotones from Mo ($Z = 42$) to Cd ($Z = 48$), in which the yrast $J^\pi = 2^+ - 8^+$ levels consist of the same multiplet that involves predominantly valence protons in the $\pi g_{9/2}$ orbital with $\upsilon = 2$. Since the single-proton levels in the $Z = 28 - 50$ shell are nearly identical in the ^{132}Sn and ^{100}Sn regions, it is expected that the level properties exhibited by the $N = 82$ isotones are similar within the valence proton space to those in the case of $N = 50$. Therefore, the excited states in ^{128}Pd can be interpreted in terms of the $\upsilon = 2$ configuration of the $\pi g_{9/2}$ subshell.

References
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