Band structures in ^{100}Pd

S. Sihotra[1],* J. Sethi[2], S. Saha[2], R. Kumar[3], R. P. Singh[3], S. Muralithar[3], R.K. Bhowmik[3], R. Palit[2], N. Singh[1], and D. Mehta[1]
[1]*Department of Physics, Panjab University, Chandigarh-160014*
[2]*Department of Nuclear and Atomic Physics, TIFR, Mumbai-400005 and*
[3]*Inter-University Accelerator Centre, New Delhi-110067, India*

Introduction

TNuclei with neutron number in vicinity of the major shell closure at $N = 50$, and the proton number lying between the semi-closed $Z = 40$ and the closed $Z = 50$ shells provide particularly good platform to probe the weakly deformed nuclei. Theoretical interpretations of level structures from new spectroscopic studies in these nuclei have revealed novel deformation-generating mechanisms [1–3]. In this mass region, the coexistence of spherical and deformed shapes results in complex level structure. The proton-neutron ($\pi\nu$) residual interaction predominates in odd-odd nuclei. The role of proton-neutron interaction and/ or core excitation in the shell model structure of N=Z nuclei gained impetus in recent studies. The Pd ($Z = 46$) isotopes with the proton Fermi surface in the middle of the $g_{9/2}$ proton shell (half-particle and half-hole), provide a platform for various intriguing phenomena. Structure of these nuclei are affected by change in the neutron number, especially the neutron valence space with reference to the $N = 50$ core consisting of the $\nu d_{5/2}$, $\nu g_{7/2}$, $\nu d_{3/2}$ and $\nu s_{1/2}$ orbitals. The prolate-driving low-Ω $\nu h_{11/2}$ intruder orbital starts filling up in case of the Pd isotopes with neutron number above $N \approx 54$ and the configuration-dependent triaxiality is achieved due to the competing shape-driving ability of the $\nu h_{11/2}$ and $\pi g_{9/2}$ orbitals

Band structures with the values and trends of dynamic moment of inertia and transition rates as a function of angular momentum have been observed to be different from those in case of the axial deformed nuclei, wherein rotational bands are known to exhibit nearly constant electric quadrupole transition rates. This led to various new phenomenon, namely, smooth band termination (ST), magnetic rotation (MR) and antimagnetic rotation (AMR), wherein angular momentum is generated through gradual alignment of valence proton hole and neutron particle angular momenta with different initial angular momentum compositions. The smooth band termination involves alignment of valence nucleons around a weakly deformed core and is indicative of the interplay between collective and noncollective behavior. By the powerfull detector array the above mentioned features can be studied.

Experimental details

Excited states in the ^{100}Pd nucleus were populated in the ^{75}As(^{31}P, 2p4n)^{100}Pd fusion-evaporation reaction at E_{lab}= 125 MeV. The de-excitations were investigated through in-beam gamma-ray spectroscopic techniques. The ^{31}P beam was provided by the Pelletron-LINAC facility at TIFR, Mumbai. The ^{75}As target of thickness 2.8 mg/cm^2 was prepared by vacuum evaporation and rolled onto a 10 mg/cm^2 thick Pb backing. The recoiling nuclei in the excited states were stopped within the target and the de-exciting gamma-rays were detected using the Indian National Gamma Array (INGA) consisting of 21 Compton suppressed clover detectors. Two and higher fold clover coincidence events were recorded in a fast digital data aquisition system based on Pixie-16 modules of XIA LLC [4]. The data sorting routine "Multi pARameter time stamped based COincidence Search program (MARCOS)", developed at TIFR,

---

*Electronic address: `ssihotra@pu.ac.in`

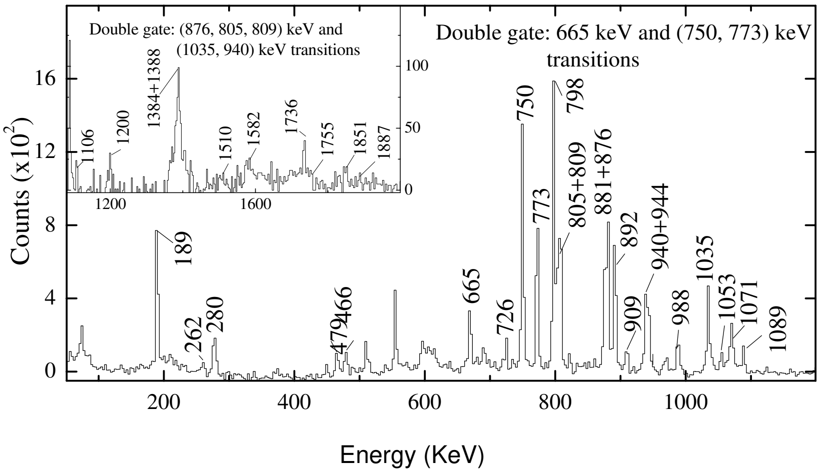

FIG. 1: Lower panel shows the double-gated coincidence spectrum for positive parity energy levels of yrast band and the inlet panel shows the transitions of excited negative parity bands for ^{100}Pd.

sorts the time stamped data to generate E_γ-E_γ matrices and E_γ-E_γ-E_γ cubes compatible with Radware format. Same nucleus was also populated in the ^{75}As(^{28}Si, p2n) fusion-evaporation reaction at E_{lab}= 120 MeV. The de-excitations were investigated through in-beam γ-ray spectroscopic techniques. The ^{28}Si beam was delivered by the 15UD Pelletron accelerator at Inter University Accelerator Centre (IUAC), New Delhi. The ^{75}As target of thickness 3 mg/cm^2 was prepared by vacuum evaporation and rolled onto a 10 mg/cm^2 thick Pb backing. The recoiling nuclei in the excited states were stopped within the target and the deexciting γ-rays were detected using the Indian National Gamma Array (INGA) consisting of 18 clover detectors mounted in five-rings configuration [5]

Discussion

The present level scheme of ^{100}Pd is built on the I = 0^+ ground state. The level scheme has been extended substantially with addition of many new transitions to the earlier reported ones [6, 7]. The level scheme is established up to $\sim$ 17 MeV excitation energy. Previously reported levels in positive parity band[7] are differ from the work reported by the Zhu et al., [6]. A new band consisting of 633-, 298-, 374-, 466, and 1167- keV transitions has been observed. The states of this band decay to yrast band by various gamma rays that have been observed in the present work. The transitions related to various bands has been shown in spectrum [Fig. 1].

Acknowledgments

Authors acknowledge the joint effort of IUAC, New Delhi, TIFR, Mumbai, and IUC-DAEF and SINP, Kolkata, in establishing the INGA clover array. Financial support from IUAC, New Delhi, under the Centre of Advanced Study Funds, and UGC, New Delhi, is duly acknowledged.

References

[1] J. A. Alcántara-Núñez *et al.,* Phys. Rev. C **69**, 024317 (2004).
[2] B. Cederwall *et al.,* Nature **469**, 68 (2011).
[3] J. Gizon *et al.,* Phys. Lett. B **410**, 95 (1997).
[4] R. palit *et al.,* Nucl. Instrum. Methods A **90**, 680 (2012).
[5] S. Muralithar *et al.,* Nucl. Instrum. Methods A **622**, 281 (2010) and references therein.
[6] G.E. Perez et al., Nucl. Phys. A **686**, 41 (2001).
[7] S. Zhu et al., Phys. Rev.C**64**, 041302R(2001).