Quadrupole and Octupole collectivity in ^{99}Pd

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Introduction

Transitional nuclei with Z $<$ 50 and mass A $\approx$ 100 are characterized by a small quadrupole deformation and a γ-soft potential at low and moderate angular momenta. The magic neutron number N=50 enhances the shell effects in these nuclei making their excitations more complex. The odd-A nuclei expected to exhibit weakly deformed rotational structures can be described by Particle-rotor model. It is always interesting to go beyond the shell model description of such nuclei which can be achieved by excitations to high spins. The ^{99}Pd (N=53) nucleus provides an opportunity of probing the role of neutrons in valence space outside the N=50 closed shell. There is ample possibility of observing maximally-aligned states in such a nucleus. The low-lying levels of ^{99}Pd have been investigated from EC-β^+ decay of ^{99}Ag by Huyse et al [1]. Investigations of low lying states via the ^{96}Ru(α,p3n) and ^{96}Ru(^{6}Li,p2n) reactions have been performed by Dubuc et al [2].

Experimental details

High spin states in ^{99}Pd nucleus were populated in fusion-evaporation reaction ^{75}As(^{28}Si,p3n) at E_{lab}= 120 MeV, and were subsequently investigated through in-beam γ-ray spectroscopic techniques. The ^{28}Si beam was delivered by the 15UD Pelletron accelerator at IUAC, New Delhi. The ^{75}As target of thickness 3 mg/cm^2 onto a 10 mg/cm^2 thick Pb backing was prepared by vaccum evaporation followed by rolling. The deexciting γ-rays were detected using the Indian National Gamma Array-2008 equipped with 18 clover detectors mounted in five rings configuration [3]. A total of about 300 million triple or higher-fold coincidence events were recorded in the experiment. The data were sorted using INGASORT program [4] to produce symmetrised E_γ-E_γ matrices and E_γ-E_γ-E_γ cubes. RADWARE analysis package was used to establish level scheme.

Results and discussion

The level scheme of ^{99}Pd from the present work is shown in Fig. 1. It is built on the ground state $I^\pi = 5/2^+$ and six bands labeled B1-B6 could be identified. The level scheme from the present work, established up to 10 MeV excitation energy and 49/2 $\hbar$ spin, has been significantly extended with addition of about 60 new transitions to those reported in the earlier work by Dubuc *et al.*[2]. The bands labeled B3, B4, B5 and B6 are being reported for the first time. The previously observed bands B1 and B2, have been assigned to be based on $\pi g_{7/2}$ and $\pi d_{5/2}$, respectively. The new band B6, with $11/2^-$ state at 2017 keV as bandhead, is based on $\pi h_{11/2}$ orbital. It exhibits higher initial alignment $\sim 6\hbar$. The band B5 is attributed to vibrations of the core coupled to the $\pi g_{7/2}$ single particle configuration. The $9/2^+$ level at 1102 keV is possibly based on the $\pi g_{9/2}$ orbital. The excitation energy plots of the bands B1 and B2, and bands B3 and B4 exhibit similar trend and appear to be in continuation. It indicates that the shape-driving orbital in bands B3 and B4 are the same. The bands B3 and B4 are in continuation to the $\pi g_{7/2}$ band and exhibit large alignment gain $\sim 6\hbar$. Observa-

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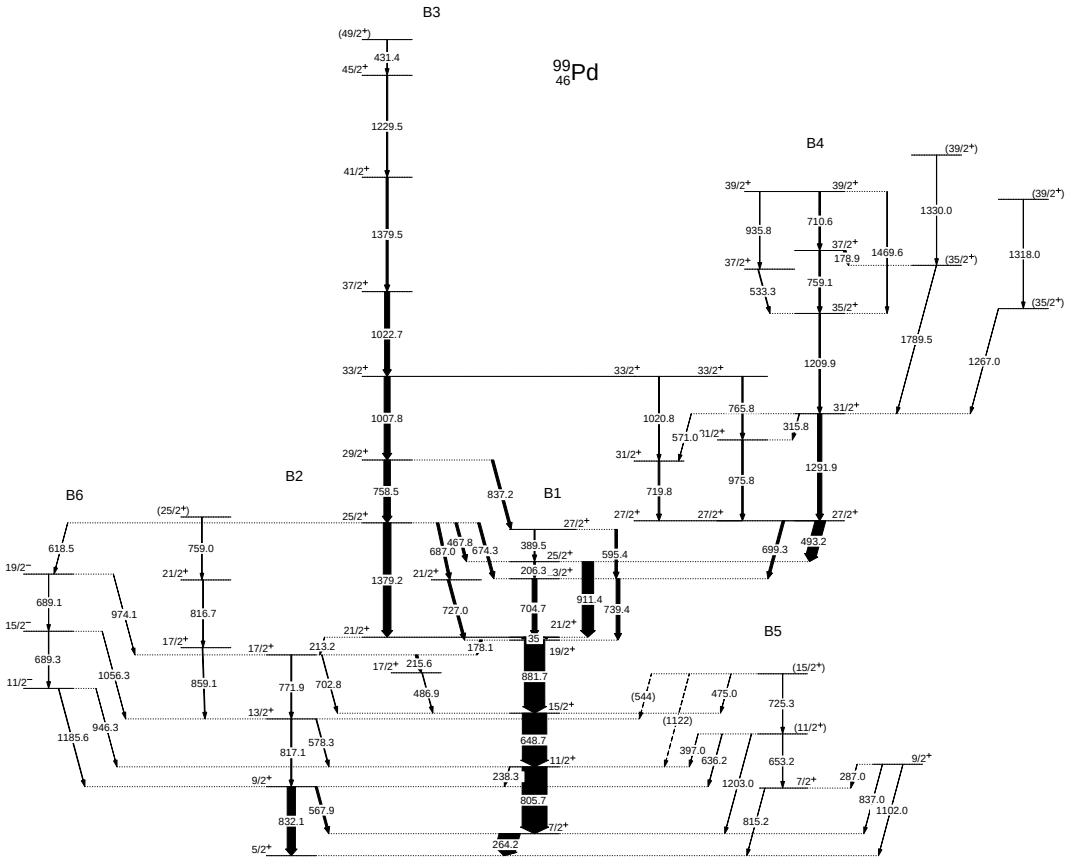

FIG. 1: The level scheme of ^{99}Pd developed in the present work.

tion of low energy 431 ($49/2^+ \rightarrow 45/2^+$) transition at state is indicative of the ($49/2^+$) maximally aligned spin state with configuration as $(g_{9/2})^{2n} \otimes (g_{7/2})^m \otimes (g_{7/2})^k \otimes (d_{5/2})^s$. Various other states will be identified with configurations as variants of this configuration. As the $\pi h_{11/2}$ and $\pi d_{5/2}$ orbitals with ΔI= 3 are near the Fermi surface, octupole collectivity is likely to be enhanced in this region. The signatures of such effects are interleaved positive and negative-parity bands connected by enhanced E1 transitions. Such E1 transitions between the levels of $\pi h_{11/2}$ band (B6) to $\pi d_{5/2}$ band (B2) have been observed in the present work. Nevertheless, the presence of these E1 transitions competing with highly collective E2 transitions is already a sign of large B(E1) values.

Acknowledgments

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