Study of yrast bands of neutron-rich ^{122,124}Pd isotopes

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The experimental level schemes for ^{122,124}Pd isotopes have been observed up to spins 4^+ by Wang et al. [1]. A study of the E_2^+ and R_{42} systematics as function of neutron number was made by Wang et al. [1] for Pd isotopes with neutron number (N) up to 78. It was found that E_2^+ value gradually increases in ^{122,124,126}Pd toward N=82, suggesting a shell closure. A comparison with the R_{42} systematics of lighter mass even-even Pd isotopes showed that this ratio decreases towards N=82 pointing to diminishing deformation. The experimental data for B(E2) and g-factor values in ^{122,124}Pd isotopes is not available as of now. Motivated by the availability of the latest level schemes in ^{122,124}Pd, the projected shell model (PSM) framework [2] has been employed to study the physical quantities such as yrast spectra, backbending phenomena, B(E2) transition probabilities and *g*-factors in these nuclei. In the present work, the theoretical yrast energies, B(E2) values as well as g-factors have been predicted up to spin 8^+.

For present study, the valence space of the model consists of three major harmonic-oscillator shells with *N*=2, 3, 4 for protons and *N*=3, 4, 5 for neutrons. The monopole-pairing strength is taken to be $G_M = \left[G_1 - G_2 \frac{N-Z}{A}\right] A^{-1}$ (MeV) for neutrons and $G_M = \frac{G_1}{A}$ (MeV) for protons. Here G_1 and G_2 are taken as 20.80 MeV and 17.50 MeV. The quadrupole–pairing strength G_Q taken are 0.26 and 0.30 for ^{122,124}Pd, respectively.

From the experimental and calculated systematics of $E(2^+)$, $E(4^+)$ and $R_{42}= E(4^+)/E(2^+)$ for ^{122,124}Pd, it is observed that the experimental $E(2^+)$ values increase from a value of 0.499MeV in ^{122}Pd to 0.590 MeV in ^{124}Pd**.** The $E(4^+)$ values follow increasing trend as one moves from ^{122}Pd to ^{124}Pd. The experimental R_{42} ratio decreases from a value of 2.333MeV in ^{122}Pd to 2.203 in ^{124}Pd. The observed systematics of $E(2^+)$ values and R_{42} ratios indicate that there is a decrease of collectivity as neutron number increases from N= 76 to 78. The calculated results of $E(2^+)$, $E(4^+)$ and R_{42} ratio for these isotopes show the similar trend as shown by the experimental ones.

In Fig. 1, the calculated energy levels of the yrast band, consisting of the lowest state for each spin, are compared with the available experimental data for ^{122,124}Pd. In these isotopes, only 2^+ and 4^+ yrast levels are available recently [1], while the calculated yrast spectra have been obtained up to spin 8^+. The observed levels in ^{122,124}Pd isotopes are seen to be reproduced satisfactorily by the calculated results.

Theoretical results predict the occurrence of backbending at spin 6^+ in both isotopes. The experimental results to confirm this are yet not available. The occurrence of backbending can be understood from the analysis of band diagrams. It is observed that the occurrence of backbending in theoretical yrast spectrum of ^{122,124}Pd around spin 6^+ could be linked to the crossing of the g-band by 2-qp bands.

Further, the calculated B(E2; $2^+ \rightarrow 0^+$) values decrease as one moves from ^{122}Pd to ^{124}Pd. This decrease suggests that there is decrease in deformation as one moves from ^{122}Pd to ^{124}Pd. This decrease in deformation is also reflected by a decrease in R_{42} values. It is seen from Table 1 that there is a decrease in the calculated B(E2) transition probabilities at spin

8^+ in ^{122,124}Pd. The decrease is due to the crossing of bands.

In Fig. 3, the g-factors are displayed against spin for ^{122,124}Pd. There is a sharp increase in these values at spin 6^+. The reason for sharp increase in ^{122}Pd is the crossing of g-band by one 2-qp proton band between spins 6^+ and 8^+ and that in ^{124}Pd, is due to the crossing of two 2-qp neutron bands by one 2-qp proton band around spin 8^+.

In these isotopes, the occurrence of backbending, decrease in B(E2) values and increase of g-factors is predicted around the same spin at which there is crossing of bands. These changes predict the occurrence of changes in the structures of yrast band in these nuclei.

Table 1 Calculated B(E2) transition probabilities (in units of e^2b^2) for ^{122,124}Pd

Nuclei	**^{122}Pd**	**^{124}Pd**
spin	Th. B(E2)	Th. B(E2)
2^+	0.066	0.051
4^+	0.106	0.099
6^+	0.110	0.113
8^+	0.003	0.003

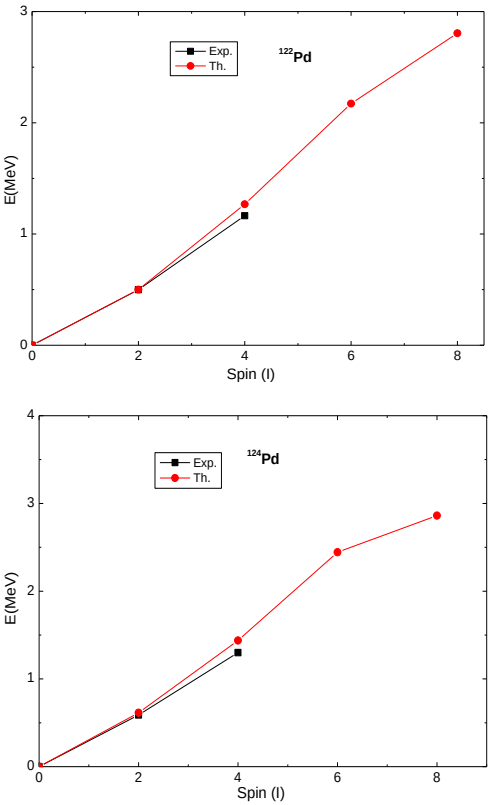

Fig. 1 Comparison of calculated (Th.) yrast energy states with available experimental (Exp.) data for (a) ^{122}Pd (b) ^{124}Pd

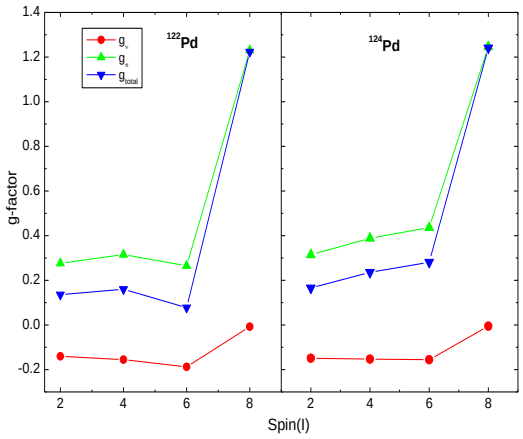

Fig. 2 Comparison of calculated (Th.) and experimental (Exp.) g-factors against nuclear Spin (I) for (a) ^{122}Pd (b) ^{124}Pd

References

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