Microscopic study of high spin states in even-even Pd mass chain

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The region of neutron-excess nuclei at mass A≈100 is an area of interest to many authors because of the observation of the shape transitions. Pd isotopes fall in this region where the change is from spherical to quasi-deformed nuclei when moving from lighter to heavier isotopes. The structure of these transitional nuclei has been the subject of many theoretical studies. Different theoretical approaches have been used to describe neutron-rich palladium isotopes, based on microscopic models. Theoretically, the transitional regions and phase transitions in Pd isotopes have been analyzed in the framework of IBA-2 model [1]. From the analysis of energies, static moments, transition rates, quadrupole moments and mixing ratios, they were able to identify states having large mixed symmetry components. Recently, the Projected Shell Model (PSM) has become quite popular to study the structure of deformed nuclei. The advantage in this method is that the numerical requirements are minimal and therefore, it is possible to perform a systematic study for a group of nuclei in a reasonable time frame.

The PSM [2] approach is applicable for the low and high spin states in heavy nuclei and is based on the shell model philosophy. The Hamiltonian which has been used throughout the present work is described as follows.

$$\hat{H} = H_0 - \frac{1}{2}\chi\sum_{\mu}\hat{Q}^{\dagger}_{\mu}\hat{Q}_{\mu} - G_M\hat{P}^{\dagger}\hat{P} - G_Q\sum_{\mu}\hat{P}^{\dagger}_{\mu}\hat{P}_{\mu}$$

where H_0 is the spherical single particle Hamiltonian. The second term is the quadrupole-quadrupole interaction and the last two terms are the monopole and quadrupole pairing interactions, respectively. The strength of the quadrupole-quadrupole term is obtained via self-consistent conditions with a given deformation parameter ϵ_2.

The aim of the present work is to study the high spin Yrast spectra, back-bending phenomena, band-diagram, B(E2) values and g-factors in isotopic chain of Pd nuclei by employing projected shell model approach. The theoretical Yrast spectra obtained by carrying out projected shell model (PSM) calculations are compared with experimental data for $^{100-118}$Pd. The Yrast spectra has been obtained by carrying out PSM calculations for prolate deformation values only and compared with the experimentally observed Yrast spectra. The reasonably good agreement of the theoretical results with the experimental data for the energy states, back bending phenomena, B(E2) transition probabilities, and g-factors test the reliability of the PSM wave function.

The PSM calculation reproduced the yrast spectra for $^{100-112}$Pd and ^{116,118}Pd within an accuracy of 8%.The calculation is seen to reproduce the observed back-bending in $^{100-118}$Pd isotopes qualitatively at an angular momentum which is close to the spin at which it is observed experimentally.

In figure (1) the results of band diagram for even-even $^{100-110}$Pd are presented. The results on band diagram show that the Yrast spectra in Pd isotopes do not arise from a single intrinsic state. The low lying states are found to arise from zero quasi particle state. As we go to higher angular momentum states it is observed that the intrinsic state changes and has multi quasi particle configuration. Some of the angular momentum states are found to have composite structure i.e. they arise from more than one intrinsic state.

References

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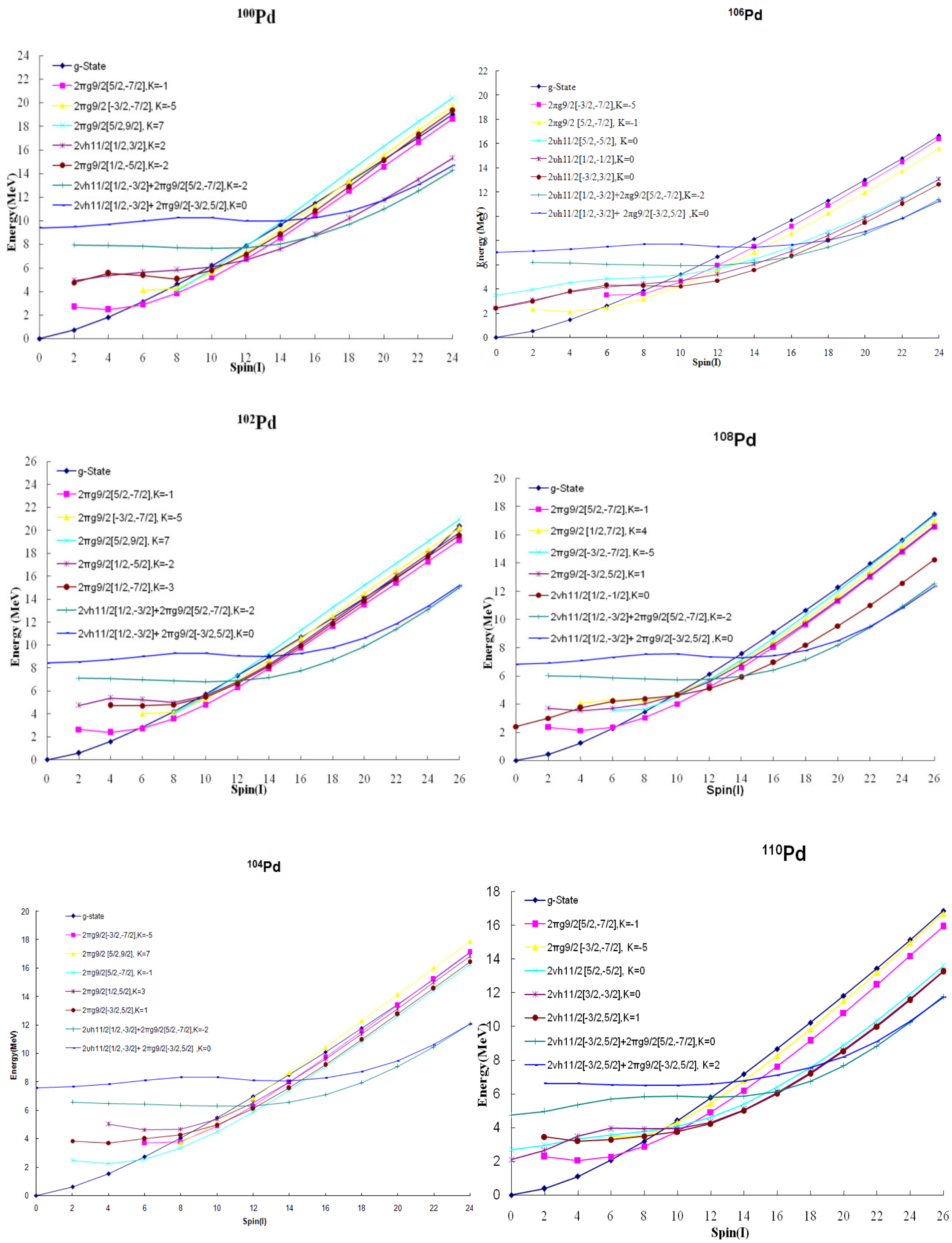

Figure1: Band diagrams for even-even $^{100\text{-}110}$Pd isotopes.