Investigation of Rotational bands in $^{183,185}Ir$ deformed nuclei within Projected Shell Model

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Introduction

The iridium isotopes (Z=77) are located in the transitional region between the rare-earth isotopic chains of well-deformed nuclei and the semimagic lead (Z = 82) chain of near-spherical isotopes. In these transitional nuclei a complex interplay between different competing degrees of freedom is observed, and in particular, consideration of the γ-degree of freedom plays an important role [1].The study of intrinsic (quasi-particle) states and their associated collective excitations in odd nuclei represents a valueable step towards reaching the understanding of the microscopic structure of collective and intrinsic excitations[2].

Most of the heavy nuclei are difficult to describe in a Spherical Shell Model framework because of the unavoidable problem of dimension explosion. Therefore, the study of nuclear structure in heavy nuclei has relied mainly on the mean-field approximations, in which the concept of spontaneous symmetry breaking is applied. The aim of the present work is to study the $^{183,185}Ir$ deformed nuclei within the Projected Shell Model (PSM) [3] framework.

Theoretical Framework

In a PSM calculation, the Shell Model truncation is first achieved within the quasi-particle (qp) states with respect to the deformed Nilsson + BCS vacuum $|\phi\rangle$ then rotational symmetry are restored for these states by standard projection techniques to form a spherical basis in the laboratory frame; finally the shell model Hamiltonian is diagonalized in this basis. The set of multi-qp states relevant even-odd systems is

$$|\phi_K\rangle = \left\{ a_\pi^\dagger|0\rangle, a_\pi^\dagger a_{\nu 1}^\dagger a_{\nu 2}^\dagger|0\rangle \right\} \qquad (1)$$

In PSM calculations, we use the Hamiltonian of separable forces

$$\hat{H} = \hat{H}_0 - \frac{1}{2}\chi \sum_\mu \hat{Q}_\mu^\dagger \hat{Q}_\mu - G_M \hat{P}^\dagger \hat{P} - G_Q \sum_\mu \hat{P}_\mu^\dagger \hat{P}_\mu \qquad (2)$$

Where $\hat{H}_0$ is the spherical single particle hamiltonian. The second term in the Hamiltonian is the quadrupole-quadrupole (Q-Q) interaction and the last two terms are the monopole and quadrupole pairing interactions. the coupling constant for the monopole pairing force G_M is taken as

$$G_M = \left(G_1 \mp G_2 \frac{N-Z}{A} \right) \frac{1}{A} \ (MeV) \qquad (3)$$

where -(+) sign for neutrons(protons) and G_1 and G_2 are the coupling constants. G_1 and G_2 are taken as 20.12 and 13.13. The quadrupole pairing strength G_Q is assumed to be proportional to G_M with proportionality constant 0.16 for $^{183,185}Ir$.

Results and Discussion

PSM result on the negative parity yrast band spectra obtain for $^{183,185}Ir$ is in good agreement with the experimental data over the entire range of available spin.The quadrupole (ϵ_2) and hexadecupole (ϵ_4) parameters used for carrying out the ^{183}Ir calculations are 0.225 and 0.037 also for ^{185}Ir calculations are 0.255 and 0.001 respectively The experimental data is taken from [4, 5].The band

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diagram for ^{183}Ir and ^{185}Ir are displayed in figure(1) and figure(2). It has been observed

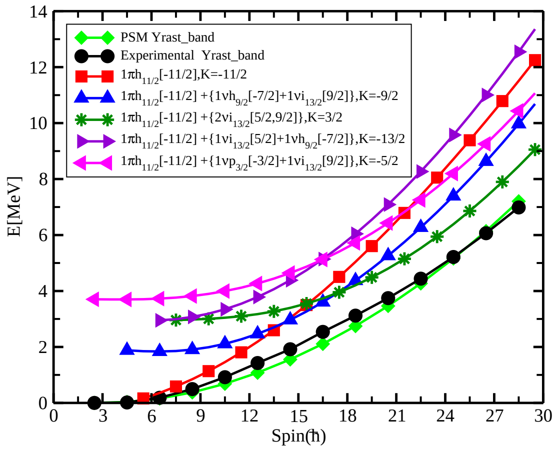

FIG. 1: Band diagram for ^{183}Ir isotope.

that the lower spin states in the Yrast band arises from 1-qp states where as the contribution towards the higher spin states come essentially from the 3-qp bands. In these diagrams, the proton 1-qp bands $\frac{11}{2}^-$[505] is represented by square symbol band. The 3-qp band with K = -$\frac{9}{2}$ (up triangle symbol band) is formed by the combination of 1-qp configuration $\frac{11}{2}^-$[505] and the two quasineutrons $\frac{7}{2}^-$[503] and $\frac{9}{2}^+$[624]. The 3-qp band with K = $\frac{3}{2}$(star symbol band) is formed by the combination of 1-qp configuration $\frac{11}{2}^-$[505] and $\frac{1}{2}^+$[404] and the two quasineutrons $\frac{5}{2}^+$[642] and $\frac{9}{2}^+$[624]. The 3-qp band with K = -$\frac{13}{2}$(right triangle symbol band) is formed by the combination of 1-qp configuration $\frac{11}{2}^-$[505] and the two quasineutrons $\frac{5}{2}^+$[642] and $\frac{7}{2}^-$[503]. The 3-qp band with K = -$\frac{5}{2}$(left triangle symbol band) is formed by the combination of 1-qp configuration $\frac{11}{2}^-$[505] and the two quasineutrons $\frac{3}{2}^-$[512] and $\frac{9}{2}^+$[624]. The 3-qp band with K = -$\frac{1}{2}$(down triangle symbol band) is formed by the combination of 1-qp configuration $\frac{11}{2}^-$[505] and the two quasineutrons $\frac{9}{2}^+$[624] and $\frac{1}{2}^+$[651]. Since the proton Fermi level remains nearly identical for both the isotopes, the energy and the character of the projected one-quasiproton state should remain unchanged.However, because of the differences of the neutron Fermi levels, the energies and the configurations of the additional neutron pair in the projected 3-qp states can and will change with neutron number.

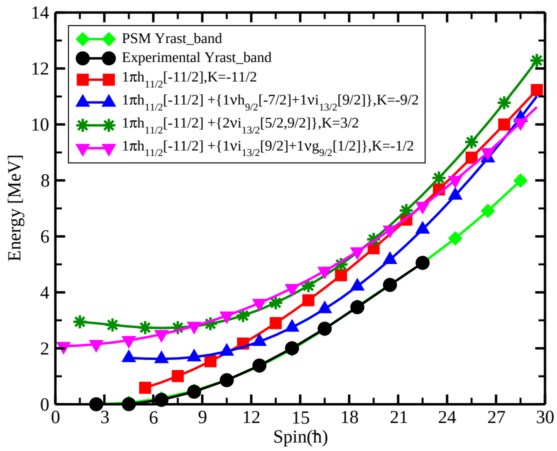

FIG. 2: Band diagram for ^{185}Ir isotope.

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