Projected shell model study of positive parity bands of $^{103,105}Ag$ isotopes

Manvi Rajput[1],* Suram Singh[1], and Veerta Rani[1]
[1]*Department of Physics and Astronomical Sciences, Central University of Jammu, Samba, J&K-(181143), India*

1. Introduction

In the mass region, A $\sim$ 105, nuclei with atomic number in the range 43 $\leq$Z$\leq$49, have attracted the attention of nuclear physicists in recent years. In this mass region, the neutrons are lying close to the low-Ω g $_{7/2}$, d $_{5/2}$ and h $_{11/2}$ orbitals and the proton Fermi surface lies near the high-Ω 1g $_{9/2}$ orbitals. While going away from Z = 50 and N = 82 (shell closures), the nucleon-nucleon interactions result in an associated deformations and increasing collectivity. In axial deformation, the $\nu h_{11/2}$ orbital with a low Ω and the $\pi g_{9/2}$ orbital with a high angular momentum projection on the symmetry axis (Ω) , tend to drive the nucleus towards prolate and oblate deformation, respectively [1-2]. Hence, emergence of triaxial shapes associated with π $g^n{}_{9/2}\times\nu$ $h^m{}_{11/2}$ configurations are expected in this region. In this context, nuclei are observed to exhibit small deformations ($\epsilon \sim 0.15$) with γ soft [3-4].This paper is a small contribution in this regard where by applying the theoretical framework of the projected shell model, we have tried to understand the structural features of $^{103,105}Ag$ isotopes[5].

2. Outline of the Projected Shell Model approach

The PSM [5] calculations usually begin with the deformed Nilsson single-particle states at deformation ϵ_2. In the present study, three major harmonic oscillator shells with N=2,3,4 for protons and N=3,4,5 for neutrons are taken. The Hamiltonian that has been used in the present calculation contains the single particle energies, monopole pairing between like particles, quadrupole - quadrupole and quadrupole pairing interactions.

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

The monopole pairing interaction constant G_M is adjusted via G_1 and G_2 and is taken as

$$G_M = \{G_1 \mp G_2\frac{N-Z}{A}\}\frac{1}{A}(MeV) \quad (2)$$

where the -(+) sign applies to neutrons (protons).The present study for $^{103,105}Ag$ isotopes has been performed with G_1=20.00 and G_2=12.12.The quadrupole pairing strength G_Q is assumed to be proportional to G_M, and the proportionality constant being fixed as 0.16. The quadrupole ϵ_2 and hexadecapole ϵ_4 parameters used for the present calculations are 0.230 and 0.000 respectively, for ^{103,105}Ag Isotopes.

3. Results and Discussion

In the present work, positive-parity yrast spectra of $^{103,105}Ag$ isotopes have been obtained through the process of diagonalization of the Hamiltonian in the deformed basis. The calculated results are then compared with the corresponding available experimental data [6] and the comparison is shown in Figs. 1. From these Figures, one can conclude that the calculated yrast spectra are in good agreement with the observed ones. Through PSM calculation, we have been able to obtain the yrast states upto $59/2^+$ whereas experimental data are available up to a maximum spin value of $27/2^+$ for ^{103}Ag and $45/2^+$ for ^{105}Ag respectively. Moreover, the present PSM calculations have reproduced successfully the experi-

*Electronic address: rmanvi96@gmail.com

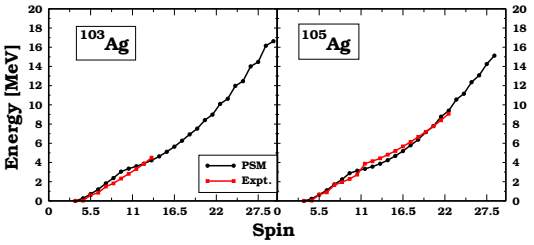

FIG. 1: Comparison of experimental and calculated (Th.) energy levels of ground state band of $^{103,105}Ag$ isotopes.

mental band head spin $7/2^+$ for positive parity band of these isotopes. The band diagram for $^{103,105}Ag$ isotopes are shown in Fig. 2. From Fig.2, it is clear that at lower spins the yrast spectra is formed by 1-qp bands whereas the at higher spins 3-qp bands contributes towards the formation of yrast spectra. The transition energies [E(I)-E(I-1)] (in MeV) of ground state bands in these isotopes are also well reproduced (fig.3). The good agreement between the calculated data with the available experimental data lends strong support to the chosen valence space as well as to a correct choice of two-body interactions in nuclear structural calculations of these odd mass Ag isotopes.

4. Summary

In summary, after performing angular momentum projection and configuration mixing calculations by employing the same quadrupole and hexadecapole deformation parameters for both the $^{103,105}Ag$ isotopes, we found that the obtained band head energies, energy levels as well transition energies between angular momentum states can reasonably explain the available experimental data within the framework of projected shell model.

Acknowledgements

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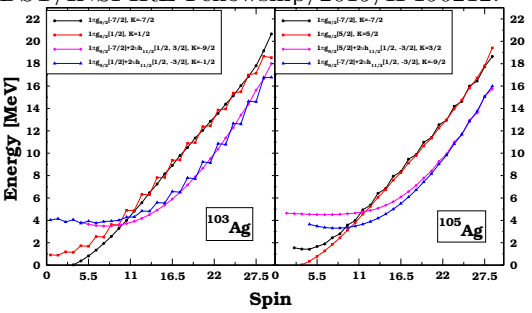

FIG. 2: Band diagrams for $^{103,105}Ag$ isotopes.

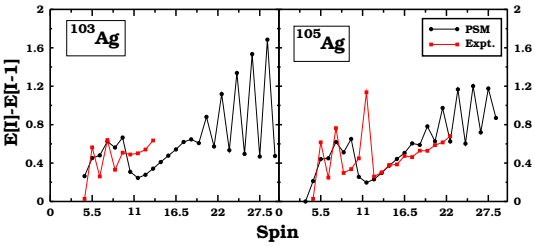

FIG. 3: Comparison of experimental and calculated (Th.) dipole transition energies of ground state band of $^{103,105}Ag$ isotopes.

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