Theoretical study of high spin structure of ^{145,147,149}Pm isotopes

Suram Singh[1],* Amit Kumar[2], and Arun Bharti[3]
[1]*Department of Physics and Astronomical Sciences, Central University of Jammu, Samba - 181143, INDIA*
[2]*Deptartment of Physics, Govt. P. G. College for Women, Gandhi Nagar, Jammu-180004, INDIA*
[3]*Department of Physics, University of Jammu, Jammu - 180006, INDIA*
** email: suramsingh@gmail.com*

Introduction

The nuclei ^{145,147,149}Pm lies in the region of transitional lanthanides where evidence has been found suggesting the presence of octupole deformation[1]. Therefore, one may expect that its excitation pattern will be dominated by single-particle configurations and vibration like, collective excitations. Pronounced octupole excitations, observed in the neighboring nuclei (like ^{149}Tb [2]), suggest that octupole collectivity may play an important role in the excitation mechanism of ^{145,147,149}Pm nuclei. A study of high spin states [3] in the Z = 61 nucleus ^{145}Pm provided evidence that the yrast spectrum of this nucleus can be interpreted in terms of the weak coupling of unpaired $d_{5/2}$, $g_{7/2}$, and $h_{11/2}$ proton holes and protons to a Nd core. This result suggests that the application of a Projected Shell Model (PSM) to promethium isotopes near the N = 82 shell closure may be fruitful.

Hence, in that direction, a systematic study of ^{145,147,149}Pm nuclei has been made in the present work using PSM.

Details of input parameters used in present work

In this work we have used the following Hamiltonian [4]

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

Where, H_o is 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 monopole pairing strength G_M is given by

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

with ‘‘-’’ for neutrons and ‘‘+’’ for protons. Values of G_1 and G_2 are taken as 21.20 and 12.70 respectively. The quadrupole pairing strength G_Q is assumed to be proportional to G_M and the proportionality constant is fixed to be 0.18. In the present calculations, we use ε_2= 0.180 for both ^{145,147}Pm and 0.160 for ^{149}Pm. The configuration space used in calculations consists of the three major shells for each kind of nucleon: N=3, 4 and 5.

Results and Discussion

Some nuclear structure properties such as yrast spectra, band diagrams, transition energies and back-bending for ^{145,147,149}Pm nuclei have been calculated and compared with the available experimental data. The calculated data for various nuclear structure properties are found to be in good agreement with the corresponding experimental data.

From the results of the calculations, it is found that:

a) PSM calculations have successfully reproduced the experimentally observed yrast states (Fig. 1).

b) We have also studied the variation of kinetic moment of inertia with rotational frequency and its comparison with the available experimental data is also made in the present work (Fig. 2).

c) Band structure for ^{145,147,149}Pm isotopes has been obtained from the PSM calculations. These band diagrams show that various 1-qp and 3-qp bands that leads to the formation of yrast spectra and this data would be explained during the presentation in the symposium.

From these results, we conclude that PSM calculation have quite successfully reproduced the experimentally observed nuclear structure properties for ^{145,147,149}Pm nuclei.

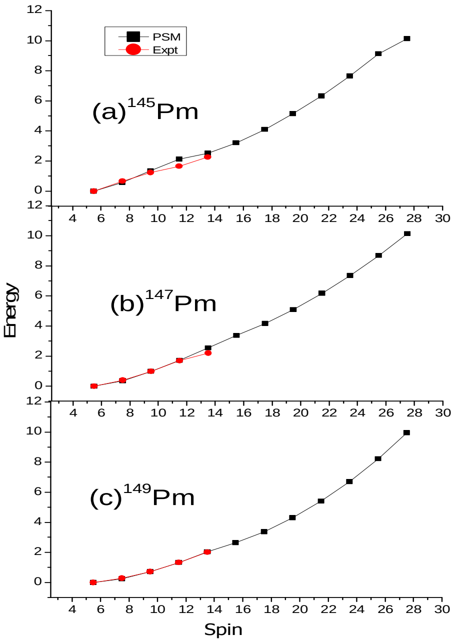

Fig. 1 Comparison of the experimental and calculated yrast spectra for (a) ^{145}Pm, (b) ^{147}Pm and (c) ^{149}Pm.

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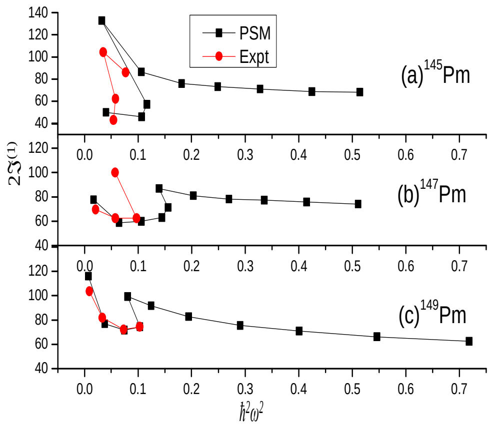

Fig. 2 Plots of twice the Kinetic Moment of inertia *i.e.,* $2\Im^{(1)}$ $(\hbar^2 MeV^{-1})$ versus square of rotational frequency $(\hbar\omega)^2$ for (a) ^{145}Pm, (b) ^{147}Pm and (c) ^{149}Pm.

References

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