Band structure of proton-hole ^{111,113}In nuclei

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Introduction

The single-particle structure that exists for spherical nuclei near closed shells gives way to more collective rotational structure for deformed nuclei that have a large number of valence nucleons outside closed shells. Such nuclei with Z ~ 50 and N ≥ 50 are of current interest because of the several shape transitions which occur in the A ~ 100 mass region. Different types of deformation (e.g. prolate, oblate, triaxial) are observed and can coexist in a same nucleus in accordance with the underlying interplay between orbitals. For Z ≥ 44, the active intruder orbitals are near the top of the $\pi g_{9/2}$ subshell, this drives shapes towards oblate deformation. On the other hand, when the neutron Fermi level lies below or near the bottom of the $\nu h_{11/2}$ subshell, the shape is driven to prolate deformation. The presence of such properties has made this region very interesting.

In recent years, great effort has been made in identification and theoretical interpretation of rotational bands in the A ~ 100 mass region. The origin of interest in nuclei from the region around the magic value of Z = 50 is that the spectra of their excited states involve a wide variety of distinct collective structures in addition to one-particle states. The mass region around A~100 is well known for its complicated interplay between single-particle and collective degrees of freedom. Spherical structures coexist with more deformed shapes associated with the proton intruder $g_{9/2}$ orbital. The high-spin structure of ^{111}In has been investigated with γ - ray spectroscopic methods using the ^{96}Zr(^{19}F,4n) reaction and comprehensive level scheme has been constructed which exhibits interesting collective as well as novel single-particle excitations [1]. Level structures of ^{113}In have been studied through the fusion-evaporation reaction ^{110}Pd (^{7}Li,4n)^{113}In at a beam energy of 50MeV. More than 40 new γ transitions have been observed in ^{113}In [2]. In the present work, the axial PSM has been systematically applied to the ^{111,113}In isotopes.

Outline of the Framework

In this work we have used the following Hamiltonian [3]

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

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. Value of G_1 and G_2 is taken as 22.50 and 12.12 respectively. The quadrupole pairing strength G_Q is assumed to be proportional to G_M and the proportionality constant is fixed to be 0.16. In the present calculations, we use ε_2= 0.230 and 0.240 for ^{111}In, and ^{113}In, respectively. The configuration space used in calculations consists of the three major shells for each kind of nucleon: N=2, 3 and 4, for protons and N= 3, 4 and 5 for neutrons.

Results and Discussions

Some nuclear structure properties such as band structure, yrast spectra and back-bending for ^{109,111}In nuclei has 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:

- PSM calculations have successfully reproduced the experimental yrast states.
- Bands structure for 111,113In isotopes has been obtained from the PSM calculations and is shown in the form of band diagram.

References

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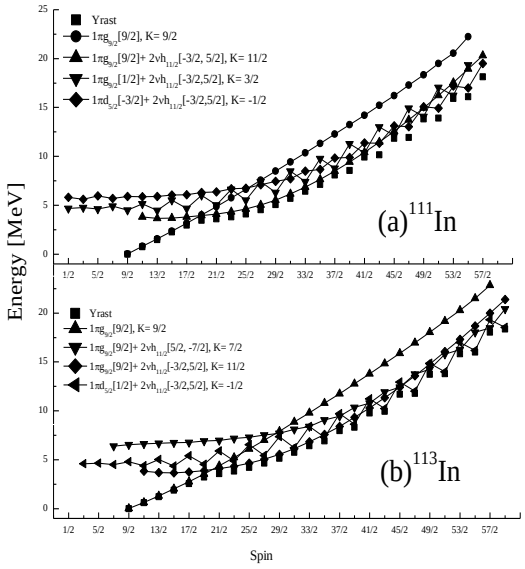

Fig. 1 Band diagram for (a) ^{111}In and (b) ^{113}In

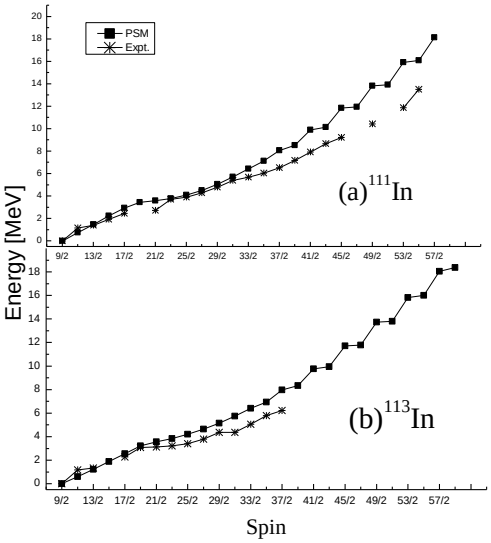

Fig. 2 Comparison of experimental observed and theoretically calculated yrast spectra for (a) ^{111}In and (b) ^{113}In.