Study of alignments in normal deformed bands of ^{165}Lu

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Introduction

The Lu isotopes with Z=71 show a variety of nuclear shapes. Andgren et al [1] have performed a fusion evaporation experiment to investigate the triaxiality and determined the lifetimes of medium spin states in ^{165}Lu. They have performed the total routhian surface (TRS) and particle rotor model calculations. The TRS calculations have predicted the axial shapes for $9/2^-[514]$, $7/2^+[404]$ and $1/2^-[541]$ bands. The ^{165}Lu has normal deformed bands and triaxial super deformed bands. The low-spin states of normal deformed bands of ^{165}Lu were known previously and they were extended to higher spin by Schönwaber et al [2]. Except one negative parity band all the normal deformed bands are coupled bands and their both signatures are known. Motivated by the availability of experimental data on multiple normal deformed bands in this isotope, the low-spin states of these bands are investigated by using projected shell model (PSM) framework [3].

Model

In PSM, three harmonic oscillator shells are taken for protons and neutrons. In the present calculation oslillator shells N=3,4,5 (4,5,6) are taken for protons (neutrons). The optimal set of deformed basis is selected from the last oscillator shell. The deformed quasi particle basis are obtained from the Nilsson plus BCS calculation. The quadrupole and hexadecapole deformation parameters known from the TRS calculations or experimental data are taken as input parameters. The shell model Hamiltonian with quadrupole-quadrupole plus monopole and quadrupole forces is diagonalized to get the energies and wave functions.

Results and discussion

The PSM calculations are performed and excitation energies of normal deformed low-spin positive and negative parity bands are obtained. The band head spins and parities of all the normal deformed positive parity bands are reproduced by the present calculations. From the experimental and theoretical excitation energies, the aligned angular momenta are obtained for all the normal deformed low-lying bands. The comparison of experimental and calculated alignments is displayed in fig. 1 for positive parity bands. For most of the bands, the experimental alignment occurs at rotational frequency ħω= 0.25 MeV in all the positive parity bands. The experimental alignment gain is of the order of 10ħ. The theoretical alignments plots reproduce nicely the observed rotational alignment frequencies and gains in all the bands.

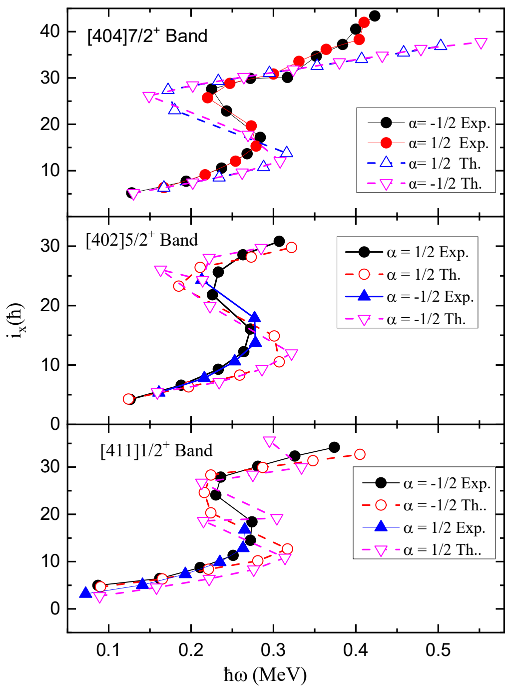

Fig. 1 Comparison of experimental and theoretical alignments in positive parity bands of ^{165}Lu

The first alignment occurs in [404]7/2^{+} band due to the crossing of this band by three quasi particle band arising from the 7/2 component of $g_{7/2}$ proton band and 3/2, 5/2 components of $i_{13/2}$ neutron band around spins 29/2, 31/2. Similarly, the first alignment in other two positive parity bands arises due to the crossing of these bands by three quasiparticle bands.

In fig. 2, the alignment plots of negative parity yrast band are displayed. From this figure, it is seen that the experimental alignment is reproduced well by the theoretical results. The alignment in these bands arises due to the crossing of 9/2^{-}[514] band by three quasi particle bands.

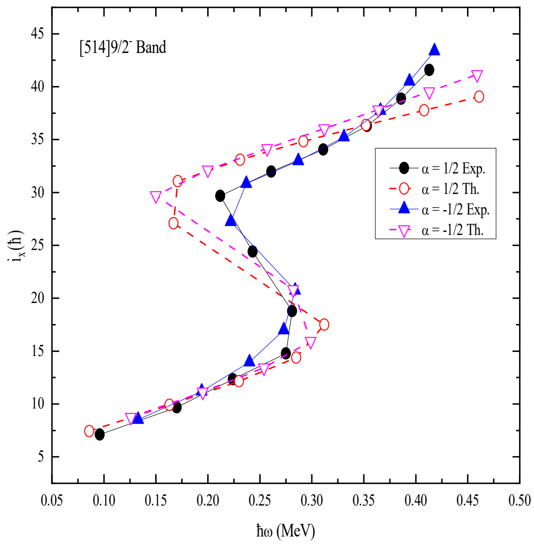

Fig. 2 Comparison of experimental and theoretical alignments in negative parity yrast bands of ^{165}Lu.

Conclusions

The PSM calculation reproduces well the observed alignments in normal deformed positive and negative parity bands. The observed alignments in these bands are interpreted due to the crossing of three quasi particle bands. The electromagnetic quantities of normal deformed states would be calculated in future work for comparison with available experimental data.

References

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[3] Y. Sun and K. Hara, Comput. Phys. Commun. 104, 245 (1997)

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