Anomalous feature in high K-bands of ^{240}Am

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Introduction

In a view of the developments over the past two decades, the rotational bands observed in odd-odd nuclei have been found to display interesting new feature such as odd-even staggering patterns.

During the course of experiment on alpha decay of ^{240}Am with a 6 mm Au-Si surface barrier detector, it has been observed the ground state of ^{240}Am is K=3, and Odd parity is a combination of the Nilsson ($\frac{5}{2}$[523]) proton state and the ($\frac{1}{2}$[631]) neutron state. The energy level scheme given by Gorman [1] in the alpha decay of ^{240}Am is different from the level scheme of recent reports [2, 3] studied using Deuteron-Induced Neutron Transfer reaction.

It has been analysed that the level scheme given by Ref. [1] is the odd favoured and even favoured spin is observed if we follow the level scheme of Ref. [2, 3] as shown in Fig 1. Also in the case of odd-odd nuclei, the favoured signature of a given ($2qp$) rotational band can be defined as : $\alpha_f = \frac{1}{2}(-1)^{(j_p-1/2)} + \frac{1}{2}(-1)^{(j_n-1/2)}$ where j_p and j_n are the spins of odd proton and odd neutron respectively [4]. According to the rule, configuration ($\frac{5}{2}[523]_\pi \otimes \frac{1}{2}[631]_\nu$) gives the odd favoured spin.

The striking feature to note here is that the level scheme given by Ref. [1] is also in accordance to the rule while the level scheme of Ref. [2, 3] is opposite to the rule. However, it was surprising to observe the different features given by two different energy levels. This interesting observation motivate us to study the odd-odd nuclei as an important area for research in ^{240}Am.

Therefore, in the present paper we focus on the anamoly in defining the energy level scheme for $K^+ = 3$ and investigate the anamolous behaviour in two-quasiparticle bands of odd-odd ^{240}Am nuclei.

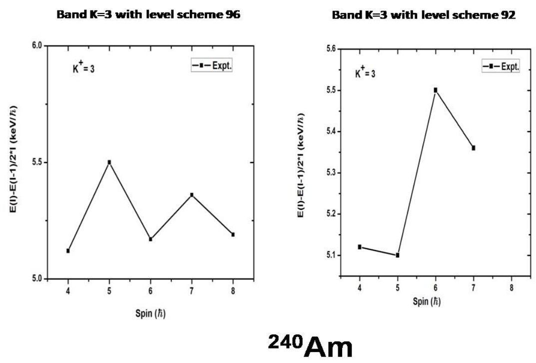

FIG. 1: (a, b) Experimental bands of ^{240}Am with level scheme 96 and 92.

Model Description

Several authors such as Jain et al. [5] has given in detail the theoretical description of the two quasiparticle rotor model (TQPRM). The total Hamiltonian of the system for odd-odd nuclei is usually expressed as:

$$H = H_{int} + H_{rot} \quad (1)$$

Single-particle energies are estimated from the neighbouring odd-A nuclei. The deformation parameters for Am nucleus is taken from Mollar and Nix [6]. The detailed model will be discussed at the time of final presentation.

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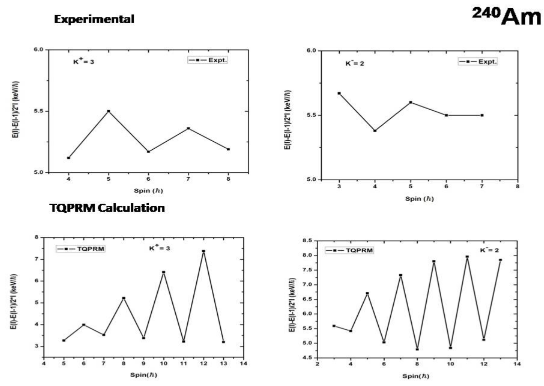

FIG. 2: $(a-d)$ Comparison of the experimental and calculated odd-even staggering of $(\frac{5}{2}[523]_\pi \otimes \frac{1}{2}[631]_\nu)$ $K^+ = 3$ and $K^- = 2$ bands of ^{240}Am.

Results

In this section, we present coriolis band mixing calculations for ^{240}Am in the actinide region. We have analysed the case of ^{240}Am and observed (i) anamoly in defining the energy level scheme of $K^+ = 3$ band and (ii) odd-even staggering in $(\frac{5}{2}[523]_\pi \otimes \frac{1}{2}[631]_\nu)$, $K^+ = 3$ and $K^- = 2$ bands.

It has been analysed that the level schemes suggested in Ref. [1] provide the odd favoured spins for $K^+ = 3$ band which is in accordance to rule while the scheme given by Ref. [2, 3, 7] is opposite to the rule. So,we have done TQPRM calculation to resolve this anamoly and found our calculation supports the rule with the recent data [2, 3, 7].

The experimental staggering plots of $\Delta E(I \to I-1)/2I$ versus I for $K^+ = 3$ and $K^- = 2$ bands are shown in figure $2(a)$ and $2(b)$. The interesting feature to note here is that there is a reverse behaviour in signature spin of experimental and the rule of α_f. The calculation done with TQPRM approach is shown in the graphs $2(c)$ and $2(d)$. In Fig. $2(c)$ we have also pointed out and observed the odd favoured spin for $K^+ = 3$ band which is in accordance to the rule but opposite to the experimental behaviour while in Fig. $2(d)$, the even favoured spin is observed for $K^- = 2$ band experimentally but opposite to rule.

The unique feature of ^{240}Am odd-odd nuclei is also to show an anamolous feature in two bands $K^+ = 3$ (Odd) and $K^- = 2$ (Even). The detailed calculations based on TQPRM model [5] help in identifying the mechanism responsible for the anamolous feature. The anamolous feature of $K^- = 0$ and $K^+ = 1$ $(\frac{1}{2}[541]_\pi \otimes \frac{1}{2}[631]_\nu)$ bands are transmitted to $K^+ = 3$ and $K^- = 2$ bands through a higher-order coriolis coupling. Thus, it is well recognised that coriolis coupling plays an important role in explaining the anamolous feature of two bands of ^{240}Am.

Conclusion

In this present work the anamoly in defining the energy level scheme of $K^+ = 3$ band is discussed and the anamolous feature of the two bands of ^{240}Am is analysed. The favoured spin in case of experimental (Even) and TQPRM (Odd) approach is reverse. The predominantly admixture of the bands with $K^- = 0$ and $K^+ = 1$ bands is responsible for transmitting this ambigous feature which is reasonably explained.

Discussion

In this study, the striking results given by Gorman and Gortdal are discussed. We have done our calculation using recent data as mentioned by many authors. Above all, we can consider it as a challenging problem and a fresh initiative may be needed to resolve this problem.

Acknowledgments

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