Shape behaviour at high spin in $^{137}_{61}$Pm

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Introduction

The nuclei in the mass $A \sim$ 130-140 region are known to be soft with respect to the triaxial deformation parameter γ and are therefore sensitive to the γ-polarizing effects of specific quasiparticle configurations. This can lead to the co-existence of quadrupole structures of different spectroscopic character, which are determined by the configuration of the valence quasiparticle. The polarizing effect is most pronounced for intruder high-j quasiparticles in the favoured signature orbitals. When occupied, these orbitals tend to stabilize the nuclear shape around a specific γ value that is strongly dependent on the position of the Fermi surface within the high-j shell. In nuclei in the mass region $A \sim$ 130-140, for $Z = 57$-63 the proton Fermi surface lies in the lower $h_{11/2}$ midshell where the occupied quasiparticle orbitals favour prolate axial symmetry. Odd-proton nuclei therefore exhibit rotational bands built on these low-K $\pi_{11/2}$ intruder levels. In contrast, the neutron Fermi surface for $N = 74$ - 78 lies in the upper $h_{11/2}$ midshell where the predicted deformation driving force is towards a collectively rotating oblate shape with $\gamma = -\ 60^0$.

The motivation of the present work is to investigate, understand and establish the observed level structure and nuclear phenomena at high spin in the ^{137}Pm nucleus due to shape driving influence of the intruder orbital (*viz.* $h_{11/2}$).In this context, the preliminary results were reported in Ref. [1]. The present paper focuses on the behaviour of the signature partner bands in this nucleus with increasing spin.

Experimental Details

High spin states in the odd-Z ^{137}Pm nucleus were populated using the ^{109}Ag (^{32}S, 2p2n) ^{137}Pm reaction at an incident beam energy of 150 MeV. The ^{32}S beam was delivered by the 15-UD Pelletron accelerator at Inter University Accelerator Centre (IUAC), New Delhi. The de-exciting γ-rays were detected utilizing the Indian National Gamma Array (INGA) which at the time of the experiment comprised of 18 Compton suppressed Clover detectors. The detail description about the INGA set-up is given in Ref. [1].

Data analysis and results

The data analysis procedures were discussed in ref. [1]. The level scheme of ^{137}Pm has been extended up to $J^\pi = \frac{43}{2}^-$ and excitation energy of $E_x \cong 6$ MeV due to the observa-

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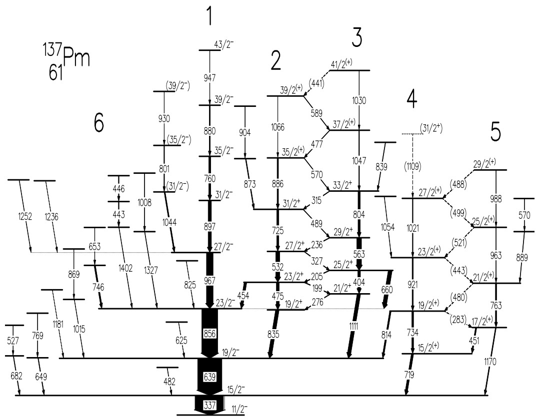

FIG. 1: The level scheme of ^{137}Pm deduced from the present work.

tion of 42 new gamma transitions and is illustrated in Fig. 1. In the odd-proton nuclei in this mass region the first proton-backbend is blocked. The first neutron alignment and second proton alignment are expected to occur at almost same frequency. In ^{139}Pm a gain of $\Delta i \cong 14\hbar$ at $\hbar\omega = 0.43$ MeV has been observed [2]. This was attributed to the simultaneous alignment of a proton and neutron pair. However in ^{137}Pm the observed gain is $\Delta i \cong 8\hbar$ [3]. This could plausibly be due to the alignment of a single pair of nucleons and could be attributed to the second and third proton alignment,based on the Cranked Shell Model calculations.

In addition to the yrast sequence, side-bands based on the configuration $\pi(g_{7/2}) \otimes \pi(h_{11/2})^2$(band 2 & 3) and $(d_{5/2}) \otimes \nu(h_{11/2})^2$(band 4 & band 5) have also been identified. Band 2 and 3 are confirmed to be the signature partner of each other due to the observation of the weak inter-connecting $\Delta J = 1$ transitions between band 2 & 3. Similarly, band 3 & 4 bands are signature partners of each other. The staggering in E(I)-E(I-1) and B(M1)/B(E2) for band 2 and 3 (shown in Fig. 2) is an indication towards the triaxial behaviour of this nucleus. Attempts have been made to measure the lifetimes of the levels for the higher lying members of the yrast band and for the bands 2 and 3 using the Doppler Shift Attenuation Method (DSAM). However, we find that the lifetimes, τ, are >1 ps and therefore not suitable for the DSAM.

The observed level structure in reference to signature partner bands would be discussed within the framework of the CSM.

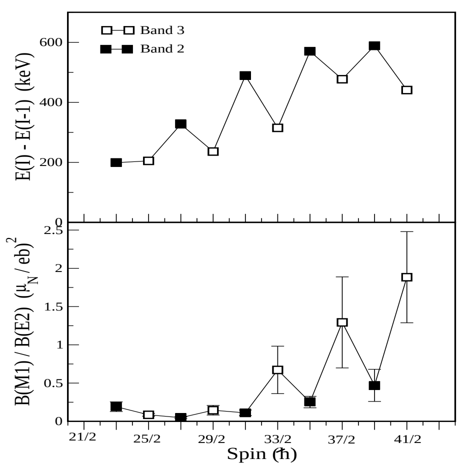

FIG. 2: The staggering in E(I) - E(I-1) and B(M1)/B(E2) for Band 2 & 3 of ^{137}Pm are shown in upper and lower panel respectively.

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