Structure of multiple bands in ^{135}Pm

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Introduction

The neutron deficient nuclei in A∼130 region are of particular interest for studying various shapes and their evolution with angular momentum. They continue to provide new information on novel nuclear excitation modes such as non-axial and super-deformed structures, shape coexistence, chirality and the wobbling mode. Pm isotopes with N ∼ 74 had been predicted to have large shape changes [1] driven by quasiparticle alignments. The proton pair alignments in ^{133}Pm, ^{135}Pm and ^{137}Pm isotopes drive shape changes in the nuclei with increasing spin [4]. Previous results on lifetime measurements reported up to spin $23/2^-$ in ^{135}Pm (see Ref. [5]) and up to $29/2^+$ in ^{137}Pm (see Ref. [6]) suggest a significant loss of collectivity. Thus more information is required to study the shape evolution in yrast band of ^{135}Pm. We have carried out detailed spectroscopy and lifetime measurements in ^{135}Pm to study the shape evolution and various excitation modes over a wide range of angular momenta. The results are discussed in terms of triaxial projected shell model (TPSM) and total routhian surface (TRS) calculations.

Experimental Details

Two separate experiments were performed to populate the high spin excited states in ^{135}Pm using the heavy ion fusion evaporation reaction ^{107}Ag(^{32}S, 2p2n) with different target thickness using the Indian National Gamma array (INGA) facility at Tata Institute of Fundamental Research, Mumbai. The first experiment involved the bombardment of ^{32}S beam with 145 MeV energy on an Au backed 1.2 mg/cm^2-thick ^{107}Ag target while the second one employed a self-supporting 0.95 mg/cm^2 ^{107}Ag target.

Two and higher-fold coincidence events were recorded in a fast digital data acquisition system (DDAQ) based on Pixie-16 modules of XIA-LLC which provides both energy and timing information [7]. The data were sorted using MultipARameter time stamped based COincidence Search (MARCOS) program to generate one-dimensional histograms, E_γ-E_γ and E_γ-E_γ-E_γ coincidence events for offline analysis. Lineshape code was used to extract the lifetimes of the excited states using Doppler shift attenuation method (DSAM).

Results and Discussion

Two- and three-fold γ coincidence analysis was performed to construct the level scheme of ^{135}Pm. The previous level scheme [3] was confirmed with some modifications. A total of 40 new transitions were identified extending the level scheme up to $I^\pi = 55/2^-$ with an excitation energy of 9058 keV. The spin, parity and intensities have been deduced for the concerned levels and transitions. The alignments of the rotational bands are shown in Fig. 1. A $\Delta I = 1$ band has also been observed with cross-over E2 transitions. A detailed investigation of this band is in progress.

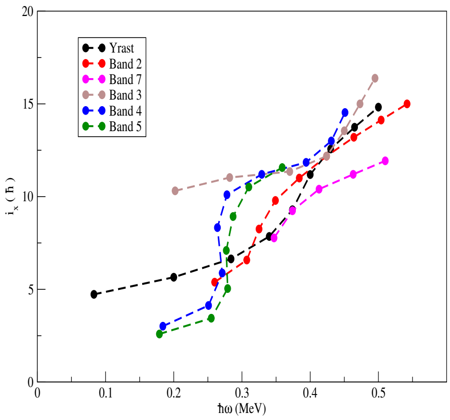

FIG. 1: Alignment of the rotational bands in ^{135}Pm established from the present work.

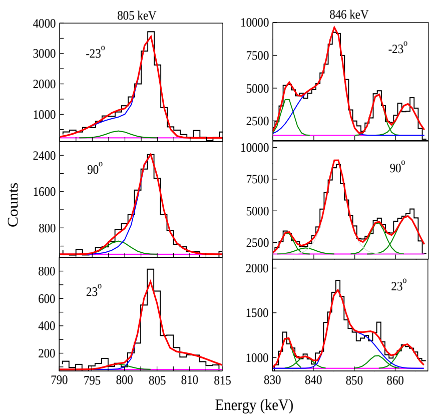

FIG. 2: Lineshape fitting for 805-, and 846-keV transitions obtained from the present work. The coincidence spectra from 23°, 90° and 157° detectors were used.

Lifetimes of excited levels of yrast band and dipole band have been measured to deduce the B(E2) and B(M1) values, respectively. Fig. 2 shows the lineshape plots for the 805- and 846-keV transitions. The results obtained from this measurement shows loss of collectivity in yrast band with increasing spin. A comparison with the TPSM and TRS calculations will also be presented. Theoretical calculations for the dipole band within the framework of the SPAC (Shears mechanism with Principal Axis Cranking) and TAC (Tilted Axis Cranking) models are in progress and will be compared with that of experimental findings.

Acknowledgement

Authors are thankful to the staff at TIFR-BARC Pelletron Linac Facility and all the members of the INGA facility. Support from S. V. Jadhav, R. Donthi, B. S. Naidu and A. Thomas during the experiment is deeply acknowledged. This work was supported in part by the Department of Science and Technology, Government of India (No. IR/S2/PF-03/2003-II) and by the U.S. National Science Foundation (Grant No. PHY- 1713857).

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