Investigation on a negative parity band in odd-odd ^{130}Cs

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Introduction

Structure of the odd-odd caesium nuclei has been drawn an immense interest over the recent years. Main focus of these investigations were to study the structure of the positive-parity $\Delta I = 1$ degenerate bands, which are supposed to be originated due to the chiral symmetry breaking in triaxial nuclei. Like other lighter mass odd-odd Cs isotopes, structure of the chiral doublet bands is investigated thoroughly in ^{130}Cs [1, 2]. However, the structure of the other side-bands are not explored fully. In particular, the structure of the negative parity bands should be investigated as it can provide information on the behaviour of the intruder $h_{11/2}$ orbital. As this orbital is the only negative parity orbital available in between 50 - 82 shell closures, therefore, the effect of this orbital can be studied without influence of any other orbitals. Therefore, in addition to a firm spin-parity assignments, lifetime measurements of the excited states can provide information about the deformation. In case of ^{130}Cs, a band based on $I^{\pi} = (14^{-})$ state at $E_x = 2596$ keV was reported earlier with tentative spin/parity assignment [2]. In this work, an attempt has been made to infer the structure of this band with spin, parity and lifetime measurements.

Experimental details and data analysis

Excited states in ^{130}Cs were populated via ^{124}Sn(^{11}B, 5nγ) fusion-evaporation reaction at a beam energy of 70 MeV. Energetic ^{11}B beam was delivered from the TIFR-BARC Pelletron Linac facility (PLF) at Tata Institute of Fundamental Research, Mumbai, India. De-exciting γ-rays were detected by 21 Compton suppressed HPGe clover detectors of Indian National Gamma Array (INGA). Valid two- and higher-fold coincident γ events were recorded in list-mode using Pixie-16 based digital data acquisition system. Gain-matched raw data were sorted into several symmetric and angle asymmetric matrices using MARCOS [3] code. Offline data analysis was carried out using RADWARE [4], INGASort [5] and LINESHAPE [6] codes. To determine the multipolarity of the transitions, the Directional Correlation of Oriented states (DCO) ratios was utilized. For this purpose, an $E\gamma$-$E\gamma$ matrix was made with detector angles of 90° on one axis and 157° on the other axis. The R_{DCO} was found to be approximately 1 for quadrupole and 0.5 for dipole transitions from stretched quadrupole gates. Doppler Shift Attenuation Method (DSAM) was used to estimate the pico-second order lifetime of excited states using Lineshape computer program. Lineshape fits were performed for detectors located at $\theta = 23°, 90°, 157°$.

Results and Discussions

The updated level scheme of the band of present interest is shown in FIG. 1. Spin of the all states are firmly assigned on the basis of the present angular correlation (R_{DCO}) results as listed in TABLE I. Lifetimes of four excited states at $E_x = 3363$, 4208 and 5120 keV are tentatively measured. Further analysis is in progress. As a representative, the intensity distribution of the 715 keV transition, decaying from $14^{(-)}$ state to $12^{(-)}$ state, in the 547 keV energy gated spectra at three different angles ($\theta = 23°, 90°, 157°$) are shown in FIG. 1 and FIG. 2 presents a typical gamma-ray spectrum for DCO analysis. The band of current interest

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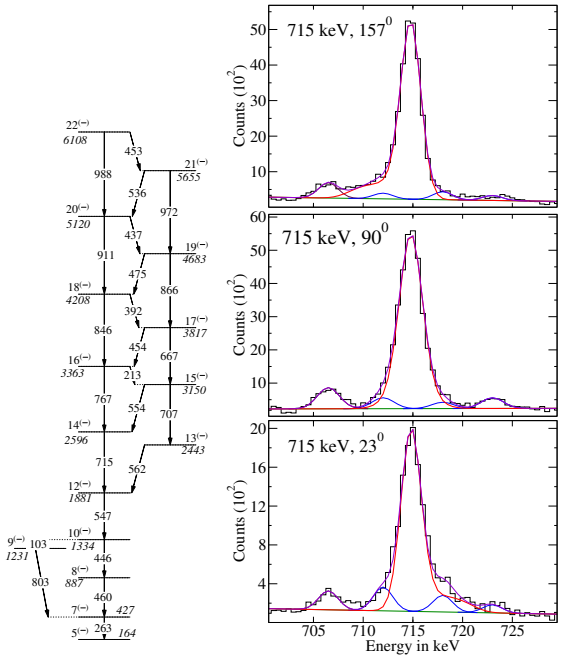

FIG. 1: Left: Partial level scheme of ^{130}Cs[2]. Right: The 547 keV γ-gated spectrum and lineshape fitting at different angles of ^{130}Cs.

was reported earlier with a possible configuration $\pi h_{11/2} \otimes \nu g_{7/2}$, based on the rotational properties and systematics. In this work, the microscopic structure of this band is currently being studied under the framework of Triaxial Particle Rotor Model (TPRM). The excitation energies of the levels of this band are well reproduced within the same configuration. Details of the results will be discussed during symposium.

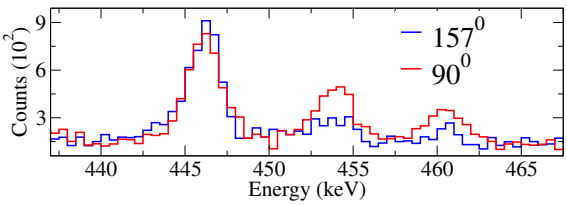

FIG. 2: Intensity of γ-rays, observed at $\theta = 90°$ and 157°, in coincidence with 547 keV γ-ray.

TABLE I: R_{DCO} of the γ-transitions, lifetime of the excited states and transition probabilities of the electric quadrupole transitions of ^{130}Cs.

E_x keV	E_γ keV	R_{DCO}	$Lifetime$ ps	$B(E2)$ e^2b^2
427	263	0.72 (0.11)		
887	460	0.34 (0.08)		
1231	803	1.15 (25)		
1334	446	0.98 (7)		
	103	1.18 (0.23)		
1881	547	0.96 (7)		
2596	715	0.88 (5)		
3150	707	0.98 (33)		
	554	0.22 (6)		
3363	767	0.86 7)	$1.25^{+0.11}_{-0.12}$	$0.25^{+0.02}_{-0.02}$
3817	454	0.42 (5)		
4208	846	1.20 (50)	$0.77^{+0.09}_{-0.09}$	$0.24^{+0.03}_{-0.03}$
	392	0.43 (9)		
4683	475	0.40 (8)		
5120	911	1.16 (22)	$1.29^{+0.14}_{-0.13}$	$0.10^{+0.01}_{-0.01}$
6108	988	0.92 (21)		
	453	0.42 (5)		

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