Investigation of Shape Coexistence in Mass 125 Region

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Introduction

Nuclei which are lying between the spherical Sb (Z=50) and well deformed La (Z=57) nuclei , generally known as transitional nuclei. The alignment of the valence nucleons outside the spherical ^{114}Sn core in the transitional nuclei of mass 125 region drives the nuclei into different shapes. The shape - driving force of the nucleons are sensible to the position of nilsson orbital for example, in 125 mass region the protons which are occupying in the lower part of $h_{\frac{11}{2}}$ intruder orbitals favors prolate shape, whereas the neutrons occupying in the upper part of $h_{\frac{11}{2}}$ subshell favors oblate shape [1]. The opposite shape driving properties of nucleons plays an important role for transforming nuclei from the collective prolate nucleon distribution to non-collective oblate distribution through an intermediate triaxial shape, which is determined by triaxial parameter γ. Deformation of nuclei from the collective prolate shape to non-collective oblate shape leads to an band termination, which is an interesting property of nuclei used to probing the nuclear structure. The lifetime measurements at high spins may useful to understanding the shape coexistence phenomenon in this region. In this paper we would like to report some lifetime measurements on neutron deficient nuclei ^{124}Ba and ^{123}Cs using DSAM method.

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Experimental Details

The excited states of ^{123}Cs were populated in the ^{96}Zr (^{32}S, p4n) ^{123}Cs reaction, whereas the high spin states of ^{124}Ba were populated in the same reaction by 4n channel. The ^{32}S beam of energy 140 MeV was provided by 15UD Pelletron accelerator at Inter University accelerator center, New Delhi. The target used was $1mg/cm^2$ enriched ^{96}Zr deposited on lead backing of thickness $10gm/cm^2$. Gamma ray coincidence events were collected by the Indian National Gamma ray Array (INGA) spectrometer consisting of 17 compton-suppressed HPGe detectors at the time of experiment [2]. The detectors were grouped into five rings at angles 57°, 32°, 90°, 123° and 148° with respect to the beam axis. The events were collected in the list mode by CANDLE, the data acquisition system with the condition of minimum three detectors were fired at the same time.

Lineshape Analysis

The lineshape analysis were carried out for the ^{123}Cs of negative-parity $h_{\frac{11}{2}}$ band and positive parity band in ^{124}Ba by assuming a sidefeeding rotational cascade of five transitions with the moment of inertia comparable with the in-band sequence feeding into each state, including the topmost state. Lineshape fitting

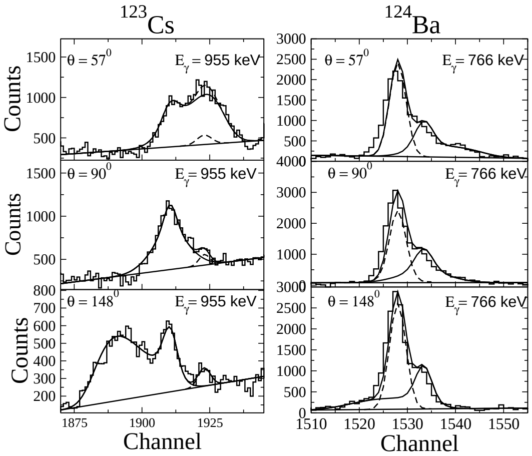

FIG. 1: Theoeritical lineshape fitted for the transition 955 KeV and 766 KeV.

was done for all the angles simultaneously and lifetimes were obtained by minimizing the χ^2 value, by comparing the theoritical lineshape generated by the program LINESHAPE [5], and the experimental lineshape. The fitted lineshapes are shown in fig1.

Results and Discussion

For ^{124}Ba nuclei, the results of lifetime measurements in the $h_{\frac{11}{2}}$ band shows, that the lifetime value decreases with increasing spin, whereas the sudden increase in lifetime for the gamma ray transition of energy 1005 keV at spin 22$\hbar$, indicates that there is drop in collectivity. The decrease in collectivity may resulting from the band crossing effect at rotational frequency of 0.49 MeV/$\hbar$ due to the alignment of decoupled $h_{\frac{11}{2}}$ neutron pair [3]. In the case of ^{123}Cs, the lifetime value decreases with increasing spin upto 39/2 $\hbar$. At spin 39/2 $\hbar$, there was sudden increase in lifetime. The previous investigation of ^{123}Cs nuclei suggests that the band crossing in the $h_{\frac{11}{2}}$ band takes place at rotational frequency of 0.44MeV/$\hbar$ due to the alignment of $h_{\frac{11}{2}}$ neutron pair [4]. However, our lifetime analysis shows that there is drop in collectivity for the gamma ray transition of energy 955 keV ($\hbar\omega\approx$ 0.48$MeV/\hbar$) at spin 39/2 $\hbar$, which is inconclusive at present, needs further clarification. The obtained lifetime values for ^{124}Ba and ^{123}Cs are tabulated as shown below.

^{124}Ba/E$_\gamma$(keV)	$J_i\rightarrow$J$_f$($\hbar$)	$\tau(ps)$
766	16→14	$0.40^{+0.006}_{-0.006}$
871	18→16	$0.19^{+0.01}_{-0.01}$
948	20→18	$0.15^{+0.008}_{-0.01}$
1005	22→20	$0.50^{+0.03}_{-0.04}$

^{123}Cs/E$_\gamma$(keV)	$J_i\rightarrow$J$_f$($\hbar$)	$\tau(ps)$
801	27/2→23/2	$0.52^{+0.004}_{-0.001}$
868	31/2→27/2	$0.31^{+0.005}_{-0.008}$
905	35/2→31/2	$0.30^{+0.006}_{-0.003}$
955	39/2→35/2	$0.42^{+0.005}_{-0.001}$
1026	43/2→39/2	$0.21^{+0.01}_{-0.002}$
1113	47/2→43/2	$0.11^{+0.01}_{-0.007}$
1206	51/2→47/2	$0.08^{+0.014}_{-0.015}$
1303	55/2→51/2	$0.05^{+0.012}_{-0.002}$

Acknowledgments

This work was supported by the Department of Science and Technology(DST/SR/S2/HEP-09/2005), New Delhi. The authors would like to thank the pelletron and Electronics group of IUAC for their kind support during the experiment. Financial support from the MHRD also gratefully acknowleged.

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