Investigation of Shape Coexistence in Mass 125 Region

K. Selvakumar1,∗ Subhashri Das1, A. K. Singh1, Purnima Singh1, A. Gowsami2, R. Raut2, M. Kumar Raju8, A. Mukherjee2, U. Datta Praminik2, P. Dutta3, S. Roy4, G. Gangopadhyay5, S. Bhowal6, S. Muralithar7, Rakesh Kumar7, R. P. Singh7, and Thomas Reddy8

1Department of Physics, IIT Kharagpur, Kharagpur-721 302, India
2Nuclear and Atomic Physics Division, SINP, Kolkata-700 064, India
3Ananda Mohan College, Kolkata-700 009, India
4S.N.Bose National Centre for Basic Sciences, Kolkata-700 064, India
5Department of Physics, University of Calcutta, Kolkata-700 073, India
6Surendranath College, Kolkata-700 009, India
7Inter University Accelerator Center, New Delhi-110 067, India and
8Department of Physics, Andhra University, Visakhapatnam-530 003, India

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 114Sn 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 h11/2 intruder orbitals favors prolate shape, whereas the neutrons occupying in the upper part of h11/2 subshell favors oblate shape [1]. The opposite shape driving properties of nucleons plays an important role for transforming nuclei from the collective prolate nucleus 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 124Ba and 123Cs using DSAM method.

Experimental Details

The excited states of 123Cs were populated in the 96Zr (32S, p4n) 123Cs reaction, whereas the high spin states of 124Ba were populated in the same reaction by 4n channel. The 32S beam of energy 140 MeV was provided by 15UD Pelletron accelerator at Inter University accelerator center, New Delhi. The target used was 1mg/cm2 enriched 96Zr deposited on lead backing of thickness 10gm/cm2. 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 121Cs of negative-parity h11/2 band and positive parity band in 124Ba by assuming a side-feeding 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

∗Electronic address: selva@phy.iitkgp.ernet.in

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Counts

Counts

Counts

Counts

Counts

θ = 57

θ = 148

θ = 90

θ = 27

θ = 37

Results and Discussion

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

<table>
<thead>
<tr>
<th>$^{124}\text{Ba}/E_i$(keV)</th>
<th>$J_i\rightarrow J_f$(h)</th>
<th>$\tau$(ps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>766</td>
<td>16$\rightarrow$14</td>
<td>0.40$^{+0.06}_{-0.06}$</td>
</tr>
<tr>
<td>871</td>
<td>18$\rightarrow$16</td>
<td>0.19$^{+0.01}_{-0.01}$</td>
</tr>
<tr>
<td>948</td>
<td>20$\rightarrow$18</td>
<td>0.15$^{+0.08}_{-0.01}$</td>
</tr>
<tr>
<td>1005</td>
<td>22$\rightarrow$20</td>
<td>0.50$^{+0.03}_{-0.04}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$^{124}\text{Cs}/E_i$(keV)</th>
<th>$J_i\rightarrow J_f$(h)</th>
<th>$\tau$(ps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>801</td>
<td>27/2$\rightarrow$23/2</td>
<td>0.52$^{+0.01}_{-0.01}$</td>
</tr>
<tr>
<td>868</td>
<td>31/2$\rightarrow$27/2</td>
<td>0.31$^{+0.08}_{-0.01}$</td>
</tr>
<tr>
<td>905</td>
<td>35/2$\rightarrow$31/2</td>
<td>0.30$^{+0.06}_{-0.01}$</td>
</tr>
<tr>
<td>955</td>
<td>39/2$\rightarrow$35/2</td>
<td>0.42$^{+0.05}_{-0.01}$</td>
</tr>
<tr>
<td>1026</td>
<td>43/2$\rightarrow$39/2</td>
<td>0.21$^{+0.02}_{-0.01}$</td>
</tr>
<tr>
<td>1113</td>
<td>47/2$\rightarrow$43/2</td>
<td>0.11$^{+0.04}_{-0.01}$</td>
</tr>
<tr>
<td>1206</td>
<td>51/2$\rightarrow$47/2</td>
<td>0.08$^{+0.04}_{-0.01}$</td>
</tr>
<tr>
<td>1303</td>
<td>55/2$\rightarrow$51/2</td>
<td>0.05$^{+0.02}_{-0.01}$</td>
</tr>
</tbody>
</table>

Acknowledgments

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References


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