Lifetimes of $11/2^-$ and $23/2^+$ isomeric states in ^{135}La

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I. INTRODUCTION

The transitional nuclei in the A∼130 mass region with few valence nucleons near shell closure offer to study rich variety of shapes and structures due to interplay of various multi quasi- particle excitations and the collective behavior of underlying core. Many experimental studies based on gamma-ray spectroscopy with heavy ion-induced reactions evidenced mainly high-spin level structures, an outstanding one being that due to the unique parity orbital $h_{11/2}$ both for protons and neutrons [1]. The different deformation driving forces of the valence protons and neutrons occupying low and high states of the $h_{11/2}$ intruder orbital leads to phenomenon of shape coexistence. The lifetime measurements can help to understand the phenomenon of shape coexistence. The present work is devoted to the measurement of the lifetimes of two isomeric states with spin- parities $11/2^-$ ($\tau_{1/2} < 10$ ns) and $23/2^+$ ($\tau_{1/2} = 28.4(8)$ ns) in ^{135}La [2].

II. EXPERIMENTAL DETAILS

The isomeric states in ^{135}La were populated and aligned in the reaction ^{128}Te(^{11}B, 4nγ)^{135}La using ^{11}B pulsed beam at 60 MeV energy from the 15UD Pelletron accelerator facility, Inter University Accelerator Centre, New Delhi. An isotopically enriched 500μg/cm^2 ^{128}Te backed with 5.7 mg/cm^2 gold foil was used as a target. The recoils were stopped in an iron foil after gold foil. The γ-rays were detected by two $LaBr_3$ detectors placed at ±135° in a horizontal plane w.r.t the beam at a distance of 20 cm from the target. The γ-ray spectrum was also monitored by a HPGe detector. The data were collected in LIST mode with four parameters: the energy and time signals for each $LaBr_3$ detector. The time signal from the $LaBr_3$ detector was used to start the time to amplitude converter (TAC) and the stop signal was provided by the primary rf signal from the buncher. The reported results are the part of the experiment carried out for the g-factor measurements of the states.

III. DATA ANALYSIS AND RESULTS

In the off-line analysis of list-mode data, two dimensional matrices of energy versus time were formed for each detector. From these matrices time-gated energy spectra and energy gated time spectra were formed. The partial level scheme of ^{135}La showing the decay of the presently investigated isomers is shown in the Fig.1.

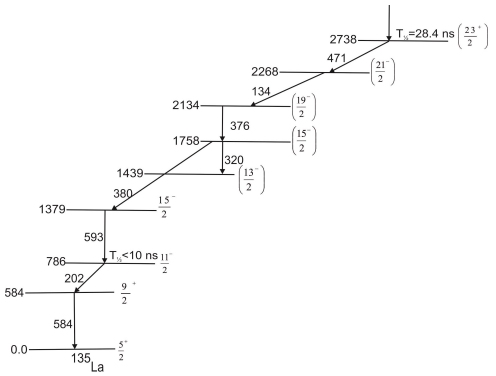

FIG. 1: Partial level scheme showing the decay of $11/2^-$ and $23/2^+$ isomeric states in ^{135}La.

For the $11/2^-$ state the 173 keV isomeric transition was analyzed, while in the case of the $23/2^+$ isomer the analysis was done for the 471 keV transition. The gamma gated time spectra after proper background subtraction and matching T_0 have been least squares fitted assuming an exponential decay. The resulting decay spectra for the $11/2^-$, $23/2^+$ isomers in ^{135}La are shown in fig. 2 and fig. 3. The observed half-life time $T_{1/2}(23/2^+) = 27.7(4)$ ns, is in good agreement with the results of the previous measurements [2,3].

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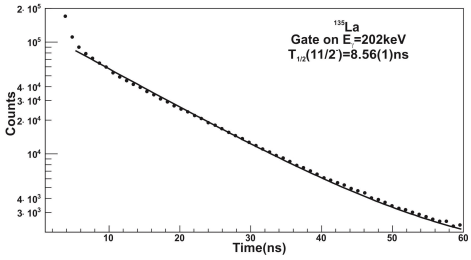

FIG. 2: Summed time spectra with gates on γ–transitions from the $11/2^-$ isomeric state in ^{135}La. The solid curve shows the least-squares fit to the data.

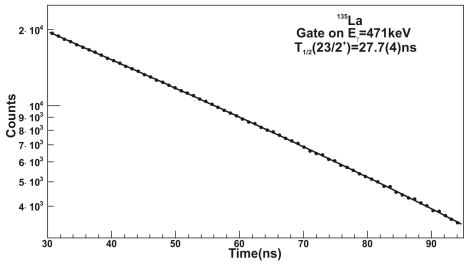

FIG. 3: Summed time spectra with gates on γ–transitions from the $23/2^+$ isomeric state in ^{135}La. The solid curve shows the least-squares fit to the data.

The extracted half-life time for $11/2^-$ isomeric state, $T_{1/2}(11/2^-) = 8.56(1)$ ns, is measured first time and falls in the systematic of the $11/2^-$ isomeric state across the isotopic chain Z=57.

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