g-factor of $11/2^-$ isomeric state in ^{133}La

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Introduction

The interplay between single-particle and collective excitation modes generates complex and rich level structures for nuclei around A $\sim$ 135. Occupation of high-j orbitals for protons and neutrons is responsible for various structure phenomena for nuclei in this region, such as signature splitting, signature inversion, wobbling motion, chiral rotation and high spin isomers. In some cases, the band structures representing the exotic modes are built on these isomers. Recently, the isomers in ^{135,136}La [1–3] isotopes in this region have attracted lot of attention. With the advancement of large scale shell model calculations [4], it is now possible to analyses the structures of these isomers. The isomers being relatively pure attract lot of theoretical attention as they can be directly related to model configurations. The measurement of the static magnetic dipole moment is very important for exploring the structure of the underlying configurations of the isomers. As a part of a systematic study of the isomers in this region, we have performed experiment to measure the g-factor of ^{133}La isotope. In the present investigation, the magnetic perturbation of the angular distribution pattern of the de-exciting γ-rays from the respective isomeric states has been exploited for the determination of the g-factor of 535 keV isomeric state of $11/2^-$ in ^{133}La [5, 6], using time differential perturbed angular distribution technique (TDPAD).

Experimental Details

The $11/2^-$ isomeric level at 535 keV in ^{133}La was populated through the reaction ^{126}Te(^{11}B, 4n)^{133}La using 52 MeV pulsed ^{11}B beam having a pulse width of 1 ns and repetition period of 800 ns provided by the BARC-TIFR Pelletron Linac Facility at TIFR, Mumbai. An isotopically enriched 1.1 mg/cm^2 ^{126}Te evaporated on 9.9 mg/cm^2 Au backing was used the experiment in presence of static external magnetic field $B_{ext} = 2$T perpendicular to the beam-detector plane. The delayed gamma-rays from the 535 keV isomer were measured by HPGe detectors placed at angles $\pm 45°$ and $\pm 135°$ with respect to the beam direction. The time signal from the HPGe detector was used to start the time to amplitude converter (TAC), which was stopped by the primary RF signal of the buncher. The data were collected in LIST mode with eight parameters for energy and time signals for four detectors. In the offline analysis, two dimensional spectra with energy *vs.* time were constructed for each detector. The lifetime spectra for the γ-rays decaying from the isomeric state were generated by taking energy gated time projections. Normalized counts for each detector $N(\theta, t)$ were used to construct the spin rotation spectra defined as

$$R(t) = \frac{[N\uparrow(\theta,t) - N\downarrow(\theta,t)]}{[N\uparrow(\theta,t) + N\downarrow(\theta,t)]} \quad (1)$$

The spectra were fitted to the function

$$R(t) = -\frac{3}{4}A_2 \sin(2\omega_L t - \phi) exp(-\lambda t) \quad (2)$$

to extract the amplitude A_2, Larmor frequency ω_L and damping factor λ. Here, ϕ denotes a phase angle due to finite bending of the incoming beam in external magnetic field.

Experimental Results

The partial level scheme of ^{133}La showing the decay of isomer is shown in Fig. 1. The delayed γ transitions from the isomer at 535 keV excitation energy is shown in Fig. 2. Fig. 3 shows the life time decay spectrum fitted with exponential decay curve with energy gate on the 477 keV γ-line to give a lifetime ($T_{1/2}$) of 68.01(41) ns which is close to the reported value in [5, 6]. The time spectra generated with 477 keV transitions were used to form the experimental modulation ratio $R(t)$. The spectra fitted to the Eqn.(2) yielded ω_L = 111.39 Mrad/s for 477 keV transitions. This provides the g-factor of the $11/2^-$ isomer in ^{133}La as 1.16(7). Our measured value of the g-factor is close to the value quoted in Ref. [7]. The large-scale shell-model (LSSM) calculations has been performed to compare with this measured value. The results of the calculations will be presented.

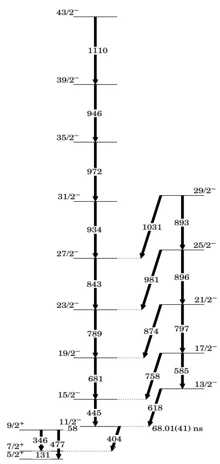

FIG. 1: Partial level scheme of ^{133}La showing the isomer at 535 keV(adopted from Ref. [6]).

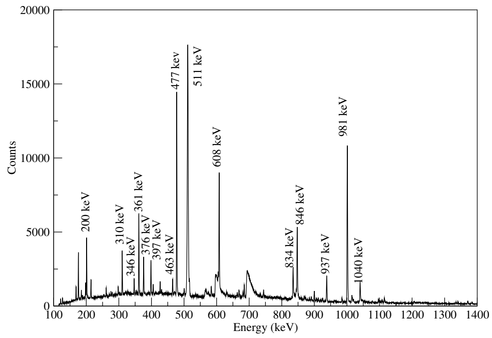

FIG. 2: Delayed gamma spectrum showing the different transitions of ^{133}La and other nuclei.

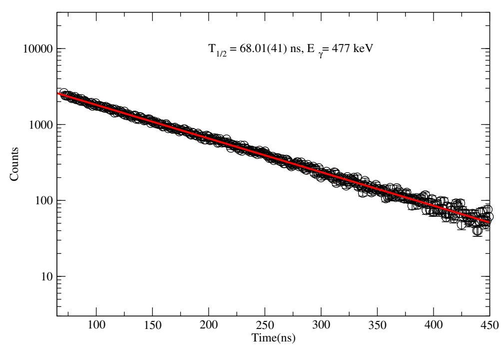

FIG. 3: Life time decay spectrum obtained with energy gate on the 477 keV γ-line.

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