Observation of triaxiality in ^{151}Eu nucleus

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Introduction

The non-uniform distribution of nuclear mass along the three principal axes results in the formation of triaxial nuclear structure, which has gained much popularity in the recent past. The prominent characteristics of triaxiality are signature inversion, wobbling, chirality, etc. In particular, Bengtsson *et al.*, established that the observation of signature inversion is one of the crucial fingerprints of triaxiality in odd-odd nuclei [1]. In general, two signature partner bands form a regular ΔI=1$\hbar$ rotational sequence where the favoured band has lower excitation energy than the unfavoured band. Whereas in the case of signature inversion the energy spacing, also called energy staggering parameter, between the two bands gradually decreases with increasing spin and after a certain angular momentum the energy of the unfavoured band becomes lower than the favoured band. It has been observed that nuclei which are sufficiently soft to γ- deformation are vulnerable to signature inversion as the alignment of the quasiparticles polarizes the core and thereby establishes a triaxial deformation.

Such triaxial structures are widely observed throughout the nuclear chart. However, much information about triaxiality is limited in 150 mass region. The signature splitting observed in ^{155,157}Ho, as well as in ^{155}Tb nuclei indicate the presence of triaxiality. While the variation in the transition strength ratio in Z = 63 ^{151}Eu nucleus is also observed to be similar to ^{155}Ho nucleus [2]. However, concrete evidence of triaxiality is yet to be established in this mass region.

Experimental Details

The excited states of ^{151}Eu nucleus were studied using the ^{148}Nd(^{7}Li, 4n)^{151}Eu fusion evaporation reaction and Indian National Gamma Array (INGA) [3] at IUAC, New Delhi. The 32 MeV energetic beam of ^{7}Li,

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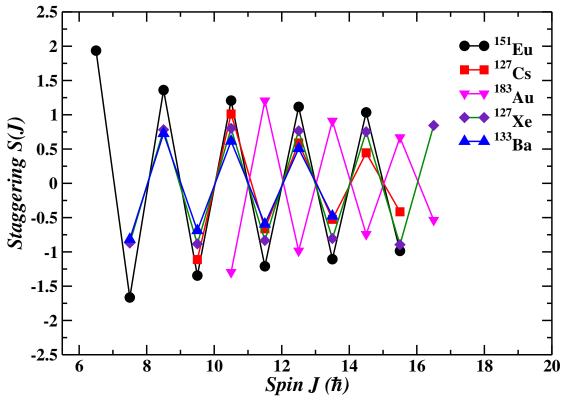

FIG. 1: The variation of energy staggering parameter S(J) as a function of spin.

provided by 15 UD pelletron at IUAC, was bombarded on ^{148}Nd target of thickness 850 μg backed with 12 mg of ^{197}Au. The decaying γ- rays were detected using 16 Compton suppressed clover detectors placed at 32°, 57°, 90°, 123° and 148° along with 2 ancillary LEPS detectors at 61° and 119° respectively. The coincidence data were sorted in different symmetric and angle-dependent asymmetric $\gamma-\gamma$ matrices using INGASORT program developed at IUAC, New Delhi. The $\gamma-\gamma$ matrices were then analyzed using the RADWARE and ROOT software packages.

Results and Discussion

In the present study, the structure of ^{151}Eu nucleus has been studied using detailed γ-ray spectroscopic techniques. Inter-connecting transitions between the favored and unfavored signature partner bands have been identified and placed in the level scheme. The multipolarity and nature of the newly observed transitions have been assigned using the R_{DCO} and polarization asymmetry measurements. To calculate linear polarization, the sensitivity of the 90° clover detectors has been measured using pure *E1* transitions observed in the present reaction. Moreover, to gain more clarity about the nature of the inter-connecting transitions, mixing ratios have also been determined from the R_{DCO}-polarization measurement.

To understand the structural properties of ^{151}Eu nucleus, the experimental energy staggering pattern S(J) of ^{151}Eu nucleus has been plotted in Fig. 1 and compared with other established triaxial nuclei. In the case of ^{127}Cs nucleus, the S(J) parameter rapidly decreases with increasing spin showing a gradual shift towards signature inversion at higher angular momentum. A similar decrease of the S(J) parameter as a function of spin is also observed for the higher mass ^{183}Au nucleus, whereas in ^{133}Ba and ^{127}Xe nuclei the S(J) parameter slowly decreases with increasing spin. The ^{151}Eu nucleus is also observed to show a gradually decreasing variation of the S(J) parameter with increasing spin. Such a pattern suggests the occurrence of polarization of the core due to quasiparticle alignment with increasing spin, which results in triaxial deformation in ^{151}Eu nucleus. Moreover, the experimental results are further interpreted using total Routhian surface (TRS) calculations. The observation of prominent γ soft minima for the yrast and unfavoured signature partner bands also supports the experimental predictions [4].

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