Lifetimes of high spin states of ^{126}I: Triaxial nuclear shapes

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Introduction

There has been growing interest to understand the role of triaxial nuclear shapes in many interesting phenomena like chirality, signature inversion. In our recent study of ^{126}I [1], we have theoretically established the cause of signature inversion to be the change in the axis of rotation from the shortest to intermediate axis of the triaxial nucleus. In the present work, we are trying to establish the same result experimentally. An attempt has been made to find the lifetimes of the high spin states of ^{126}I by the Doppler shift attenuation method (DSAM).

Experimental details

The experiment was performed using the heavy-ion fusion reaction ^{124}Sn(^{7}Li, 5n)^{126}I at the Pelletron accelerator facility at Inter University Accelerator Center, New Delhi, India. The target was an isotopically enriched self-supporting foil of ^{124}Sn of thickness 2.7 mg/cm^2. The Indian National Gamma Array (INGA), consisting of 15 Compton suppressed clover HPGe detectors, was used. These detectors were placed at 32°, 57°, 90°, 123° and 148° with respect to the beam direction. The triple-γ coincidence data were collected in the event-by-event mode.

Data analysis and results

The standard procedure of data analysis was outlined in our earlier work [1]. After initial sorting of the data, three E_γ *vs* E_γ matrices, corresponding to three different positions of the detectors, $\theta_1 = 32°$, $\theta_2 = 90°$ and $\theta_3 = 148°$ were created. For instance, for the first matrix, the energy of the γ-transition detected at θ_1 formed one axis of the matrix. The other axis corresponded to the energy of the coincident γ-transition detected in any of the clover detectors. Energy gates were put on these matrices and three projected spectra, θ_1, θ_2 and θ_3, were created.

The yrast band of the decay scheme of ^{126}I is presented in Fig. 1. The phenomenon of signature inversion was observed at 13$\hbar$. The projected spectra for the 893 keV transition were generated by gating on the lower transition 968 keV (Fig. 2). Two contamination peaks at 888 keV and 891 keV were observed. The computer program LINESHAPE [2] was used to fit the peak profiles including the contamination peaks by the χ^2 minimization routines. In the fitting procedure, the side feeding and direct feeding intensities were kept fixed which were calculated from the known intensities of the γ-transitions. Furthermore, the lifetimes of the both types of feedings were kept as free parameters. From our preliminary analysis, the lifetime of the 17^- was estimated to be 0.26 ps. The simultaneously lineshape fitting for many transitions in the yrast band (Fig. 1) is being carried out.

Theoretical discussion

In Lund convention, the deformation parameters (β, γ) can have values in the range $\beta > 0$ and $-60° \leq \gamma \leq +60°$ for rotating nuclei. Furthermore, the transition quadrupole moment Q_t for a triaxial nucleus is defined as follows :

$$Q_t = Q_{20}\frac{\cos(\gamma + 30^o)}{\cos(30^o)},\ Q_{20} = \frac{3}{\sqrt{5}}Ze(r_o A^{\frac{1}{3}})^2\beta$$

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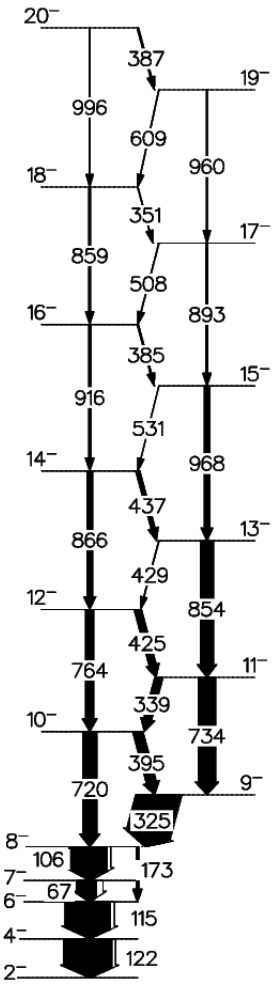

FIG. 1: Partial decay scheme of ^{126}I [1]

Our plan is to find the lifetimes and transition quadrupole moments of many high spin states of the yrast band, shown in Fig. 1, from the DSAM analysis. From the above equations, we will determine the values of the (β, γ) for states below and above the signature inversion $13^{-}\hbar$. These values of (β, γ) will then be compared with our earlier theoretical estimates [1] to verify if the cause of signature inversion was indeed due to change in the axis of rotation.

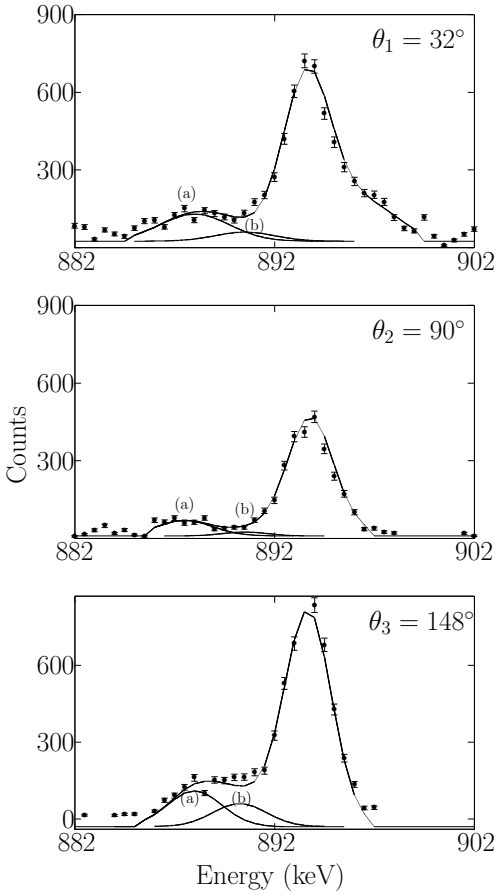

FIG. 2: Spectra of 894 KeV transition with DSAM fitting. The contamination peaks are marked as (a) and (b).

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References

[1] B. Kangalekar *et al.* Phys. Rev. C 88, 054306 (2013).
[2] J. C. Wells and N. R. Johnson, ORNL report 6689, 44 (1991).