Measured transition probabilities and observed signature inversion in ^{126}I

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Introduction

The observed signature inversion in ^{126}I is due to a change in the axis of rotation [1]. The valence neutron occupies the intruder orbit $h_{11/2}$, whereas a mixed configuration exists for valence proton involving orbitals $d_{5/2}$ and $g_{7/2}$ and which one is dominant is still obscure [1, 2]. The present work on lifetime using Doppler shift attenuation method (DSAM) aims to throw further light on understanding signature inversion.

Experiment and data analysis

We studied the high spin states of ^{126}I [1] using the reaction ^{124}Sn(^{7}Li, 5n)^{126}I at 50 MeV incident energy. The target was an enriched (99.4%) ^{124}Sn of thickness 2.7 mg/cm^2. We utilized 15 Compton suppressed HPGe clover detectors installed in the INGA set-up at IUAC, New Delhi [3].

From the collected triple-coincidence data, the asymmetric matrices - corresponding to the detector at the angle of interest *vs.* all detectors - were sorted. These were 32° *vs.* all detectors for the forward Doppler shift, 148° *vs.* all for the backward Doppler shift, and 90° *vs.* all for the full unshifted gamma-peak to examine contamination due to other transitions. We adopted two gating methods, gating on a transition below (GTB) and gating on a transition above (GTA). We also analyzed the Doppler shifts by fitting globally and simultaneously all the concerned gamma peaks for the angles 32° and 148° using the computer program by J. C. Wells *et al.* [4]. The GTA method has solved the side-feeding problem; however, a side-feeding model of two or three levels was used in GTB analysis. Fig. 1 shows one example of lineshape fitting and Table I summarizes all our results.

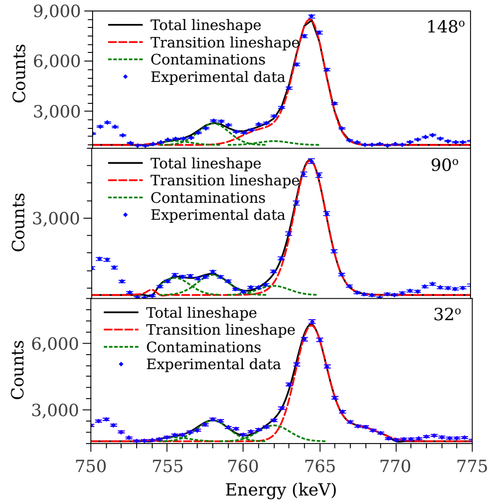

FIG. 1: Lineshape fitting of 765 keV transition.

TABLE I: Lifetime values for the gamma transitions of yrast band.

$I(\hbar)$	E_γ (keV)	Q_t (eb)	τ (ps)
10	720	$4.87^{+0.17}_{-0.17}$	$1.48^{+0.11}_{-0.10}$
11	734	$3.64^{+0.12}_{-0.12}$	$1.88^{+0.12}_{-0.13}$
12	765	$2.50^{+0.05}_{-0.05}$	$2.76^{+0.08}_{-0.10}$
13	854	$2.72^{+0.06}_{-0.06}$	$1.18^{+0.05}_{-0.06}$
14	866	$1.83^{+0.03}_{-0.03}$	$2.24^{+0.08}_{-0.06}$
15	969	$1.49^{+0.12}_{-0.13}$	$1.79^{+0.36}_{-0.26}$
16	916	$1.75^{+0.12}_{-0.12}$	$1.62^{+0.15}_{-0.20}$
17	894	$1.68^{+0.08}_{-0.09}$	$1.89^{+0.23}_{-0.16}$

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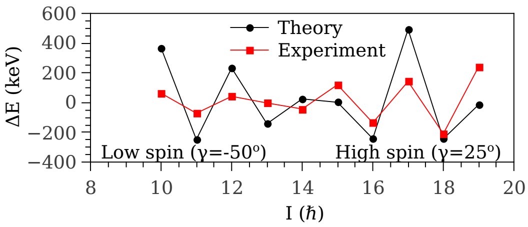

FIG. 2: Signature inversion and splitting.

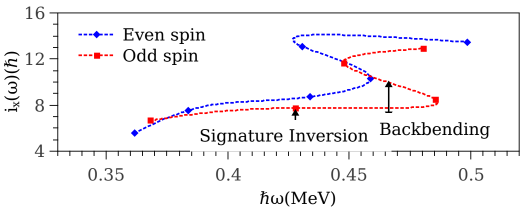

FIG. 3: Experimental backbending in ^{126}I in terms of RAL model.

Theoretical discussion and results

In our earlier work [1], the triaxial deformation parameter γ - estimated from the total Routhian surface (TRS) calculation - played a vital role in understanding the cause of signature inversion in the yrast band. In the present study, a better estimate of γ was obtained from the measured quadrupole moment Q_t using eq. (1)

$$Q_t = \frac{3}{\sqrt{5\pi}} Z (r_0 A^{1/3})^2 \beta \frac{\cos(\gamma + 30^\circ)}{\cos(30^\circ)} \quad (1)$$

for a constant value of $\beta = 0.15$ [1]. The sign of γ turned out to be negative ($\gamma = -50^\circ$) below the inversion and positive ($\gamma = 23^\circ$) above the inversion. With the current values of deformation parameters, we performed the two quasi-particle rotor model calculation. We could reproduce the correct phase of the signature splitting, but the inversion point was slightly up (Fig. 2).

The valence proton configuration was dominant in $g_{7/2}$, consistent with the proposition by Zheng *et al.* [2]. The band exhibited back bending (Fig. 3) occurring roughly at the same point as signature inversion, also reflected in the sudden change in the B(E2) values (Fig. 4). The quasi-neutron diagram, obtained through TRS calculation at $\gamma = -50^\circ$, indicated neutron alignment at the 2$^{\rm nd}$ crossing frequency 0.53 MeV which compared reasonably well with the experimental value 0.47 MeV. The 2$^{\rm nd}$ crossing of proton occurred at a much high frequency, so the proton alignment was ruled out.

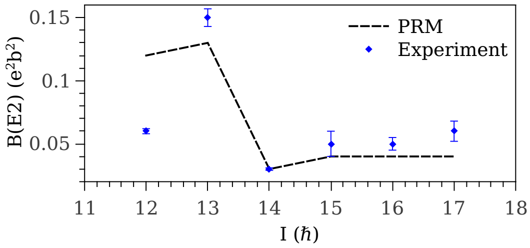

FIG. 4: Transition probabilities and their comparison with two quasiparticle rotor model calculations.

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