

## Is there a wobbling band in $^{129}\text{Cs}$ ?

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### Introduction

Investigations on the negative parity one-quasiparticle bands of odd- $A$  triaxial nuclei in the  $A \approx 130$  region have gained new momentum recently, following a re-evaluation of their structure in terms of the *wobbling mode* in certain cases [1, and references therein]. The wobbling motion is considered one of the experimental fingerprints of triaxiality, along with chirality and  $\gamma$ -vibration. In odd- $Z$  nuclei below  $Z = 64$  sub-shell closure,  $^{151}\text{Eu}$ ,  $^{139}\text{Pm}$ ,  $^{135}\text{Pr}$ , and  $^{133}\text{La}$  are found to exhibit wobbling motion. However, no such bands have been reported in any of the  $^{55}\text{Cs}$  isotopes, although the observation of several chiral bands in these isotopes indicates their triaxial shapes. The experimental identification of this phenomenon depends on the  $E2$  and  $M1$  amplitudes of the  $\Delta I = 1$   $\gamma$ -transitions between successive phonon wobbling bands [2]. In this context, determination of the multipole mixing ratio ( $\delta$ ) of the connecting transitions between the so-called *signature partner* bands becomes crucial.

A recent study has shown that the existence of a wobbling mode in odd- $A$  nuclei depends on the deformation of their *even-even* neighboring nuclei [3]. Based on this, the  $^{129}\text{Cs}$  has been identified as a potential candidate for exhibiting wobbling motion. The currently available spectroscopic results provide intriguing insights into this matter [4]. Therefore, in this work, the angular correlation ( $R_{\text{DCO}}$ )

and linear polarization ( $P$ ) measurements were carried out for the  $\Delta I = 1$  transitions of interest to determine the mixing ratio of these transitions.

### Experimental Details

Excited states of  $^{129}\text{Cs}$  were populated via the  $^{127}\text{I}(^4\text{He}, 2n\gamma)$  reaction at  $E_\alpha = 33$  MeV, utilising the K-130 cyclotron at VECC, Kolkata. The target consisted of elemental iodine beads, sandwiched between Kapton tapes. Indian National Gamma Array [5], with eleven Compton-suppressed HPGe Clover detectors and a planer HPGe LEPS, served as the  $\gamma$ -spectrometer. A PIXIE-16 digital data acquisition system recorded  $\gamma$  events in both single and coincidence modes [6]. Offline data were sorted and analysed with BiNDAS [7], INGASORT [8], and RADWARE [9] codes.

### Results

FIG. 1 shows the low-spin part of the  $\pi h_{11/2}$  band of  $^{129}\text{Cs}$ . From the earlier reported angular distribution coefficients,  $\delta \approx -0.3$  or  $\delta \approx -2.2$  were

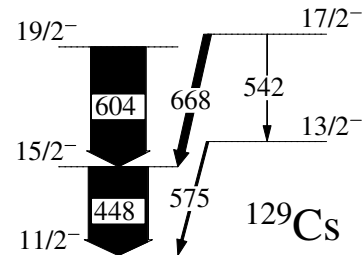


FIG. 1: Negative parity states of interest in  $^{129}\text{Cs}$ .

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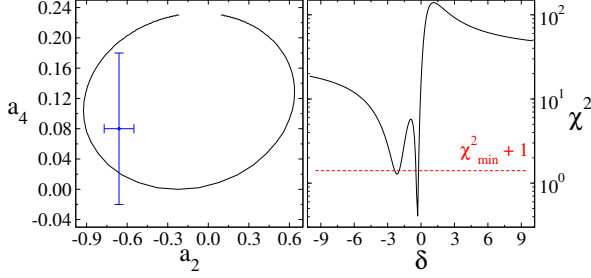


FIG. 2: Left: Contour plot of the calculated angular distribution coefficients ( $a_2$ ,  $a_4$ ) for different values of  $\delta$  (black). Corresponding dispersion of the experimental data is marked with blue cross. Right: The  $\chi^2$  analysis for experimental  $a_2$  and  $a_4$  of the 668 keV  $\gamma$ -ray.

estimated for the 668 keV transition [4]. However, the  $\chi^2$  analysis indicates a comparatively higher probability for the lower value of  $\delta$ , as presented in FIG. 2. In the present spectroscopic study, the  $R_{\text{DCO}}$  and  $P$  of the 668 keV transition have been measured. The value of  $R_{\text{DCO}}$  is influenced by the initial spin alignment of the residual nucleus emitting the  $\gamma$ -ray, represented by the width of the substate population ( $\sigma/J$ ), and by the mixing ratio ( $\delta$ ) in the case of a mixed transition. In  $\alpha$ -induced reactions, like those in this study, the  $\sigma/J$  value is expected to be broader ( $\sigma/J = 0.37(3)$  [12]) compared to heavy-ion induced reactions, where typically  $\sigma/J \approx 0.3$ . For the present nuclear reaction, the value of  $\sigma/J = 0.36(2)$  was estimated by comparing the experimental  $R_{\text{DCO}}$  of the 182 keV  $\gamma$ -ray with its calculated values (FIG. 3). Using this, the  $R_{\text{DCO}}$  and  $P$  of the 668 keV  $\gamma$ -ray were calculated for different values of  $\delta$ . By comparing these calculated  $R_{\text{DCO}}$  and  $P$  values with their experimentally measured values,  $\delta = -3.5(2)$  was estimated

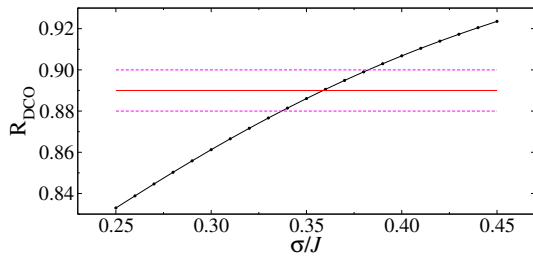


FIG. 3: Plot of the calculated (black) and measured (red / magenta)  $R_{\text{DCO}}$  values of 182 keV  $\gamma$ -ray ( $7/2^+ \rightarrow 5/2^+$ ,  $\delta = 0.25(2)$  [10, 11]), as a function of  $\sigma/J$ .

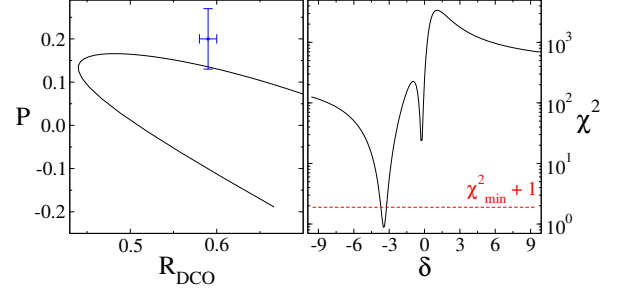


FIG. 4: Left: Contour plot of the calculated  $R_{\text{DCO}}$  and  $P$  for different values of  $\delta$  (black). Corresponding dispersion of the experimental data is marked with blue cross. Right: The  $\chi^2$  analysis of experimental  $R_{\text{DCO}}$  and  $P$  for the 668 keV  $\gamma$ -ray.

for this transition (FIG. 4), indicating a large  $E2$  contribution. Therefore, the band above the  $13/2^-$  state in  $^{129}\text{Cs}$  most likely originates from the excitation of a wobbling phonon.

## Summary

In summary, excited states in  $^{129}\text{Cs}$  were populated through  $\alpha$ -induced reactions with a  $^{127}\text{I}$  target at a beam energy of 33 MeV. The present spectroscopic results show a large  $E2$  admixture in the 668 keV  $\gamma$ -ray, indicating the existence of a wobbling mode in this nucleus. Further data analysis is underway and will be presented at the symposium.

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