Is there a wobbling band in ^{129}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 γ-vibration. In odd-Z nuclei below $Z = 64$ sub-shell closure, $^{151}_{63}$Eu, $^{139}_{61}$Pm, $^{135}_{59}$Pr, and $^{133}_{57}$La are found to exhibit wobbling motion. However, no such bands have been reported in any of the $_{55}$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 $\Delta I = 1$ γ-transitions between successive phonon wobbling bands [2]. In this context, determination of the multipole mixing ratio (δ) 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}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_{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}Cs were populated via the ^{127}I(^{4}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 γ-spectrometer. A PIXIE-16 digital data acquisition system recorded γ 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}Cs. From the earlier reported angular distribution coefficients, $\delta \approx -0.3$ or $\delta \approx -2.2$ were

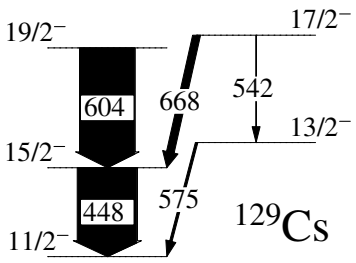

FIG. 1: Negative parity states of interest in ^{129}Cs.

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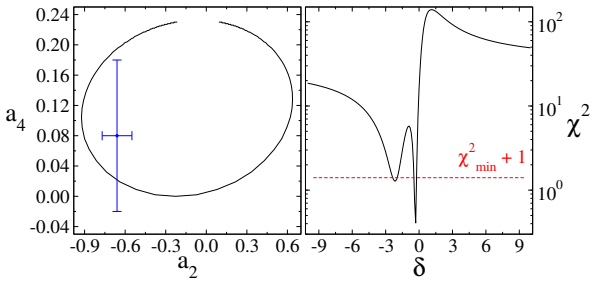

FIG. 2: Left: Contour plot of the calculated angular distribution coefficients (a_2, a_4) for different values of δ (black). Corresponding dispersion of the experimental data is marked with blue cross. Right: The χ^2 analysis for experimental a_2 and a_4 of the 668 keV γ-ray.

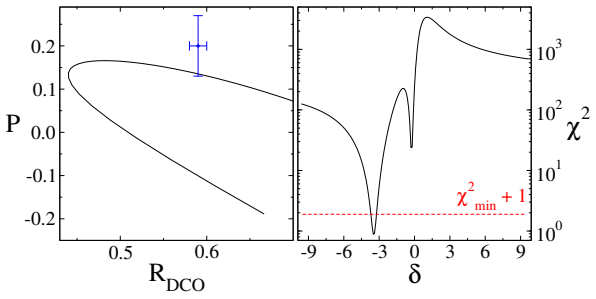

FIG. 4: Left: Contour plot of the calculated R_{DCO} and P for different values of δ (black). Corresponding dispersion of the experimental data is marked with blue cross. Right: The χ^2 analysis of experimental R_{DCO} and P for the 668 keV γ-ray.

estimated for the 668 keV transition [4]. However, the χ^2 analysis indicates a comparatively higher probability for the lower value of δ, as presented in FIG. 2. In the present spectroscopic study, the R_{DCO} and$P$ of the 668 keV transition have been measured. The value of R_{DCO} is influenced by the initial spin alignment of the residual nucleus emitting the γ-ray, represented by the width of the substate population (σ/J), and by the mixing ratio (δ) in the case of a mixed transition. In α-induced reactions, like those in this study, the σ/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_{DCO} of the 182 keV γ-ray with its calculated values (FIG. 3). Using this, the R_{DCO} and P of the 668 keV γ-ray were calculated for different values of δ. By comparing these calculated R_{DCO} and P values with their experimentally measured values, $\delta = -3.5(2)$ was estimated for this transition (FIG. 4), indicating a large $E2$ contribution. Therefore, the band above the $13/2^-$ state in ^{129}Cs most likely originates from the excitation of a wobbling phonon.

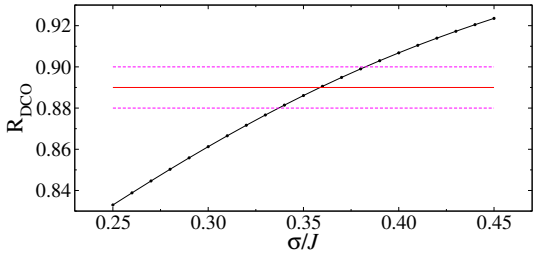

FIG. 3: Plot of the calculated (black) and measured (red / magenta) R_{DCO} values of 182 keV γ-ray ($7/2^+ \rightarrow 5/2^+$, $\delta = 0.25(2)$ [10, 11]), as a function of σ/J.

Summary

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

Acknowledgements

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