

Is there a wobbling band in ^{129}Cs ?

S. Chakraborty,^{1,*} S. Bhattacharyya,^{1,2,†} G. Mukherjee,^{1,2} S. S. Nayak,^{1,2} Shabir Dar,^{1,2} Sneha Das,^{1,2} S. Basu,^{1,2} Suchorita Paul,^{1,2} Snigdha Pal,^{1,2} S. Basak,^{1,2} A. Pal,^{1,2} D. Kumar,^{1,2} Soumik Bhattacharya,¹ Debasish Mondal,¹ R. Raut,³ Pankaj K. Giri,³ A. Sharma,³ S. S. Ghugre,³ C. Majumder,⁴ R. Banik,⁵ S. Das Gupta,⁶ S. Rajbanshi,⁷ S. Ganguly,⁸ A. Karmakar,^{9,2} J. Dey,^{9,2} U. Datta,^{9,2} and S. Chattopadhyay^{9,2}

¹Variable Energy Cyclotron Centre, Kolkata, India

²Homi Bhabha National Institute, Mumbai, India

³UGC-DAE Consortium for Scientific Research, Kolkata Centre, Kolkata, India

⁴Indian Institute of Technology Bombay, Mumbai, India

⁵Institute of Engineering and Management, Kolkata, India

⁶Victoria Institution (College), Kolkata, India

⁷Presidency University, Kolkata, India

⁸Bethune College, Kolkata, India

⁹Saha Institute of Nuclear Physics, Kolkata, India

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}Eu , ^{139}Pm , ^{135}Pr , and ^{133}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 $^{127}\text{I}(^{4}\text{He}, 2n\gamma)$ 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 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

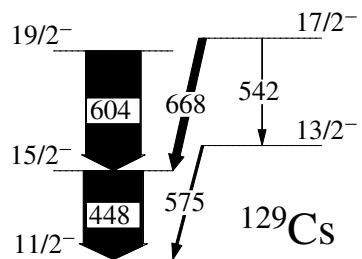


FIG. 1: Negative parity states of interest in ^{129}Cs .

*Electronic address: saikat.c@vecc.gov.in

†Electronic address: sarmi@vecc.gov.in

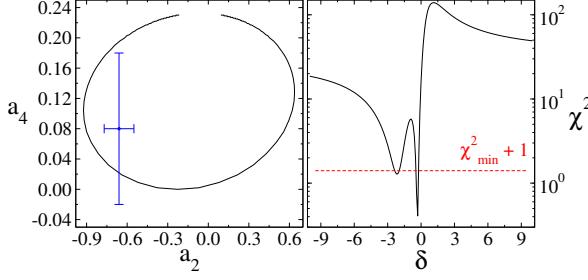


FIG. 2: Left: Contour plot of the calculated angular distribution coefficients (a_2 , a_4) for different values of δ (black). Corresponding dispersion of the experimental data is marked with blue cross. Right: The χ^2 analysis for experimental a_2 and a_4 of the 668 keV γ -ray.

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 sub-state 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

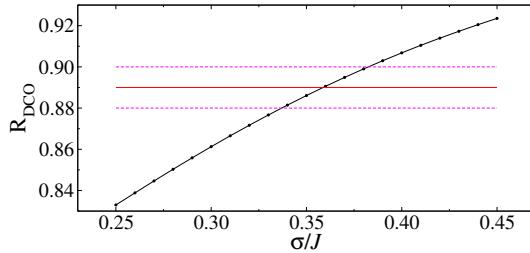


FIG. 3: Plot of the calculated (black) and measured (red / magenta) R_{DCO} values of 182 keV γ -ray ($7/2^+ \rightarrow 5/2^+$, $\delta = 0.25(2)$ [10, 11]), as a function of σ/J .

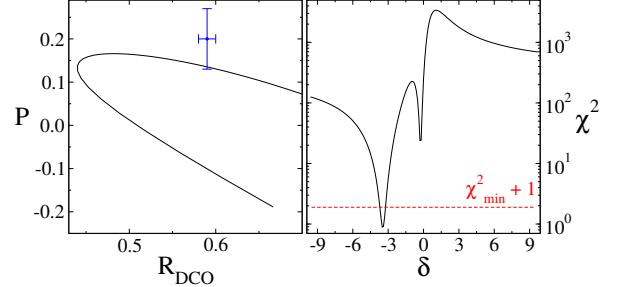


FIG. 4: Left: Contour plot of the calculated R_{DCO} and P for different values of δ (black). Corresponding dispersion of the experimental data is marked with blue cross. Right: The χ^2 analysis of experimental R_{DCO} and P for the 668 keV γ -ray.

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.

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.

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