Two-phonon wobbling in ^{135}Pr

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Introduction

Wobbling is a phenomenon characteristic of triaxial nuclei. It is the oscillation of one of the principal axes about the space fixed angular momentum $\vec{J}$.

Characteristics of Wobbling bands:

- Rotational bands corresponding to $n_w = 0, 1, 2, ...$
- Transitions from $n_{w+1} \rightarrow n_w$ ($\Delta n_w = +1$)
- Interband Transitions are $\Delta I = 1$, E2.

Types of Wobbling:

- ***Longitudinal Wobbling***
  1) Odd particle aligns with Medium (m) axis
  2) Wobbling energy (E_{wobb}) increases with the spin J

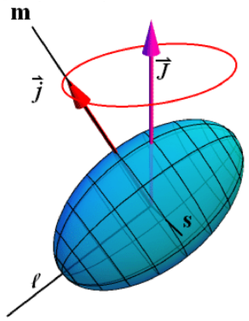

Figure: Schematic of Longitudinal wobbling in triaxial nuclei.

- ***Transverse Wobbling***
  1) Odd particle aligns with Short (s) axis
  2) Wobbling energy (E_{wobb}) decreases with the spin J

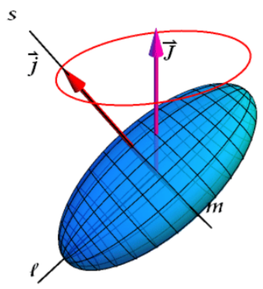

Figure: Schematic of Transverse wobbling in triaxial nuclei.

- Only 7 known cases of wobbling: ^{163,161,165,167}**Lu**, ^{167}**Ta** in the A$\sim$160 and ^{135}**Pr**, ^{133}**La** in the A$\sim$130 region.
- Higher phonon ($n_w = 2$) wobbling bands have been identified only in 2 nuclei: ^{163,165}**Lu**.

Experimental Details

- Experiment performed using Gammasphere array at the Argonne National Laboratory.
- Reaction: ^{123}Sb(^{16}O,4n)^{135}Pr at 80 MeV.
- 83 Compton suppressed Ge detectors used.
- A total of 1.45$\times$10^{10} three and higher-fold γ-ray coincidence events collected.

Figure: The Gammasphere array at the Argonne National Laboratory

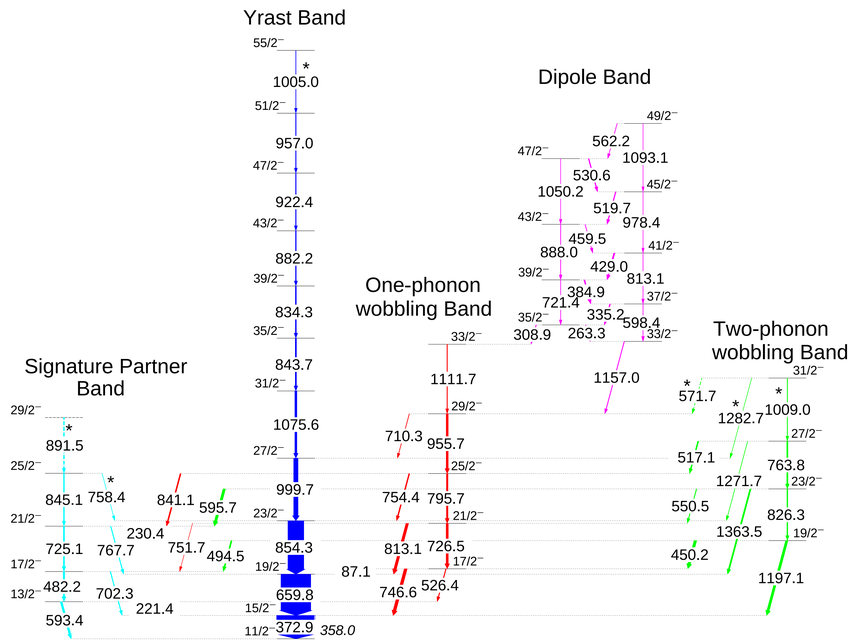

Figure: Partial negative parity level scheme of ^{135}Pr developed in the present work. Newly identified transitions are shown with an asterisk (*).

Transverse Wobbling in ^{135}Pr

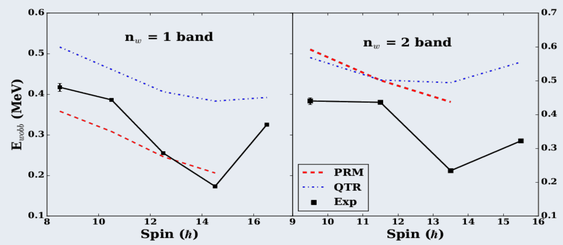

Figure: Variation of the wobbling energy E_{wobb} with spin for the $n_w = 1$ and $n_w = 2$ bands in ^{135}Pr. The decreasing trend confirms Transverse wobbling. Quasiparticle Triaxial Rotor (QTR) and Particle Rotor Model (PRM) calculations are also shown for comparison.

Results

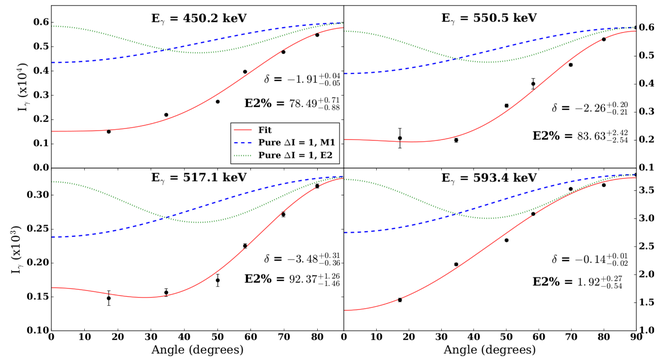

Figure: Angular distribution plots showing a high E2 mixing for the three lowest $n_w = 2 \rightarrow n_w = 1$ linking transitions in comparison with that of the pure M1 Signature Partner$\rightarrow$Yrast linking transition.

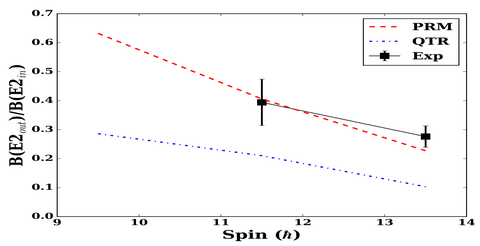

Figure: Variation of the $B(E2_{out})/B(E2_{in})$ ratio with spin for the $n_w = 2$ band and its agreement with the QTR and the PRM models.

Conclusion

A transverse wobbling band built on $n_w = 2$ excitations has been identified in ^{135}Pr. This is the first observation of two-phonon wobbling in A$\sim$130 region and further affirms the existence of wobbling in a mass region and spin values different from all the previously reported cases.

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