First Observation of Multiple Transverse Wobbling Bands of Different Kinds in ^{183}Au

S. Nandi,[1,2] G. Mukherjee,[1,2,†] Q. B. Chen,[3] S. Frauendorf,[4] R. Banik,[1,2,‡] Soumik Bhattacharya,[1,2] Shabir Dar,[1,2] S. Bhattacharyya,[1,2] C. Bhattacharya,[1,2] S. Chatterjee,[5] S. Das,[5] S. Samanta,[5] R. Raut,[5] S. S. Ghugre,[5] S. Rajbanshi,[6] Sajad Ali,[7] H. Pai,[8] Md. A. Asgar,[9] S. Das Gupta,[10] P. Chowdhury,[11] and A. Goswami[8,*]

[1]*Variable Energy Cyclotron Centre, 1/AF, Bidhan Nagar, Kolkata 700064, India*
[2]*Homi Bhabha National Institute, Training School Complex, Anushakti Nagar, Mumbai 400094, India*
[3]*Physik-Department, Technische Universität München, D-85747 Garching, Germany*
[4]*Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556, USA*
[5]*UGC-DAE CSR, Kolkata Centre, Kolkata 700098, India*
[6]*Department of Physics, Presidency University, Kolkata 700043, India*
[7]*Government General Degree College at Pedong, Kalimpong 734311, India*
[8]*Saha Institute of Nuclear Physics, Kolkata 700064, India*
[9]*Department of Physics, Prabhat Kumar College, Contai 721404, India*
[10]*Victoria Institution (College), Kolkata 700009, India*
[11]*University of Massachusetts Lowell, Lowell, Massachusetts 01854, USA*

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We report the first observation of two wobbling bands in ^{183}Au, both of which were interpreted as the transverse wobbling (TW) band but with different behavior of their wobbling energies as a function of spin. It increases (decreases) with spin for the positive (negative) parity configuration. The crucial evidence for the wobbling nature of the bands, dominance of the $E2$ component in the $\Delta I = 1$ transitions between the partner bands, is provided by the simultaneous measurements of directional correlation from the oriented states ratio and the linear polarization of the γ rays. Particle rotor model calculations with triaxial deformation reproduce the experimental data well. A value of spin, I_m, has been determined for the observed TW bands below which the wobbling energy increases and above which it decreases with spin. The nucleus ^{183}Au is, so far, the only nucleus in which both the increasing and the decreasing parts are observed and thus gives the experimental evidence of the complete transverse wobbling phenomenon.

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Nuclear wobbling excitation is a manifestation of nonaxial nuclear shape, which was first discussed by Bohr and Mottelson [1]. The nonaxial (triaxial) nuclear shape appears due to the unequal nuclear mass distribution along the three principal axes and implies three unequal moments of inertia about the three principal axes. A triaxially deformed nucleus always tries to rotate around the medium (m) axis having the largest moment of inertia but the presence of the rotations around the other two axes, i.e., short (s) and long (l), generates a precession of the medium axis rotation about the space-fixed angular momentum axis, similar to the classical wobbling motion of an asymmetric top [2]. The energy spectrum of this excitation is given by [1]:

$$E = E_{\mathrm{rot}} + (n_w + 1/2)\hbar\omega_{\mathrm{wob}}$$

where, the term E_{rot}, corresponds to the rotation about the medium axis while n_w is the wobbling quanta and ω_{wob} is the wobbling frequency with wobbling energy $E_{\mathrm{wob}} = \hbar\omega_{\mathrm{wob}}$. This generates a series of rotational bands with different n_w.

This exotic excitation has been observed only in a few odd-A nuclei [3–13]. In case of the odd-A nuclei, the odd particle in high-j orbital couples with a triaxial core and modifies the wobbling motion. Depending on the coupling of the odd particle, two types of wobbling bands can be observed: longitudinal wobbling (LW) and transverse wobbling (TW) [14]. In LW, the angular momentum of the odd particle aligns along the medium axis while in TW, it aligns along one of the perpendicular axes (short or long).

An extensive theoretical description of the wobbling motion has been given by Frauendorf and Dönau [14] in terms of a quasiparticle triaxial rotor model. Analytical expression for $\hbar\omega_{\mathrm{wob}}$ has been derived with the assumption of "frozen alignment" and harmonic oscillation (HFA). It was shown that E_{wob} increases as a function of angular momentum (I) in case of LW which has been recently observed experimentally in ^{133}La [10] and ^{187}Au [12]. However, in case of TW, the variation of E_{wob} is highly dependent on the values of the moments of inertia, $\mathcal{J}_m$, $\mathcal{J}_s$, and $\mathcal{J}_l$ along the medium, short, and long axes, respectively, of the triaxial core. In general, E_{wob} decreases with I. But in a situation where $\mathcal{J}_m$ is slightly larger than $\mathcal{J}_s$ and

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Gmail **shinjinee dasgupta <shinjinee14@gmail.com>**

experiment at VECC

2 messages

Sarmishtha Bhattacharya <sarmi@vecc.gov.in> Fri, Nov 20, 2020 at 1:01 PM
To: Shinjinee Dasgupta <shinjinee14@gmail.com>, subhphy@gmail.com, Ranabir Banik <ranabir.banik@vecc.gov.in>, Sajad Ali <sajadali113@gmail.com>
Cc: Soumik Bhattacharya <soumik@vecc.gov.in>, Shabir Dar <phy.shabir@gmail.com>

Dear Shinjinee, Subhendu, Ranabir and Sajad

Hope you all are keeping well.

We have started setup at VECC for few experiments.
From VECC, we have two experiments:

1. For PhD thesis of our student Shabir: "Search for signature partner bands based on g7/2 in 115Sb"

2. Expt of Soumik: "Effect of high-j orbitals towards the triaxiality in 199Hg"

We would like you to be present and collaborate in both the experiments.

We will let you know the exact schedule.
tentatively, we will start testing of detectors, DAQ etc. next week and
actual run probably from 1st week of December.

Regards
Sarmishtha and Soumik.

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shinjinee dasgupta <shinjinee14@gmail.com> Fri, Nov 20, 2020 at 1:13 PM
To: Sarmishtha Bhattacharya <sarmi@vecc.gov.in>

Dear Sarmishthadi,

Great News. Will be present during the experiments.

Regards,
Shinjinee
[Quoted text hidden]