

Evaluation of the Wobbling Motion in Even-Even Nuclei Within a Simple Rotor Model

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Nuclear Deformation

- Most of the nuclei are either *spherical* or *axially symmetric* in their ground-state.
- Deformation parameter β (Bohr, 1969): preserves axial symmetry

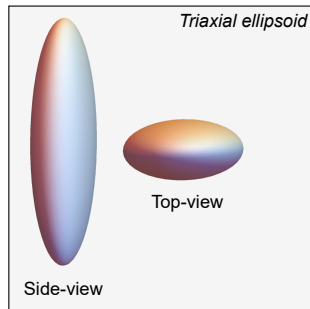
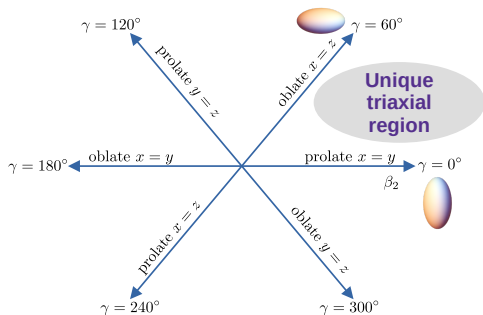


Figure 1: **spherical:** $\beta = 0$ **prolate:** $\beta > 0$ **oblate:** $\beta < 0$

Nuclear Triaxiality

Non-axial shapes

- Deviations from symmetric shapes can occur across the chart of nuclides → **triaxial nuclei**.
- The triaxiality parameter γ (Bohr, 1969): departure from axial symmetry



Fingerprints for Triaxiality

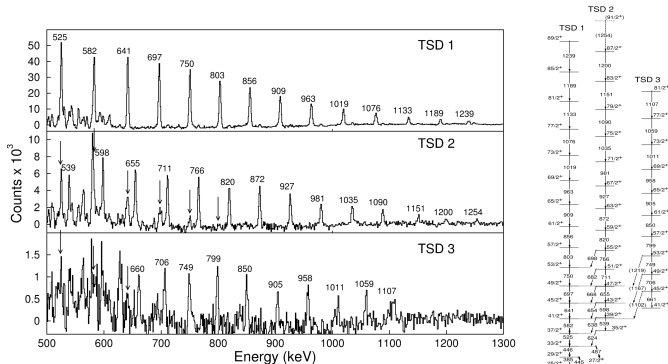
- Stable triaxial nuclei represent a real challenge for experimentalists and theoreticians
- Clear signatures for confirming stable triaxiality in nuclei
 - ① Chiral symmetry breaking (*Frauendorf, 1997*)
 - ② **Wobbling motion** (*Bohr & Mottelson, 1975*)

Wobbling Motion (WM)

- Unique to non-axial nuclei
- Predicted 50 years ago for even- A nuclei
- First experimental evidence for ^{163}Lu (*Ødegård, 2001*)
- Currently: confirmed wobblers within the mass regions $A \approx [100, 130, 160, 180]$.

Triaxial Rotor Energy

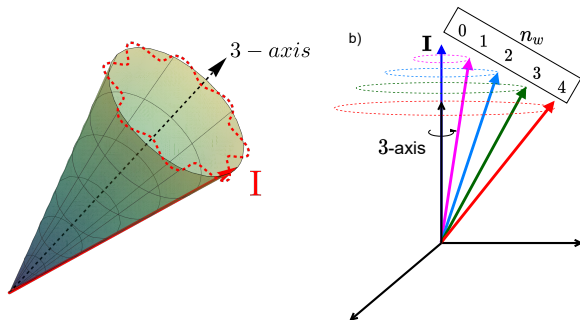
- Rigid body rotational energy $E_{\text{rot}} \propto \frac{\hbar^2}{2\mathcal{J}_{\text{max}}} I(I+1)$
- A triaxial nucleus can rotate about any of the three axes
- MOI anisotropy \rightarrow the *main rotation* around \mathcal{J}_{max} is disturbed by the other two axes \rightarrow **total motion of the rotating nucleus has an oscillating behavior**



Figures from Schönwaßer et al., 2001

Wobbling Motion

- Total angular momentum \mathbf{I} disaligned w.r.t. body-fixed axes
- The a.m. **precesses** and **wobbles** around the axis with \mathcal{J}_{\max}
- The precession of \mathbf{I} can increase by **tilting**
- Tilting by an energy quanta \sim *vibrational character* \rightarrow **wobbling phonon** $n_w = 0, 1, 2, \dots$



Wobbling Spectrum

Even-A Nuclei

- Employing the Harmonic Approximation (*Bohr, 1969*)
- \hat{H} composed of a *rotational* part and *harmonic oscillation* (i.e., wobbling) part:

$$\hat{H} = \frac{\hbar^2}{2\mathcal{J}_{\max}} I(I+1) + \hbar\omega_{\text{wob}} \left(n_w + \frac{1}{2} \right), \quad n_w = 0, 1, 2, \dots \quad (1)$$

