New Results Concerning Collective Motion in Triaxial Nuclei

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Table of Contents

Nuclear Deformation

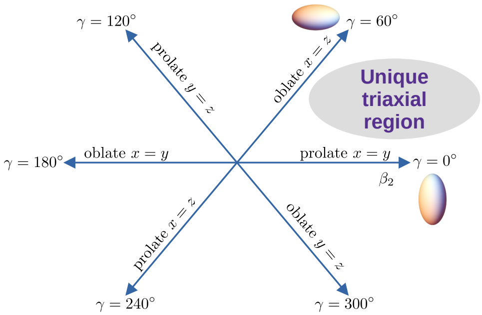
Most of the nuclei are either *spherical* or *axially symmetric* in their ground-state.
Deformation parameter β (*Bohr, 1969*): preserves axial symmetry

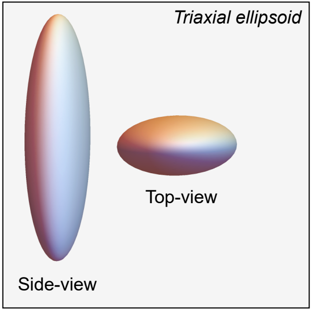
Figure 1: **spherical:** $\beta = 0$ **prolate:** $\beta > 0$ **oblate:** $\beta < 0$

Nuclear Triaxiality

Non-axial shape

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





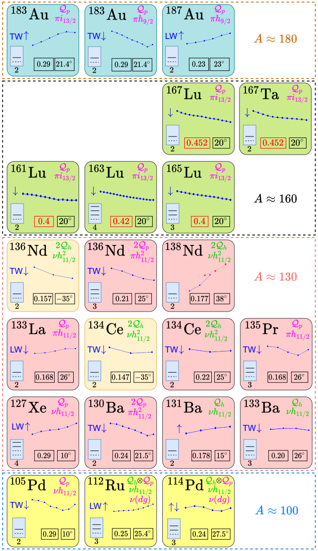
Fingerprints for Triaxiality

- Experimentally, stable triaxial nuclei represent a real challenge
- 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 $A \approx [100, 130, 160, 180]$.

Experimental Evidence



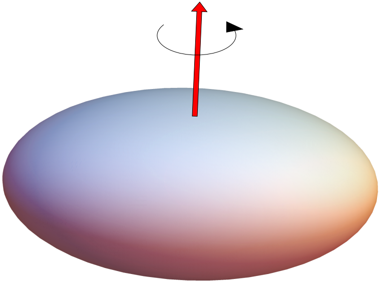
Wobbling nuclei (up to date)

Poenaru, 2022, in progress

Energy of Deformed Nuclei

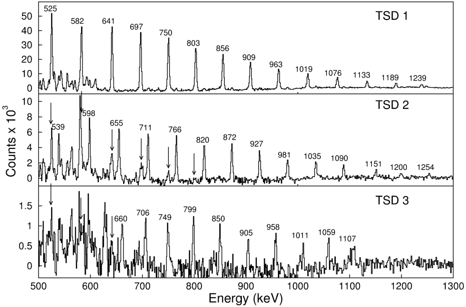
Collective Motion

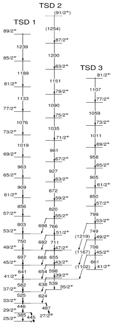
- A nucleus - *droplet* - can generate angular momentum from the rotation and vibration of the droplet itself
- Each individual nucleon contributes to the total angular momentum $\rightarrow$ *collectiveness*



Triaxial Rotor Energy

- A triaxial nucleus can rotate about any of the three axes
- Rotation about the axis with **the largest moment of inertia** (MOI) is energetically the most favorable: $E_{\text{rot}} \propto \frac{\hbar^2}{2\mathcal{I}_{\text{max}}} I(I+1)$
- MOI anisotropy $\rightarrow$ the *main rotation* around $\mathcal{J}_{\text{max}}$ is disturbed by the other two axes $\rightarrow$ *total motion of the rotating nucleus has an oscillating behavior*





Wobbling Motion

- Anisotropy $\rightarrow$ total angular momentum **I** disaligned with any body-fixed axis
- The a.m. **precesses** and **wobbles** around the axis with $\mathcal{J}_{\text{max}}$
- The precession of **I** can increase by **tilting** away more
- Tilt $\sim$ *vibrational character* $\rightarrow$ **wobbling phonon** $n_w = 0, 1, 2 \ldots$