

DESCRIPTION OF THE WOBBLING MOTION THROUGH A BOSON METHOD

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Outline

1 Introduction

2 Triaxial Shapes

Nuclear Radius

The **shape** of the nucleus is most generally described in terms of the *nuclear radius*:

$$R(\theta, \varphi; t) = R_0 \left(1 + \sum_{\lambda=0}^{\infty} \sum_{\mu=-\lambda}^{\lambda} \alpha_{\lambda\mu}(t) Y_{\lambda}^{\mu}(\theta, \varphi) \right) \quad (1)$$

- The $\alpha_{\lambda\mu}$ are collective coordinates \implies *vibrations of the nucleus*.
- Y_{λ}^{μ} are the spherical harmonics.

Nuclear shapes

Most nuclei are spherical or axially symmetric in the ground state.



Figure 1: **Spherical:** $\beta_2 = 0$; **Prolate:** $\beta_2 > 0$; **Oblate:** $\beta_2 < 0$

Quadrupole deformations

- Most relevant vibrational degrees of freedom in nuclei.
- Play a crucial role in the rotational spectra of nuclei.

Quadrupole radius

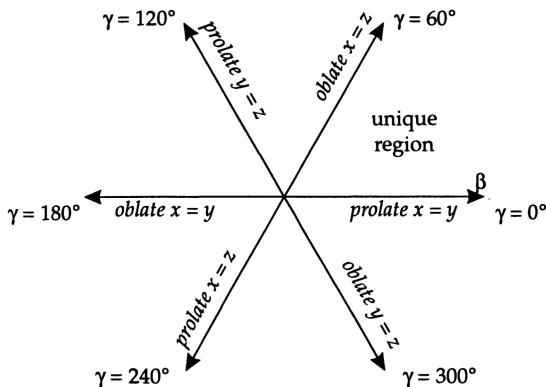
For pure quadrupole deformations:

$$R(\theta, \varphi) = R_0 \left(1 + \sum_{\mu} \alpha_{2\mu} Y_2^{\mu}(\theta, \varphi) \right) , \quad (2)$$

Using A. Bohr's description, the coordinates $\alpha_{2\mu}$ can be reduced to only two *deformation parameters*: β_2 (*eccentricity*) and γ (**triaxiality**).

Nuclear triaxiality

- Besides the axially symmetric shapes (i.e., spherical, prolate, and oblate), nuclei can be **triaxial** \implies lack of symmetry along any of the principal axes.
- The asymmetry is given by the non-zero value of γ .



Triaxial ellipsoid

Schematic example with a triaxial ellipsoid ($\gamma \neq 0$) $\beta_2 > 0$.

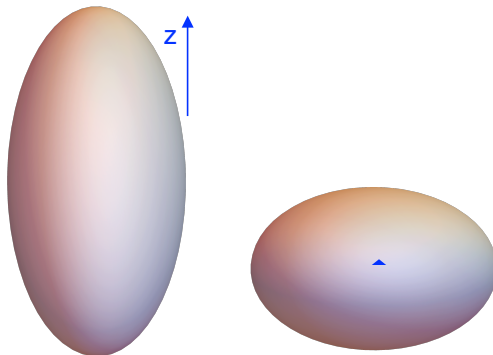


Figure 2: **Left:** side-view. **Right:** top view.

- Probing triaxiality experimentally is a real challenge (e.g., large and complex detector setups).
- Only two fingerprints known so far: **chiral motion** (Frauendorf, 1997) and **wobbling motion** (Bohr and Mottelson, 1975).

Wobbling Motion (WM)

- Collective effect → *unique* to triaxial nuclei.
- Predicted almost 50 years ago, first experimental confirmation: in 2001 (Odegard et al.) for ^{163}Lu .
- In present, few wobblers are experimentally confirmed in the mass regions: $A \approx 130, 160, 180$.

Wobbling motion

Triaxial nuclei

A triaxial nucleus can rotate about any of the three axes.

The rotational angular momentum (a.m.) is NOT aligned along any of the body-fixed axes \Rightarrow **precesses** and **wobbles** around the axes with the largest MOI.

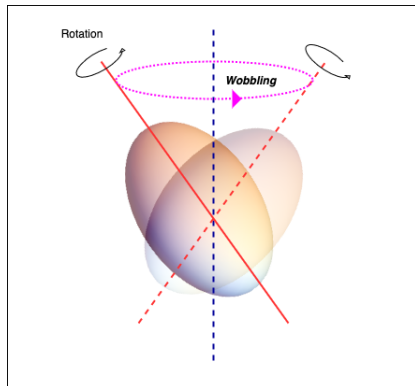


Figure 3: Schematic representation for the nuclear wobbling motion.