DESCRIBING THE WOBBLING MOTION IN ^{163}Lu THROUGH A SEMI-CLASSICAL APPROACH

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Introduction

Wobbling Motion (WM) is a unique feature of triaxial nuclei. These systems have strong (charge) + (mass) + (shape) deformations and asymmetries that are stable in the ground state.

Current project goal: Describe the wobbling spectrum of an odd-A nucleus, i.e., ^{163}Lu by using a semi-classical set of equations for the system's dynamics.

Wobbling Motion in Nuclei

WM employs a *precession* of the total angular momentum $\vec{I}$ combined with an *oscillation* of its projection on the rotational axis. Different *core-particle* couplings lead to different wobbling regimes.

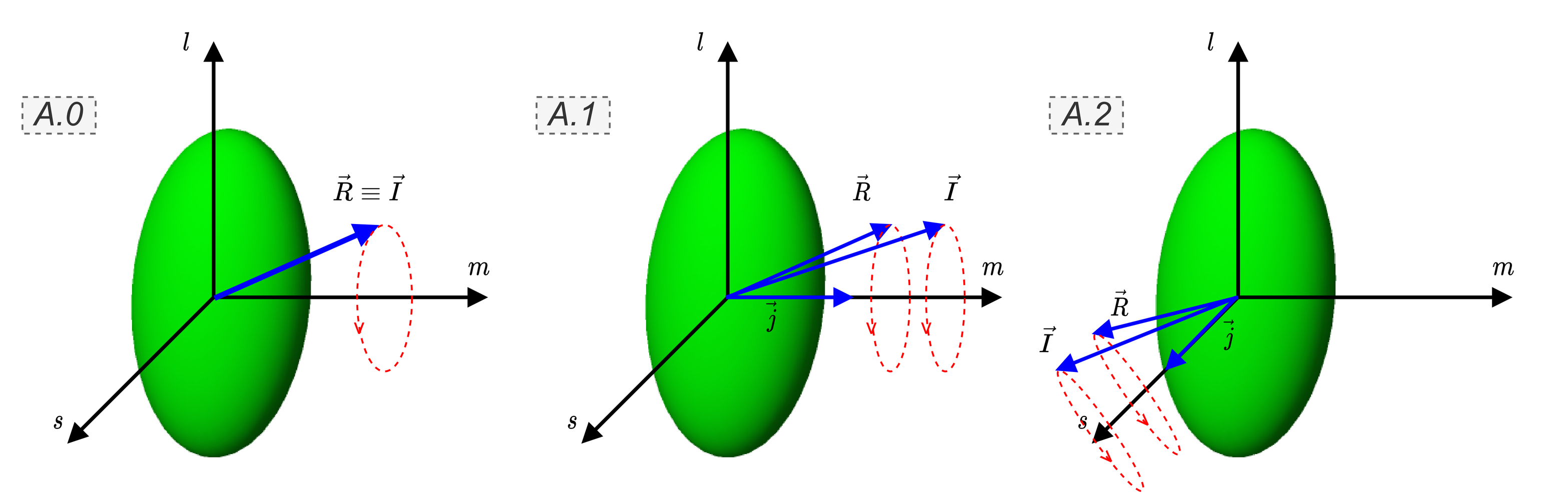

Figure 1:An illustration with the wobbling regimes which can occur in a nucleus. From left to right: *simple/ideal wobbler*, *longitudinal wobbler*, *transverse wobbler*.

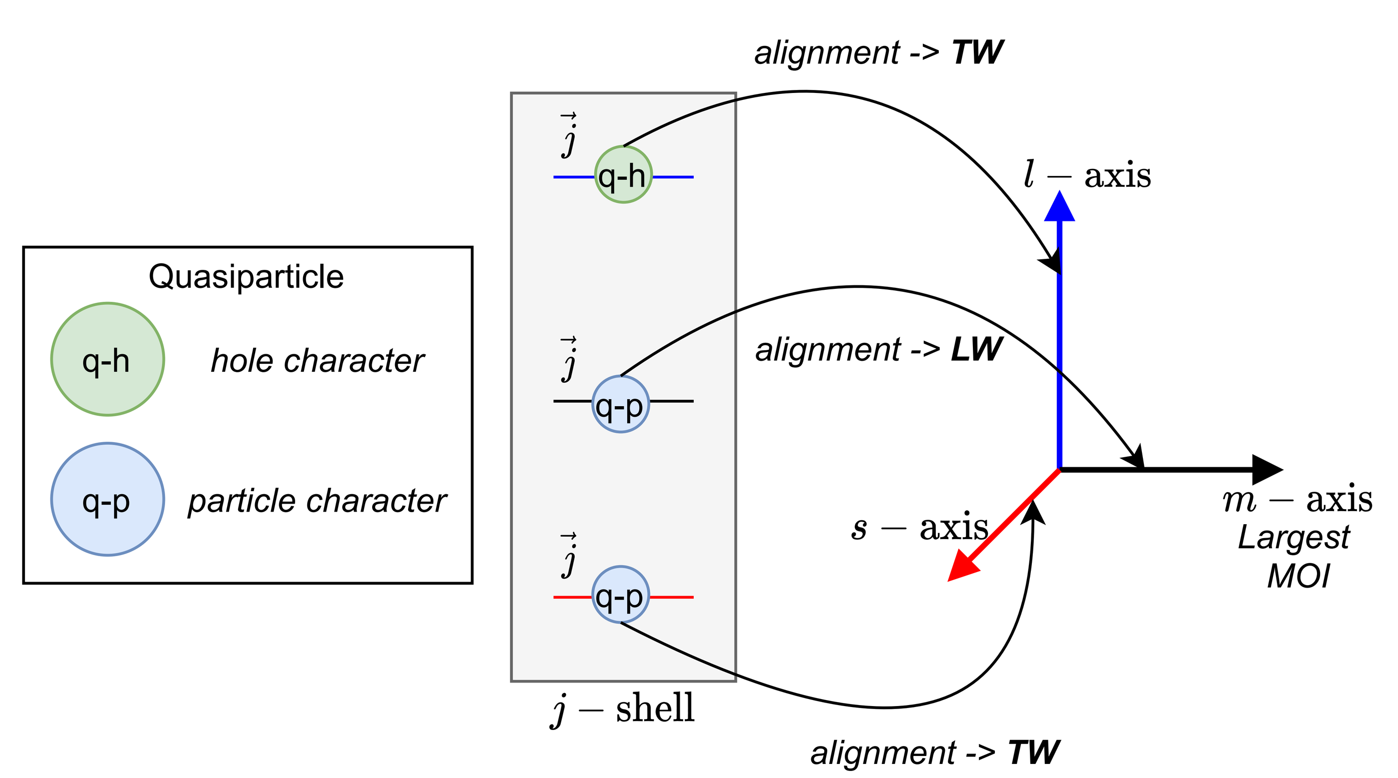

Figure 2:**Longitudinal** (LW) and **Transverse** (TW) Wobbling regimes, depending on the *core-particle* coupling. l, m, s are the principal axes of a triaxial ellipsoid.

Wobbling Motion: Odd-A Formalism

The system is described by the total Particle-Rotor-Model Hamiltonian:

$$\hat{H} = \hat{H}_{\text{core}} + \hat{H}_{\text{sp}} \ , \tag{1}$$

where $\hat{H}_{\text{core}}$ describes the triaxial core, and $\hat{H}_{\text{s.p.}}$ is the single-particle potential that corresponds to the odd nucleon (for ^{163}Lu it is the $\vec{j} = \pi(i_{13/2})$ nucleon).

Hamiltonian is dequantized through the **Time Dependent Variational Principle** and a set of *classical* expressions for the system dynamics are obtained.

$$\mathcal{H}_{\text{classical}} = \mathcal{H}_{\text{min}} + \Omega_1\left(n_{w1} + \frac{1}{2}\right) + \Omega_2\left(n_{w2} + \frac{1}{2}\right) \ . \tag{2}$$

The system's behavior consists of a main rotational motion due to the core ($\mathcal{H}_{\text{min}}$), and two harmonic-like motions emerging from the core-particle coupling (Ω_1 and Ω_2).

Results

The excitation energies for each wobbling band (triaxial strongly-deformed -TSD- band) were obtained using the above equation.

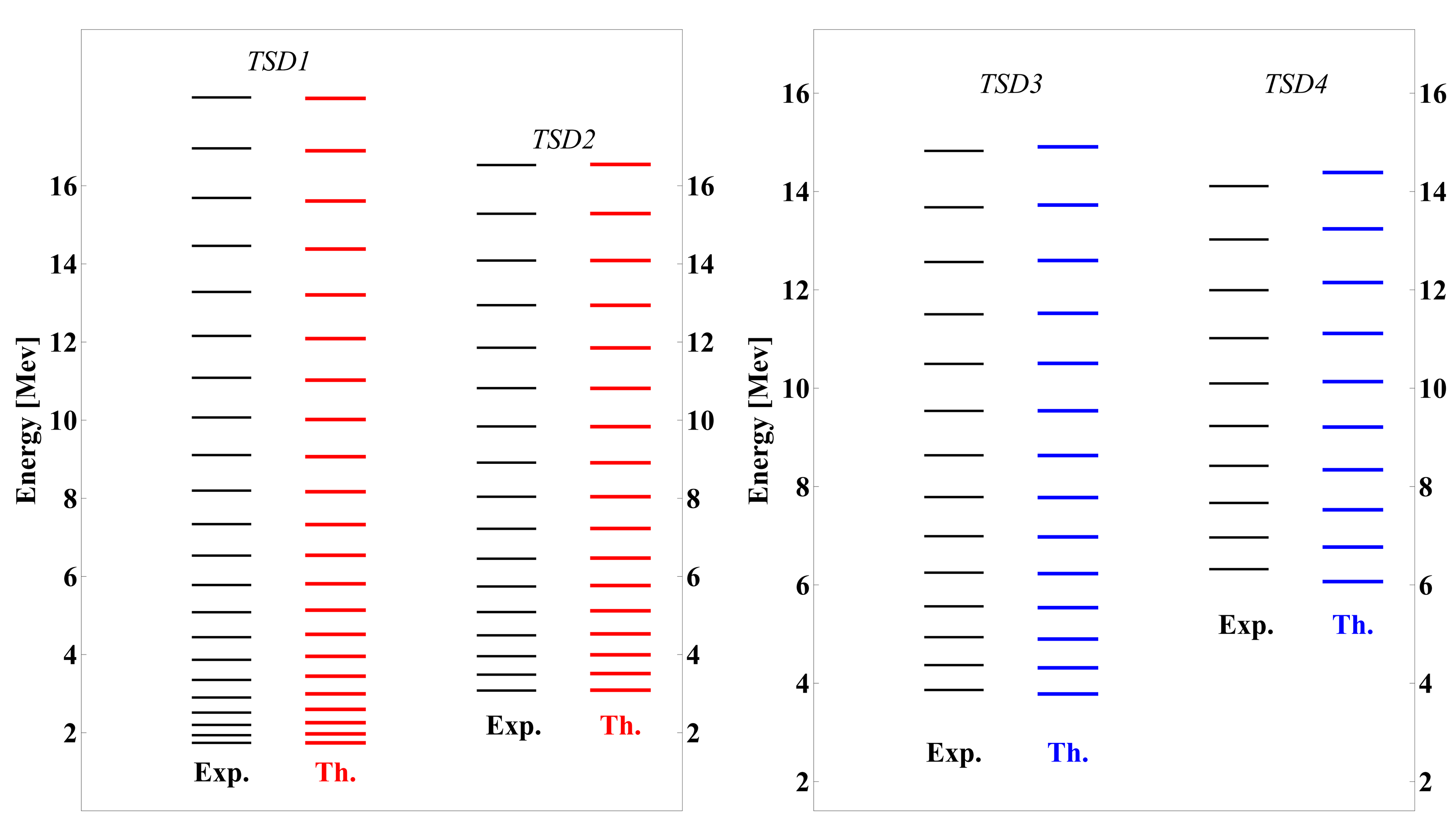

Figure 3:Energy spectrum of the four triaxial strongly-deformed bands in ^{163}Lu.

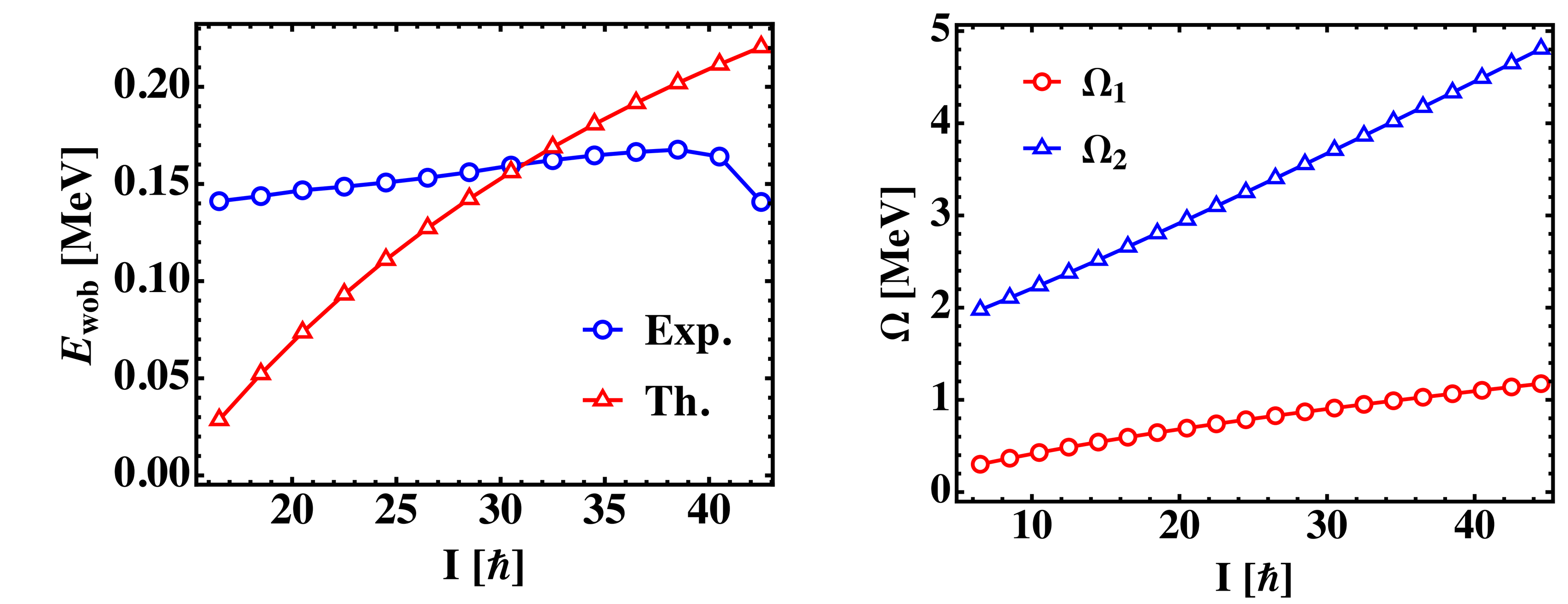

Figure 4:**Left:** The wobbling energies, defined as the $E_{\text{wob}} = E_1(I) - \frac{1}{2}(E_0(I+1) - E_0(I-1))$, where E_0 is the ground-state band and E_1 is the first excited band. **Right:** The wobbling frequencies obtained analytically after the dequantization of $\hat{H}$. Ω_1 corresponds to the motion of core, while Ω_2 corresponds to the dynamics of the odd-nucleon.

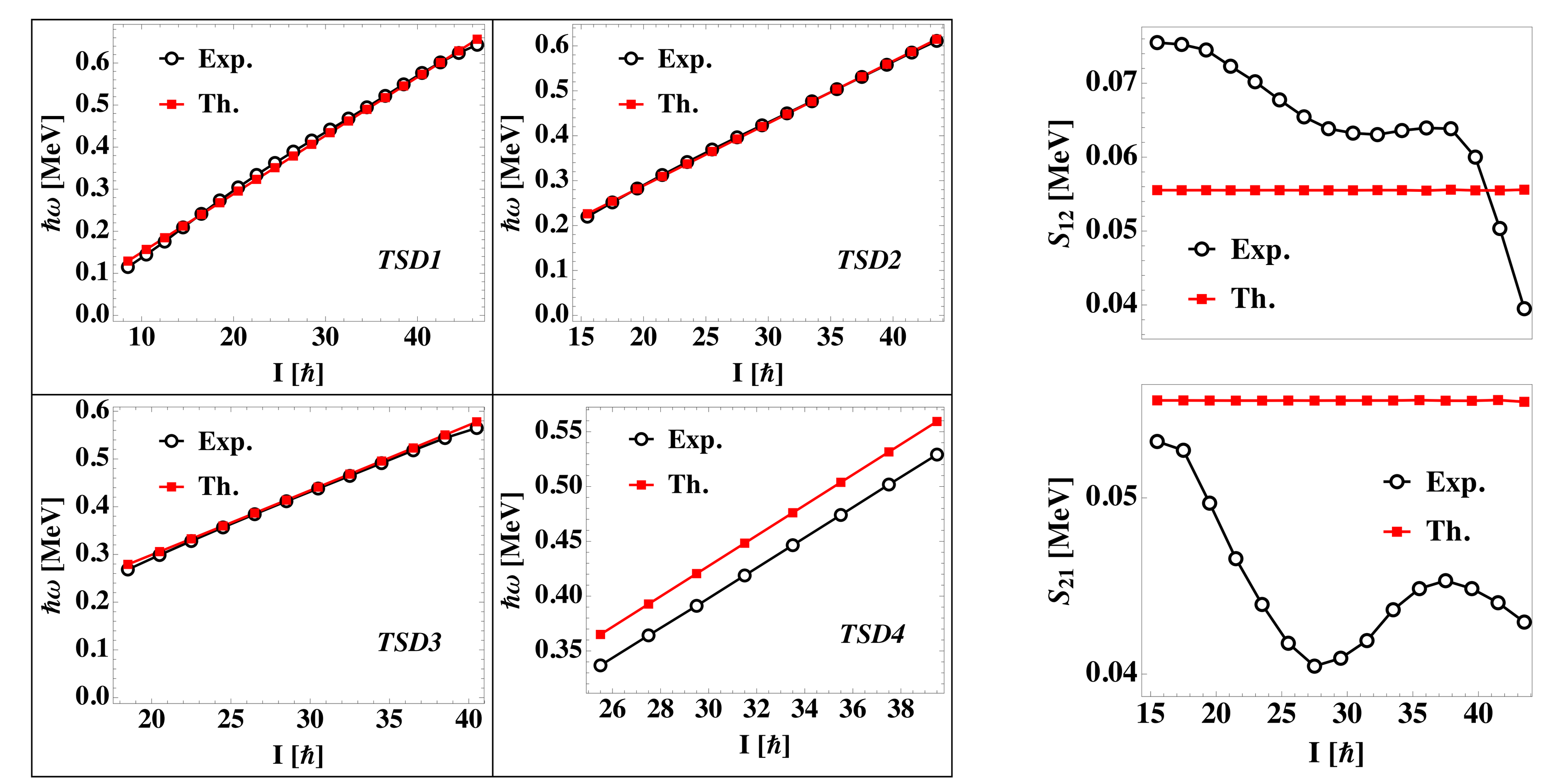

Figure 5:**Left:** The rotational frequencies of ^{163}Lu, defined as the averaged increase in energy between two wobbling states with respect to the increase in angular momentum of the total system. **Right:** Energy staggering between the bands TSD1 and TSD2.

Conclusions

- The excitation spectrum of the wobbling states in ^{163}Lu is accurately described by a classical set of equations.
- The single-particle motion has a larger contribution in the total energy of a wobbling nucleus (Fig. 4).
- Due to the increasing trend of the wobbling energies (Fig. 4 left), the nucleus has a longitudinal wobbling regime.