SINGLE-PARTICLE MOTION IN A WOBBLING NUCLEUS
A CASE-STUDY FOR ODD-MASS ISOTOPES

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Introduction

In the present work, a description of the collective motion which occurs in odd-mass triaxial nuclei known as **Wobbling Motion** (WM) is done, using the Particle Rotor Model (PRM) [?]. Within this framework, the total nuclear system consists of an even-even core and a *valence* nucleon (also known as *intruder*) which is moving in a quadrupole deformed mean-field, generated by the core. The strength of this deformed potential turns out to be a major player in driving the coupled system to different triaxial shapes.

Research goals

1. A quantitative analysis on the shapes of the deformation potential for several isotopes
2. Comparison of the potential strength of nuclei at different quadrupole deformation and triaxiality parameters which dictate the nuclear shapes.

Wobbling Motion

A nucleus in which WM occurs behaves in a certain way with respect to the total angular momentum (i.e., *nuclear spin* I).

- a *precession* of the total angular momentum combined with an *oscillation* of its projection onto the rotational axis.
- the precession + oscillation leads to **wobbling frequencies**: energy quanta of phononic type that will lead to collective excitations with harmonic-like structure in the nucleus (See Fig. 2-left).
- different *core-particle* couplings lead to different wobbling regimes (See Fig. 1).

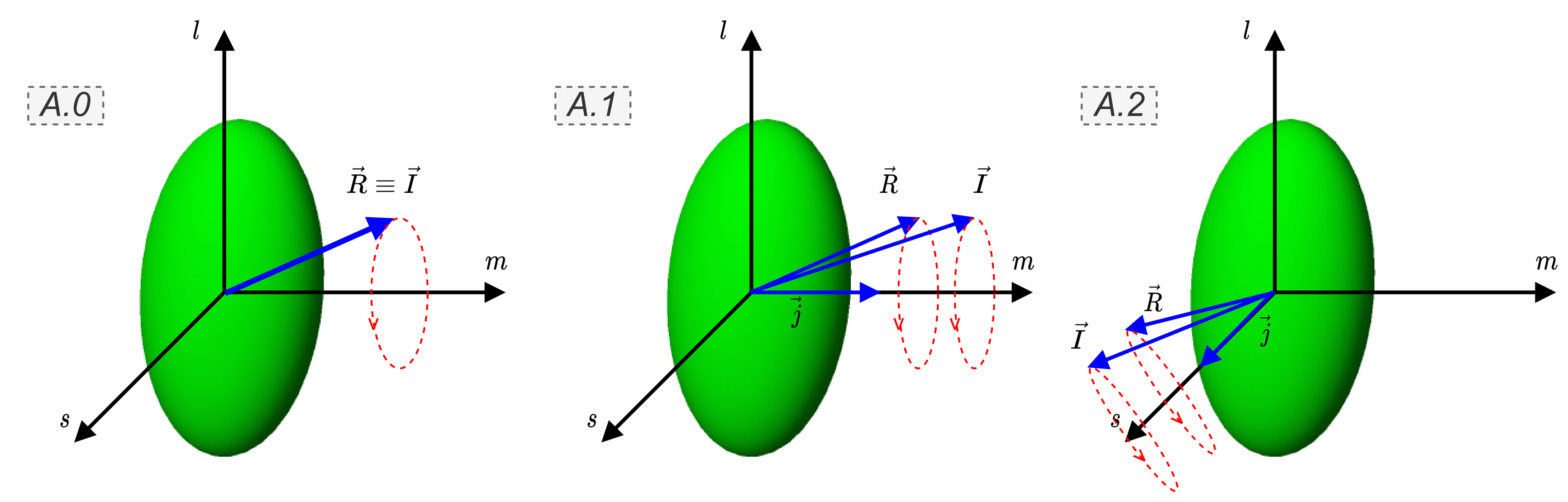

Figure 1:An illustration with the wobbling regimes which can occur in a nucleus. From left to right: *simple/ideal wobbler*, *longitudinal wobbler*, *transverse wobbler*.

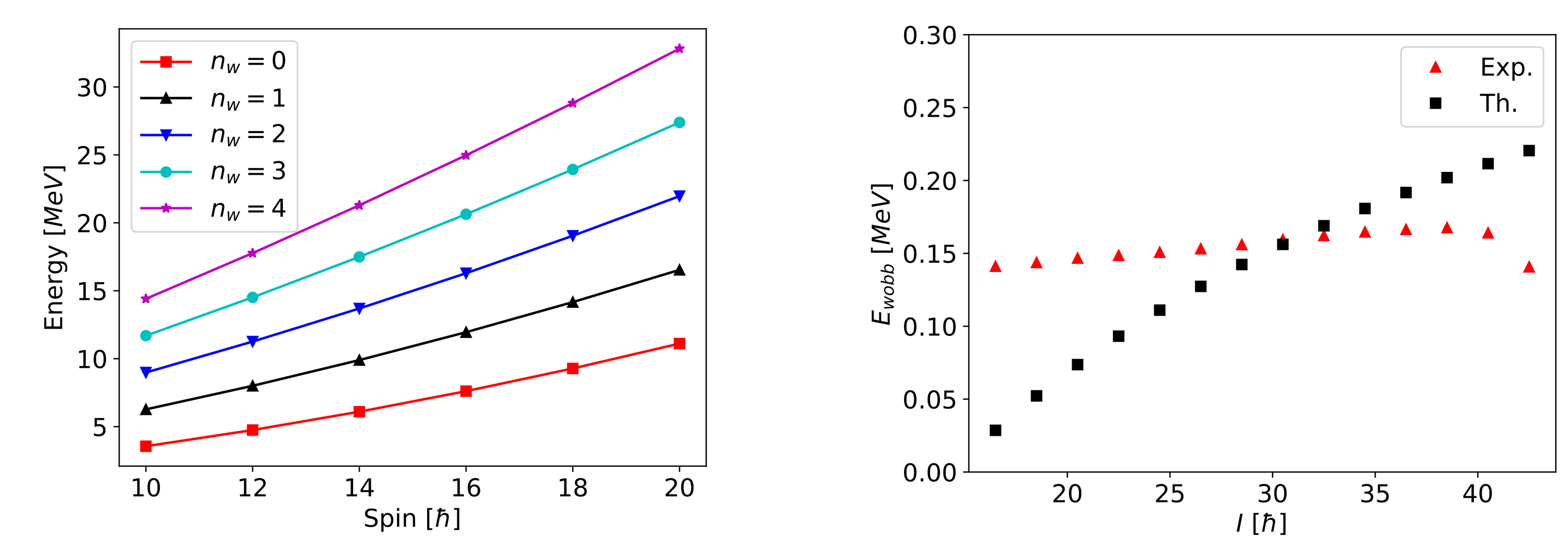

Figure 2:**Left:** ideal wobbler (case $A.0$ depicted above). **Right:** real wobbling spectrum of ^{163}Lu (case $A.2$ depicted above).

Single-Particle Deformed Potential

The system is described by the total PRM Hamiltonian:

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

where $\hat{H}_{\text{core}}$ describes the dynamics of the triaxial core [?], and $\hat{H}_{\text{s.p.}}$ is the single-particle potential that corresponds to the odd nucleon. Depending on the angular momentum $\vec{j}$ of the nucleon, and the strength parameter V, its expression corresponds to a Nilsson potential [?] as such:

$$\hat{H}_{\text{sp}} \equiv V_{\text{sp}} = \frac{\mathbf{V}}{j(j+1)}\left[\cos\gamma Y_{20} + \frac{\sin\gamma}{\sqrt{2}}\left(Y_{2-2} + Y_{22}\right)\right] , \tag{2}$$

$$V = \chi(A, \beta_2) \tag{3}$$

Results

The deformed potential in which the valence nucleon is moving, with respect to different values of triaxial parameter γ, for fixed quadrupole deformation $\beta = 0.3$ and odd-angular momentum $j = 13/2\ \hbar$ can be seen in Fig. 3. Fig. 4 shows the same potential, but for fixed γ, same angular momentum of the valence nucleon, but variable deformation parameter β_2.

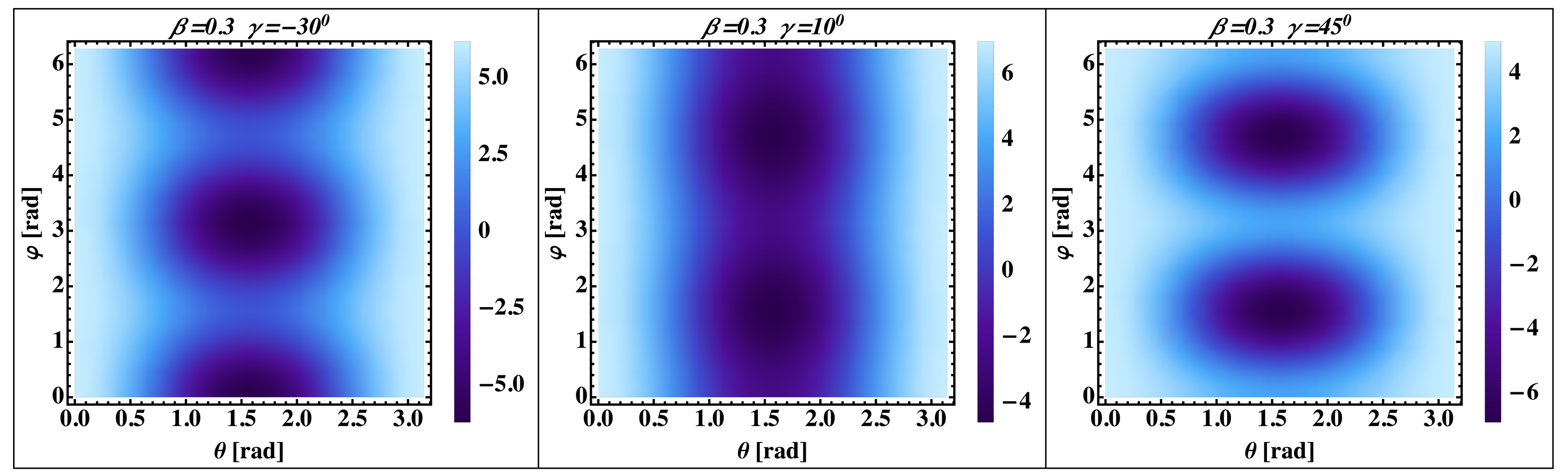

Figure 3:V_{sp} for fixed β_2 and j.

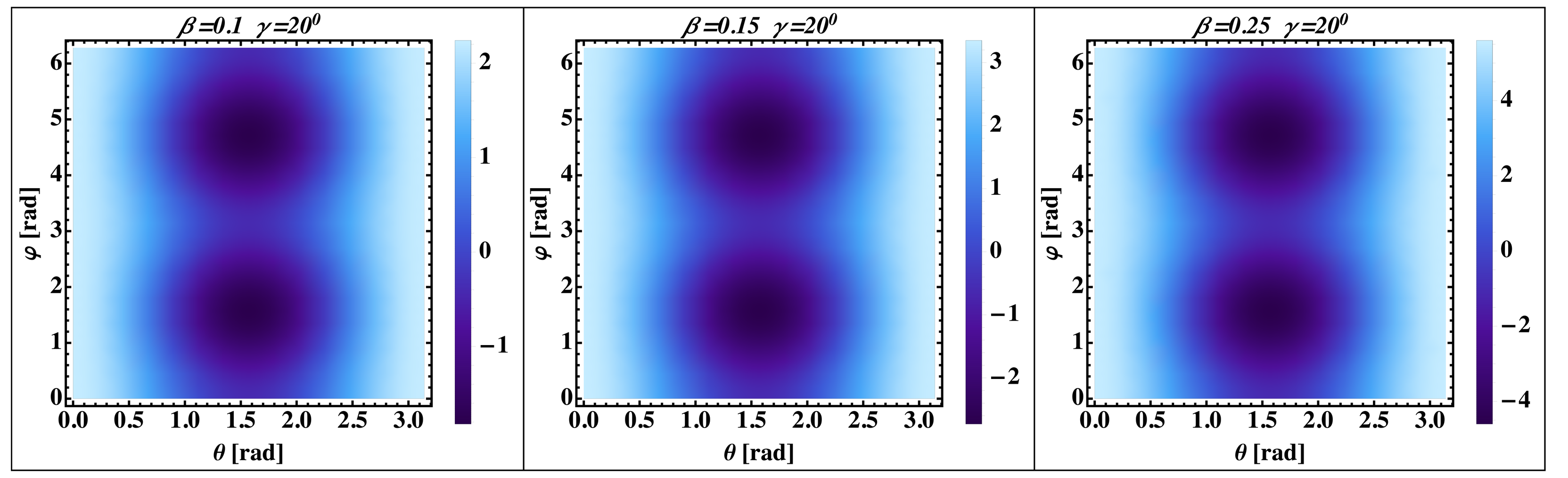

Figure 4:V_{sp} for fixed γ and j.

Conclusions

Some conclusions.

References