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

Wobbling motion in nuclei employs a *precession* of the total angular momentum combined with an *oscillation* of its projection onto the rotational axis. Different *core-particle* couplings lead to different wobbling regimes (See Fig. 1).

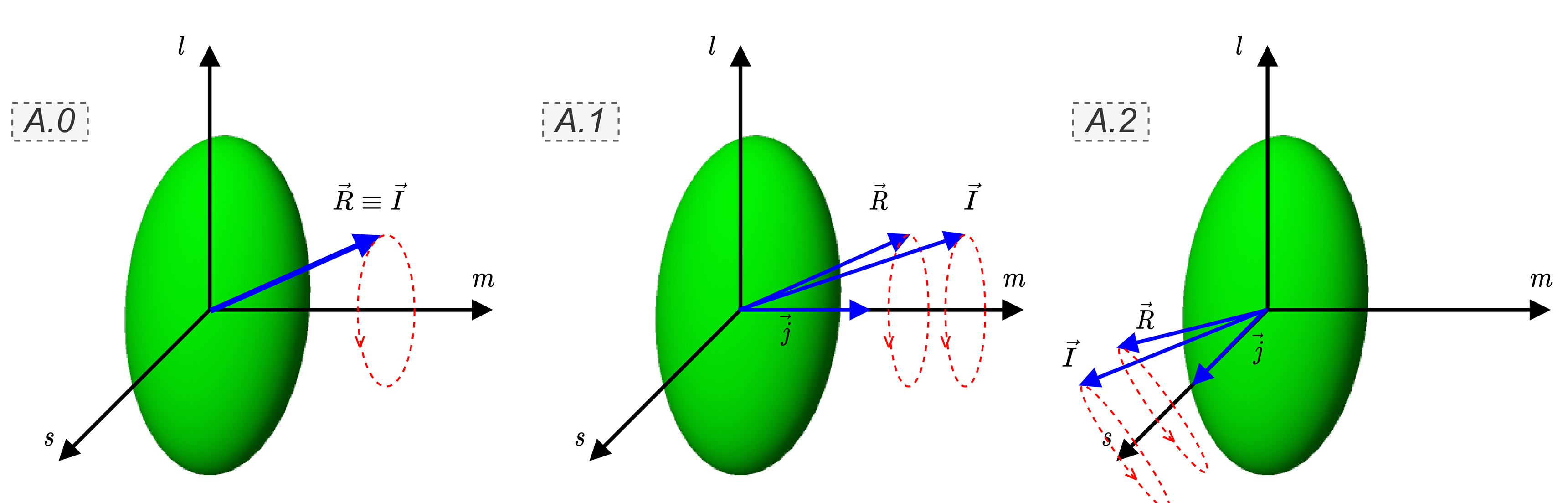

Figure 1: An illustration with the wobbling regimes which can occur in a nucleus. From left to right: *simple/ideal wobbler*, *longitudinal wobbler*, *transverse wobbler*.

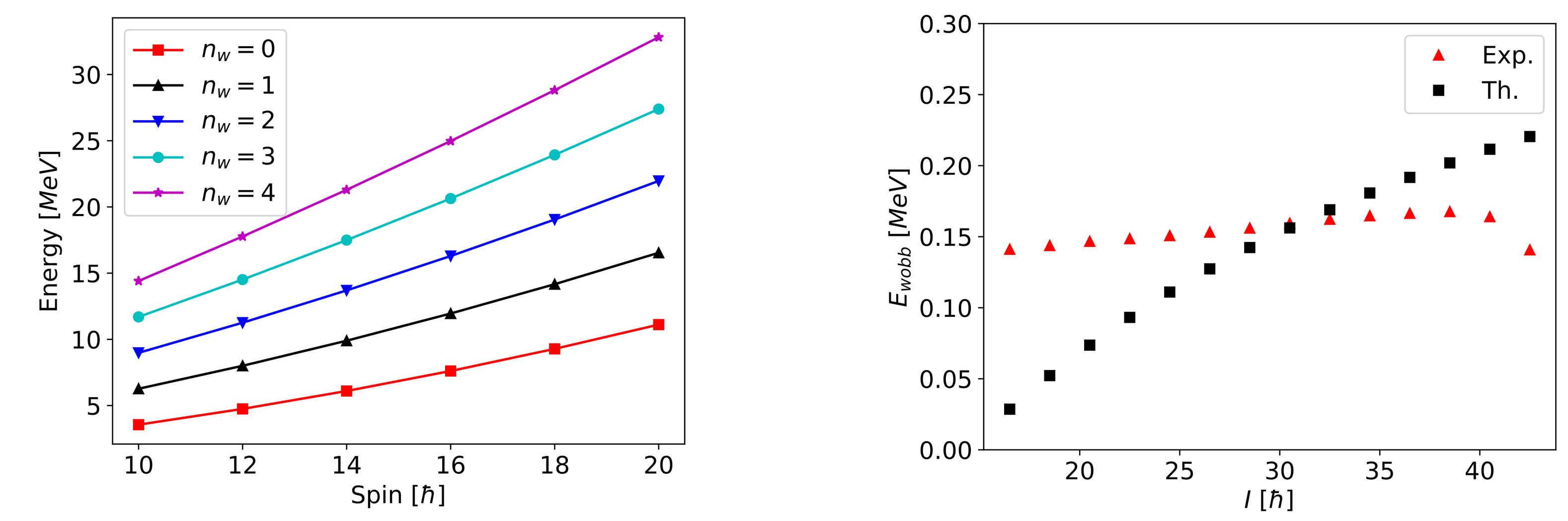

Figure 2: **Left:** ideal wobbler (case $A.0$ depicted above). **Right:** real wobbling spectrum of ^{163}Lu (case $A.2$ depicted above).

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:

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

Results

The potential V_{sp} behavior with respect to different values of triaxial parameter γ and quadrupole deformation can be seen in Figs. 3-4.

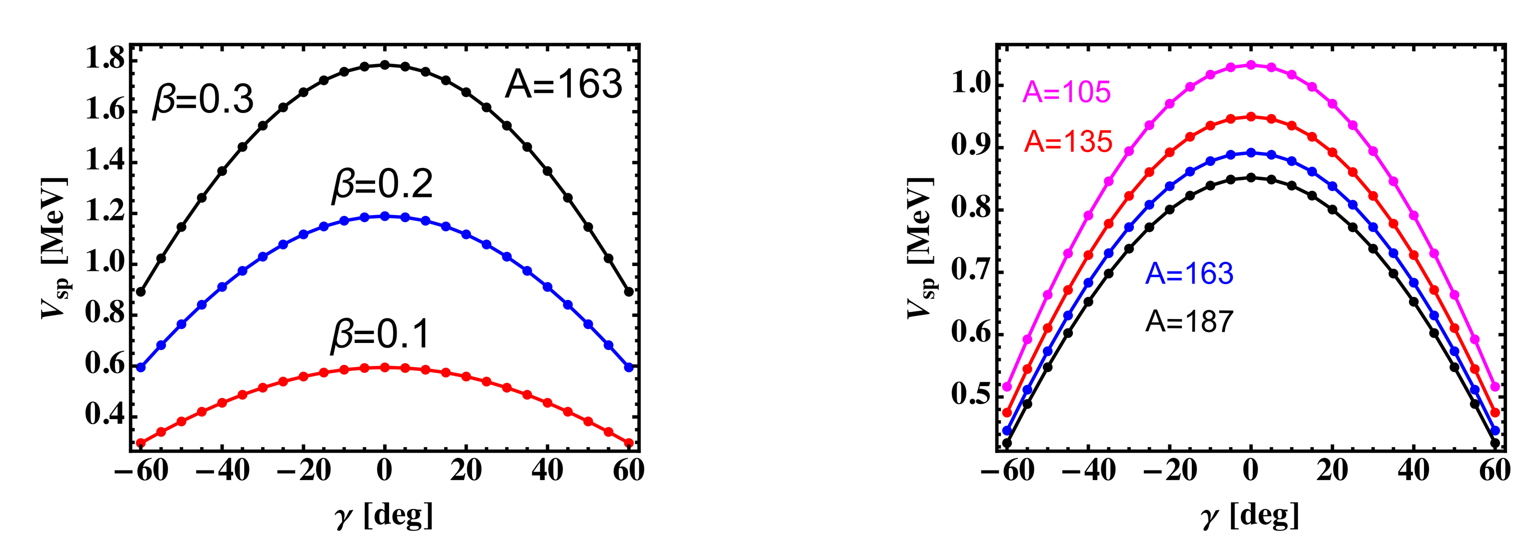

Figure 3: **Left:** $V_{\text{sp}}(\gamma)$ for ^{163}Lu. **Right:** V_{sp} with fixed $\beta_2 = 0.15$ but different mass number.

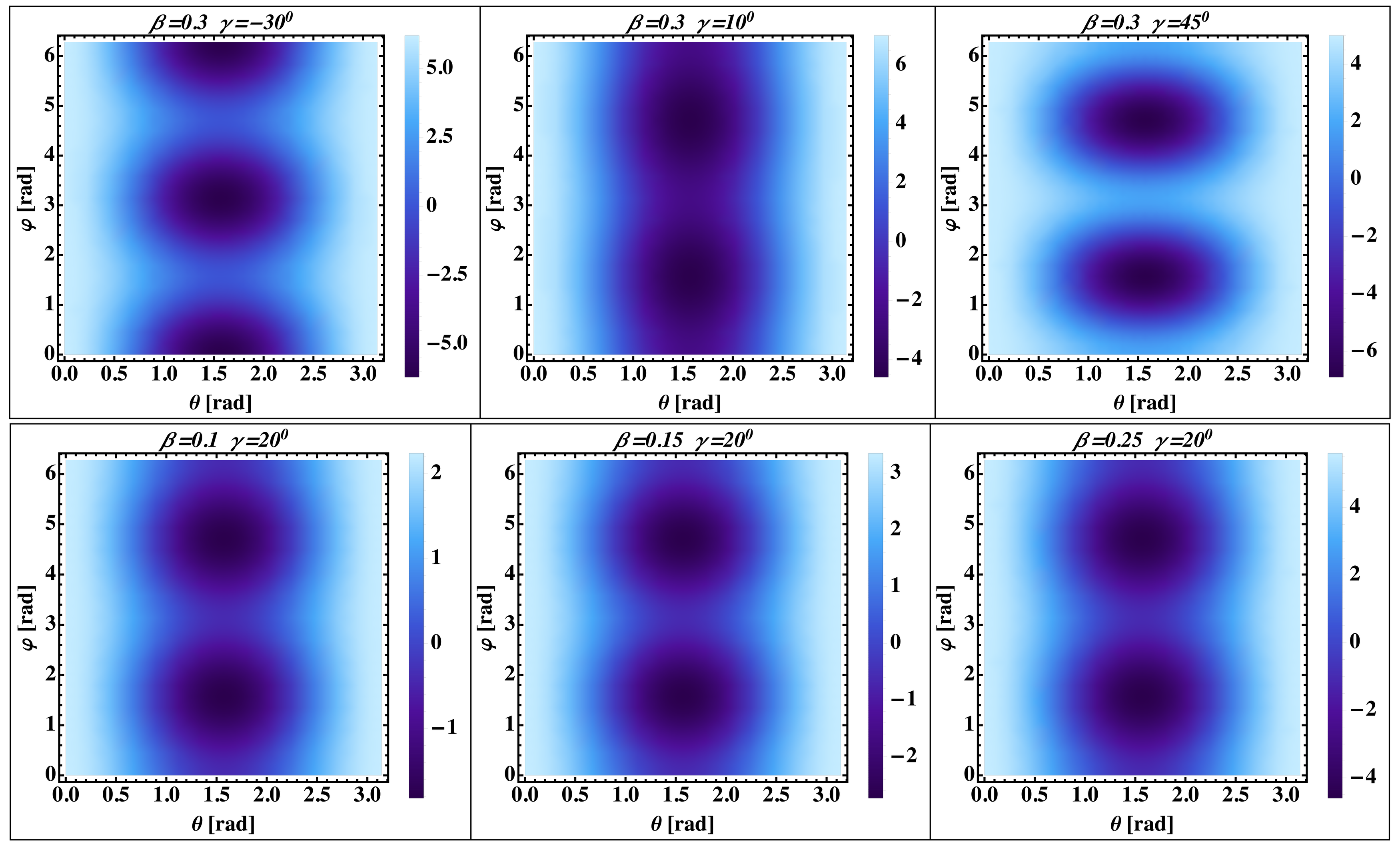

Figure 4: V_{sp} for fixed β_2 (top) and fixed γ (bottom). The odd nucleon's a.m. is $j = 13/2\,\hbar$.

Conclusions

- The shape of the deformed potential is much more *sensitive* with respect to parameter γ.
- The strength parameter V that characterizes the potential V_{sp} has a specific shape.

References