📈 Poster-P1 | OpenReadings Conf2021

This is a page for writing the content of the poster for the conference.

Title:

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

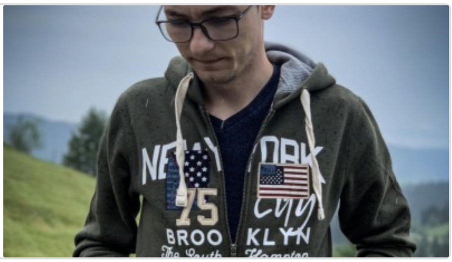
https://s3-us-west-2.amazonaws.com/secure.notion-static.com/e48a6b3e-58e4-4549-9773-ce71afea898e/abstract-poster.pdf

Text can be found in the GitHub repository dedicated to the poster development.

basavyr/Poster-OpenReadings2021

This project represents the development of a scientific poster that will take part on the poster session during the 64th International Conference for Students of

https://github.com/basavyr/Poster-OpenReadings2021



The main project of the poster development process.

Introduction
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Speech

Introduction

Triaxial nuclei are non-spherical and non-axial nuclear objects which have an asymmetry between the moments of inertia associated with the principal axes of the ellipsoid and, therefore, a triaxial nucleus has an asymmetry in the mass/charge distributions within the nucleus. This \emph{feature} gives rise to rich energy spectra of collective character, and interactions between different states of predominately electric $E2$ type.

Final version

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Poster @Conference-page

Official version of the poster can be seen on the main page of the conference:

http://www.openreadings.eu/thesismanager/posters21/431Poenaru.pdf

Speech

This topic is attractive because there is a real challenge in finding (experimentally) stable triaxial shapes, and one of the few phenomena that are uniquely related to triaxiality is wobbling motion

Triaxial nuclei have no symmetry axes

Theoretical models that describe this effect are also quite complicated.

In this research project we studied the wobbling motion of several odd-A isotopes which are experimentally confirmed to have this kind of behavior.

This phenomenon is strictly related to triaxial nuclei (nuclei without any axes of symmetry) that have strong deformations.

A strong deformation implies large degrees of asymmetry between the three moments of inertia that correspond to each of the three principal axes

Strong deformation also implies asymmetry in the charge distribution within the nucleus → **quadrupole deformation plays a crucial role**

- Large static quadrupole moments

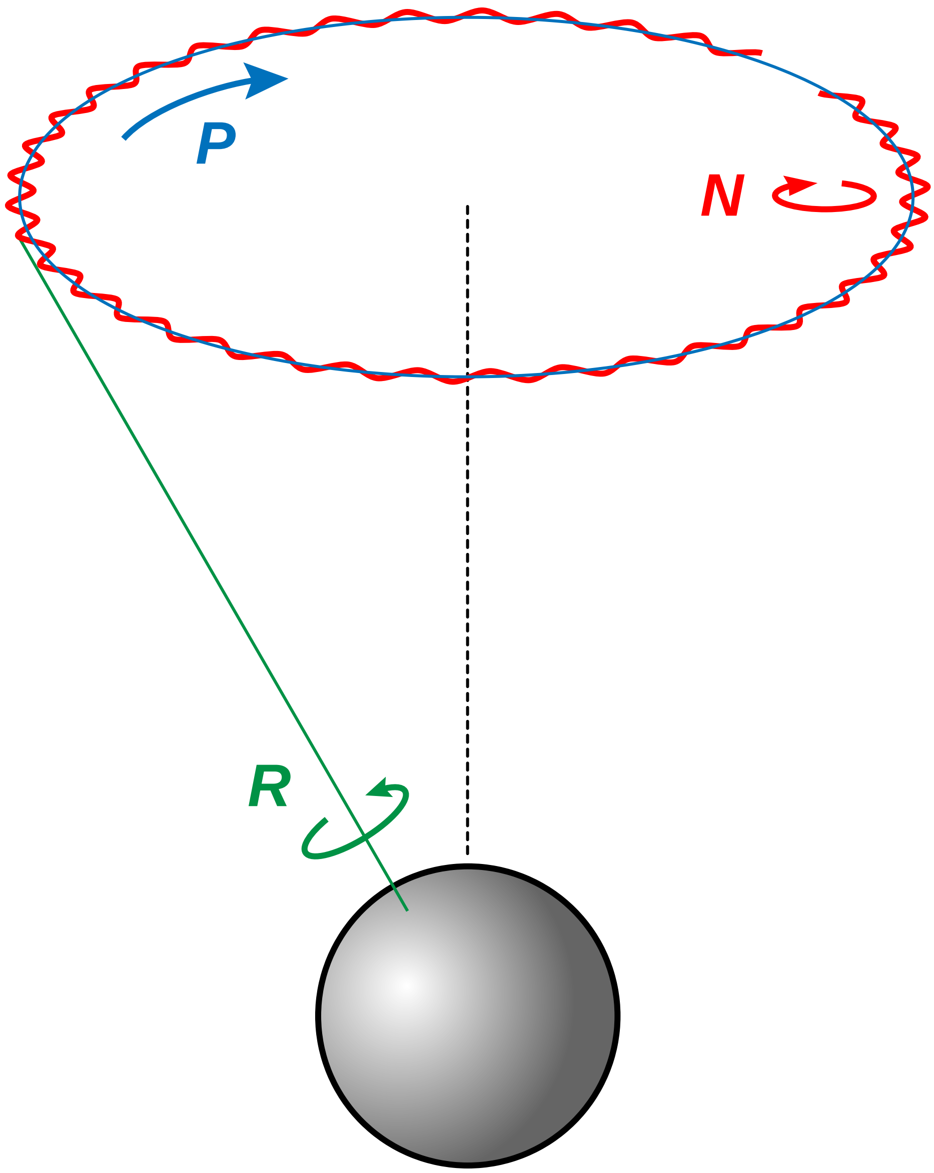
In this example, we only focused on showing some preliminary results for an odd-A isotope such as $^{!63}Lu$, using the so-called **Particle Rotor Model**

The PRM starts from the assumption that the whole nuclear system is composed of

- One even-even core (with a triaxial shape)
- One single-particle (also called valence nucleon or intruder) that is moving in a quadrupole mean field potential generated by the core

The wobbling phenomenon implies a precession of the nuclear spin, combined with the oscillation of its projection on the rotational axes q

- An example with the specific motion of a wobbling nucleus can be visualized in terms of nutation of a rigid body, as is our planet.



In figure 1, some illustrations with the wobbling regimes which can occur in a nucleus are presented. Namely, the **transverse** wobbling regime and the **longitudinal**.

The main different between the two pictures relies in the fact that A2 has a specific coupling where the odd-particle's angular momentum aligns perpendicular with the axis of the largest moment of inertia.

Difference in the energy spectrum can be seen between the two regimes

The wobbling energies of a transverse wobbler will decrease with increase in angular momentum

In order to investigate the coupling scheme in this isotope, we start from the PRM Hamiltonian, where the total Hamiltonian is written in terms of a core part and a particle term.

The core Hamiltonian:

This term is known from the dynamics of a rigid body, where there is a main rotational motion around the axes with largest MOI, and a harmonic like-motion due to the asymmetry of the inertia moments.

Thus, one can write this Hamiltonian as a rotational term, that is proportional to the angular momentum squared, plus a frequency of the type $\hbar\omega_w \left(n_w + \frac{1}{2}\right)$

The single-particle Hamiltonian:

This term corresponds to the one-particle motion in deformed potential, described by a Nilsson Hamiltonian, represented in the above equation

The two terms will give the entire energy spectrum of the isotope.

However, here we only focus on the `sp` term, that is the single particle energy. Namely, we are interested to see how does the coupling parameter change with respect to the deformation parameters, but also the atomic mass.

Variation of the single particle coupling parameter with the atomic mass might be a great indicator for predicting some new wobbling nuclei, or checking if the description used for a new "wobbler" is consistent with the already confirmed results.

Results

The first analysis was focused on the shape of the single-particle potential, more precisely, the trajectories of the particle in the angular momentum space for different deformations

In figure 4, this quantity is represented for different sets of deformation parameters

One can see that the trajectories will always surround a minimum point, where the nucleon will most like "be found"

Another interesting aspect of the current research is that the coupling between the core and the particle increases with quadrupole deformation, meaning that the nucleon will align stronger with increasing "force" of the generated mean field.

Moreover, the higher the angular momentum of the nucleon is, the less coupling will experience

From the density plots, one can see that the triaxiality parameter γ is causing the single particle potential to suffer shape changes more dramatic than the variation of the β_2 parameter.