Systematics study of ground-state bands in rotating even-even nuclei to reveal triaxial deformation at ground state

Project: MSc level
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Project Aim / Scope:
This MSc project offers an investigation of the ground-state bands in all rotating even-even nuclei using a Coriolis-interaction analysis. This is a new idea that allows to determine which nuclei have triaxial shape near their ground state in a parameter-free approach. Our results will then be compared with the present knowledge on the deformation of the nuclei and in particular with global calculations done for all nuclei in the nuclear chart that predicted regions of nuclei with probable rigid triaxial shape at ground state.

Abstract:
Triaxial nuclei rotate around all three of their axes. This is a complex three-dimensional (3D) rotation that involves precession of the rotational axis around the nuclear axis with largest moment of inertia. This precessional motion is different from the simple rotation of an axially symmetric nucleus and generates series of rotational bands, eg the ground-state band, and the γ bands with band head spins of 2^+, 4^+, etc. The rotational bands in nuclei with rigid triaxial shape are typically described by the triaxial-rotor model, first introduced by Davydov and Fillipov [1]. It is known that the ground state band of a triaxial nucleus is little affected by the axial asymmetry of the nuclear shape. It is thus believed that that it is the γ bands alone that can offer an indication about non-axiality of the nuclear shape. However, it was found at iThemba LABS that even the ground-state band shows sufficient difference with respect to the ground-state band in axially symmetric nuclei, which stems from the precessional motion of a triaxial nucleus in contrast to the simple rotation of an axially symmetric one. It was found that the difference in the rotation can be clearly revealed in an analysis of the features of the rotational bands (called by us Coriolis-interaction analysis). We want to apply this new idea to reveal empirically important features of rotating nuclei.

The Coriolis analysis involves an analysis of the shape of the curve of the gamma-ray energy as a function of the spin of the initial nuclear state, of particular interest is the value I_c at which the curve crosses the x-axis. The project involves a systematics studies of the ground-state bands in all known even-even nuclei (about 600 cases) where the nuclear shape will be extracted using such an analysis. The results will be compared with the presently adopted nuclear shapes (axially symmetric, rigid triaxial, or γ-soft shape) and also with global calculations for all even-even nuclei that predicted the nuclear shapes at ground state [2]. Available experimental data, listed in the NNDC data base [3], will be used.

Relevant References:

[1] A.S. Davydov and G.F. Fillipov, Nucl. Phys. 8 (1958) 237
[2] P. Möller, R. Bengtsson, B. G. Carlsson, P. Olivius, T. Ichikawa, Phys. Rev. Lett. 97, 162502 (2006)
[3] National Nuclear Data Center, https://www.nndc.bnl.gov/