Systematics study of 2^+ gamma-state bands in rotating even-even nuclei to reveal triaxial deformation

Project: MSc level
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Project Aim / Scope:
This MSc projects offers an investigation of the 2^+ gamma bands in all rotating even-even nuclei using Coriolis analysis. This is a new idea that allows to determine which nuclei have triaxial shape near the second 2^+ state in a parameter-free approach. These results will then be compared with the present knowledge on the nuclear deformations and also with the predictions of the energy staggering analysis, (the standard way to predict triaxiality at present).

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.
To evaluate the nuclear deformation, one usually studies the energy staggering, S(I), in the 2^+ γ band, as one expects different patterns of S(I) for axially symmetric nuclei, for nuclei with rigid triaxial deformation, and for nuclei with gamma-soft nuclear shape, see for example [2]. However, this analysis is affected by the presence of other bands, for instance an excited 0^+ band would interact with the even-spin members of the 2^+ γ band, which may modify the observed energy staggering. In this project a new approach is proposed, to study the 2^+ γ bands using the Coriolis-interaction analysis. This analysis is sensitive to the nuclear shape and can distinguish between axially

symmetric, gamma-rigid and gamma-soft nuclear shape. The analysis will be applied to all even-even nuclei. The results will be compared with the present knowledge on the nuclear deformation and also with the results from the analysis of the energy staggering. 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] E. A. McCutchan, Dennis Bonatsos, N. V. Zamfir, and R. F. Casten, Phys. Rev. C **76**, 024306 (2007)
[3] National Nuclear Data Center, https://www.nndc.bnl.gov/