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Investigating the gamma back-decay from the shape isomer in ^{236}U

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Shape isomers (SI) in actinide nuclei are poorly understood metastable states lying in the second super-deformed prolate potential well. Their unique characteristics include a super-deformed shape, a low spin - similar to that of the normally-deformed ground state - and a main decay mode that is spontaneous fission. Although many such isomers have been discovered in the actinides since their first discovery in the early 1960's (Polikanov, 1962), information about the second potential well remains nowadays very limited (Björnholm and Lynn, 1980) (Metag, 1980).

The unexpected absence of such short-lived spontaneously fissioning isomers below Plutonium isotopes has tentatively been explained by a competing γ back-decay branch, depopulating the SI back to normally deformed states. Amongst the many experiments aiming at directly observing this transition, only one produced strong evidences in favor of such a transition, performed on the shape isomer of ^{236}U at GSI using the Crystal-Ball detector (Reiter, 2025).

The main aim of this work is to reproduce and refine this experiment using state-of-the-art technology. In 2022, ^{236}U was produced by the $^{235}\text{U}(d,p)^{236}\text{U}$ at the ALTO facility of IJCLab and its decay detected by the nu-Ball2 hybrid spectrometer (made of 24 HPGe Clovers, 64 PARIS detectors and a DSSD for light particles).

The full characterization of these back-decay gamma-rays would enable a unique and precise way to determine the parameters of the fission barriers, which play an essential role in fission's theory. Moreover, spectroscopy in the second well can allow for a better understanding of nuclear structure of these mysterious highly-deformed states.

Here, the results of this fission shape isomer experiments will be presented, along with a proposition of a re-analysis of the isomeric fission half-lives systematics.

References :

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Regular Abstract

Primary author: HIVER, Corentin (Heavy Ion Laboratory, University of Warsaw)

Co-author: WILSON, Jonathan (IJCLab, Orsay)

Presenter: HIVER, Corentin (Heavy Ion Laboratory, University of Warsaw)

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