

# Study of shape isomers in actinide nuclei

Corentin Hiver

February 2026

Shape isomers (SI) in actinide nuclei are metastable states lying in the second super-deformed prolate potential well (see figure 1), giving them a rugby ball-like shape. Their main decay mode is spontaneous fission. A previous experiment presented strong evidence for the existence of a competing  $\gamma$  back-decay branch, depopulating the SI back to normal deformation. This experiment, carried out at GSI in 1989, reported a relative cross-section of  $\Gamma_{\text{delayed } \gamma} / \Gamma_{\text{delayed fission}} \approx 6.5 \pm 0.8$ .

The main aim of my thesis work was to reproduce and refine this experiment using the state-of-the-art nu-Ball2 spectrometer, constructed at the ALTO facility of IJCLab in 2022-2023. This complex hybrid spectrometer allowed for high-resolution gamma spectroscopy thanks to its 24 HPGe Clovers, and calorimetry capabilities thanks to the high-efficiency and large solid angle coverage of the BGO anti-Compton shields and additional 64 PARIS phoswich detectors. The DSSD placed in the reaction chamber allowed for light particle energy measurement.

The  $^{235}\text{U} (d, p) ^{236\text{II}}\text{U}$  and  $^{232}\text{Th} (d, x)$  reactions were used to produce the SI of interest. The main experimental goals were to perform a high-resolution spectroscopy of a) the  $\gamma$ -back decay of the SI  $^{236\text{II}}\text{U}$ , b) the prompt  $\gamma$ -feeding of the SI from states in the deformed potential well and c) of the as-yet-unobserved SI in  $^{231,232,233}\text{Th}$  isotopes.

In this seminar, I will present in more details the theory of these shape isomers and gamma-back decay, the experimental setup and the main results reported in my PhD thesis.

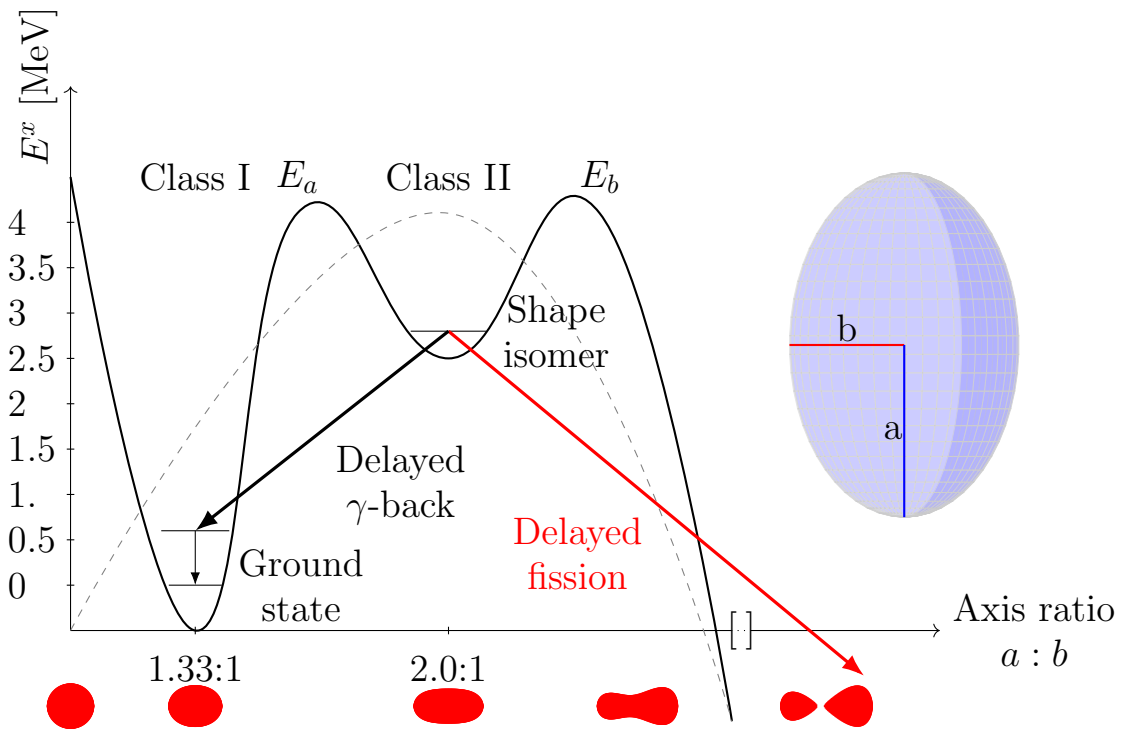


Figure 1: Double-humped fission barrier, explaining the formation of fission isomers. The caption defines the axis ratio as the ratio of the major semi-axis  $a$ , along the symmetry axis, and the semi-minor axis  $b$ , perpendicular to the symmetry axis (prolate deformation). The dashed line correspond to the pure liquid drop fission barrier, without Strutinsky modifications.