Contribution ID: **8** Type: **not specified**

New experimental insights into the ”Thorium anomaly” from isotopic fission fragment yields of 232Th produced in inverse-kinematics

Tuesday, 10 March 2026 11:15 (15 minutes)

Since the discovery of fission in 1939, several theoretical models were developed to properly explain the observations [1]. It wasn't until the introduction of shell effects by Strutinsky [2], that the microscopic - macroscopic models [3] could match the measured yields of heavy actinides like 252Cf or 254Es [4]. The interplay between both quantities prevents, so far, from a fully microscopical description of the interaction. Despite the development of different theoretical models [5] and simulation codes based on experimental data, such as GEF [6], the fission process is not reproduced with enough accuracy along the nuclear chart. A large set of experimental data is needed in order to constrain the models.

Following the advantages of inverse-kinematics, the VAMOS group and collaborators have performed fission studies for more than 10 years [7,8]. The VAMOS++ spectrometer, composed of a pair of magnetic quadrupoles and a dipole, is coupled to a set of Multi-Wire Proportional Counters (MWPCs) before and after the optical modules and an Ionization Chamber (IC) positioned at the end of the focal plane [9]. This configuration enables the isotopic identification of complete fission fragment distributions. The magnetic spectrometer is combined with a highly stripped silicon detector (PISTA), which allows the identification of the fissioning system and the reconstruction of its excitation energy with high resolution. The combination of both devices permit to systematically study the fission process.

This setup was used in a new experiment conducted with the newly accelerated 232Th beam at Coulomb energies. Transfer reactions performed with a 12C target permitted to populate fissioning systems from 230Th up to 244Cm. This allows the systematic study of the shell-closure effects occurring for different deformation parameters, like octupolar deformation, recently proposed to be responsible for the asymmetric fission in the actinides region [10]. Moreover, experimental results show that the isotopic distributions around Th isotopes deviate from the general actinide behaviour [11].

In this work, the atomic number and mass fission fragment yields of 232Th will be presented. These distributions have been obtained as a function of the excitation energy. The comparison between Thorium yields and heavier actinides give new experimental insight into understanding the so-called “Thorium anomaly” [11].

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Session Classification: session 4 (Chair: N. Pillet)