PhD position in experimental nuclear physics

Complete fission yields in the Thorium region from inverse-kinematics transfer-induced fission

The fission mechanism is a violent complex reaction in which a heavy nucleus is split in two fission fragments. This process is strongly determined by the nuclear structure along with the nuclear dynamics that drives the system from an initial state to the final break-up through different states of extreme deformation [1].
Despite more than 80 years of intense research on fission, the complex interplay between intrinsic and collective degrees of freedom still prevents from a full microscopic description and hence, the theoretical knowledge of the process is still limited.
From the experimental point of view, the relative production of the different fission fragments, pre- and post-neutron evaporation isotopic fission yields, together with their kinetic energies are good candidates to reveal the mechanism behind the fission process. However, the access to the complete identification of fission fragments is still very challenging due to the large number of produced species – more than 300 different isotopes are produced from one fissioning system – and their low kinetic energy.

GANIL is a pioneer using the inverse-kinematics transfer-reactions to produce in-flight fission [2]. Exotic actinides are produced through multi-nucleon transfer reactions between a heavy beam – Uranium/Thorium – and light targets such as Carbon. The 300 different fragments generated from the fission of the actinides are completely identified in the VAMOS large-acceptance magnetic spectrometer in terms of mass, nuclear charge, and velocity [3]; while a silicon telescope is used to characterize the fissioning system by detecting the residual recoil emitted in the transfer reaction [4].

The fission@VAMOS project [5,6] is undergoing a detection upgrade of the silicon detection system used to tag the fissioning systems produced by transfer reactions. The existing setup will be replaced by a state-of-art device based on highly-segmented silicon detectors (PISTA). This will result in an improved selectivity and precision of the formation condition of the fissioning system (Mass, Atomic charge, and Excitation energy). The detection setup of the VAMOS spectrometer has also been improved with new high-performance gaseous detectors.

The proposed thesis is an experimental project that aim to study the fission process of light actinides in the Thorium region using the VAMOS spectrometer and the PISTA charged particle array. The successful candidate will be in charge of the multi-parameter data analysis of both apparatus, the production and interpretation of results, and dissemination of the experimental data in national and international conferences. This experimental setup is unique worldwide, hence the scientific results of this work are expected to be published on high-impact international journals and the successful candidate will be also in charge of this.

[1] K.-H. Schmidt and B. Jurado, Rep. Prog. Phys. 81 (2018) 106301
[2] M. Caamano et al. Phys. Rev. C 88 (2013) 024605.
[3] M. Rejmund et al., Nucl. Instrum. Methods A **646**, 184 (2011).
[4] C. Rodriguez-Tajes et al., Phys. Rev. C 89 (2014) 024614.
[5] D. Ramos, et al., Phys. Rev. Lett. **123**, 092503 (2019)
[6] D. Ramos, et al. Phys. Rev. C **101**, 034609. (2020)

Expected skills:

The PhD candidate is expected:

- to have a good background in nuclear structure and reactions and in the physics of fission as well as in the radiation-matter interaction.
- to have skills in computing languages such as C++ and knowledge on software packages of data analysis and simulation such as ROOT and GEANT4.
- to be a motivated person with strong communication skills and good English level.
- will join the international researcher team and take an active part in the ongoing experimental program conducted by the group.

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