PhD proposal

Title : Study of fission of exotic actinides by integral measurement of fission fragments

Spéciality/keywords :

Experimental nuclear physics, actinide fission, exotic nuclei, radioactive beam, data analysis, simulations

Laboratory : IPNO

Institut de Physique Nucléaire, 15 rue G. Clémenceau, 91406 Orsay Cedex
Direction : F. AZAIEZ
Division – DR - PACS

Responsible(s) :

- AUDOUIN Laurent
- Tél. : +33 01 69 15 50 09
- Courriel : audouin@ipno.in2p3.fr

- TASSAN-GOT Laurent
- Tél. : +33 01 69 15 72 55
- Courriel : tassango@ipno.in2p3.fr

Duration : 3 years

Workplaces :

Orsay, GSI (Germany).

Travels :

Missions to GSI + conferences

Collaboration :

SOFIA collaboration : CEA Bruyères-le-Châtel, CEA Saclay, CEN Bordeaux-Gradignan, GSI (Germany), Universitad Santiago de Compostela (Spain)

Details of the project :

Fission is one of the most complex phenomenon on the nuclear scale, and its theoritical description remains largely incomplete. Beyond its interest in terms of fundamental physics, the study of fission has been strongly revived for some years as part of the research activities in relation with nuclear waste management and the prospects for new types of nuclear reactors. As ever more precise simulations are required for any development, reliable data covering a wide range of nuclei and reactions have become mandatory. Among this data, the neutron production during fission and the distributions of fission fragments (as a function of both mass and charge) appear as key ingredients.

The SOFIA collaboration (Study Of Fission in Inverse kinematics with Aladin) aims at measuring simultaneously the charge and mass of both fission fragments and the number of neutrons emitted during fission. Such an integral measurement would be the first ever done.

These measurements will be performed for a wide range of nuclei, some of them directly concerned by nuclear fuel cycles (for example 236U, the composed nuclei formed by reaction of 235U with a neutron), and some of them exotic, proton-rich nuclei. The later should bring new constraints for microscopic fission models. Among them stands the 180Hg, recently studied at ISOLDE (CERN), which exhibits an unexpected cold-fission behavior.

Measurements will be performed at GSI (Darmstadt, Allemagne) using the inverse kinematics method : an actinide beam will be sent on a target in which its fission will be triggered, either by electromagnetic interaction (using a lead target) or by collision with a proton (liquid hydrogen target). The fission fragments, forward-focused due to the impulsion of the fissioning nuclei. For both of them, the charge will be determined by measuring their energy loss in an ionisation chamber, and the mass will be determined by measuring their time of flight and their magnetic rigidity in the ALADIN magnet. Neutrons, also forward-focused, will be detected by the LAND plastic wall.

The first experiment is expected to take place in the summer of 2012. Several beams will be used : 238U as a reference, and several exotic actinides. The later will be produced by fragmentation of the 238U beam on a first target, the reaction products being separated in-flight by the FRS spectrometer and then conducted to the fission target and the detection system.

The PhD fellow will take part to the experience preparation, realization and analysis, and then to the physical interpretation of the results. He/She will especially be involved in the development and analysis of the position detectors (multiwire proportional chambers) which have been developed and build at IPNO.

This work will give to the future doctor the opportunity to develop its abilities in all fields relevant for a nuclear physicist : complex detection system, skills data analysis, simulations, physical interpretation. The work will take place in the frame of an international collaboration, and will be performed in a group of physicists who have a long experience of the detection techniques used in this experiment. In addition, the PhD fellow will have the opportunity to come up-to-date with the latest research in the field of nuclear reactors : a part of the PACS group works in reactor simulations, and the whole group is part of the GEDEPEON research association, which covers all the relevant scientific fields (nuclear data, safety, materials...) and includes industrial partners such as EDF and AREVA.