> Thesis subject offer – 2025

Studies of the ^{238}U(n, 2n) and (n, 3n) reactions at the NFS Facility using prompt γ-ray spectroscopy.

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Context:

The group Données Nucléaires pour les réacteurs (Nuclear data for reactors, DNR) activities focus on nuclear data for nuclear energy application. The development of new nuclear reactor systems and fuel cycles is mostly done via computer simulations and required high quality evaluated nuclear data. The improvement of these databases requires both experimental and theoretical work, to achieve the goal of reducing uncertainty in nuclear application simulations. In this context, our group focuses on the (n, xn) process by measuring (n, xn γ) reaction cross sections. The combination of our experimental results with predictions from models, allows us to deduce the total (n, xn) reaction cross section[1].

Our measurement programs are mainly devoted to reactions involving actinides. Up to now, experiments have been carried out using the "white" neutron beam at GELINA (EC-JRC in Geel, Belgium), where we have developed the GRAPhEME device[2], comprising a set of planar HPGe detectors and a fission chamber. Particular attention was paid to minimizing all sources of uncertainty linked to our measuring instruments and the environment. The GELINA facility delivers a neutron beam whose energy range is well suited to the study of inelastic - (n,n') - neutron scattering reactions.

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[1] Measurement of ^{238}U(n, n′ γ) cross section data and their impact on reaction models. M. Kerveno, et al. Phys. Rev. C 104, 044605

[2] M.Kerveno et al., EPJ Web of Conferences 284, 01005 (2023)

The arrival of GANIL's new SPIRAL2/NFS (neutrons for sciences) facility[3], has opened up a whole new field of investigations. The neutrons delivered by this facility make it possible to study higher-threshold processes such as (n,2n) and (n,3n) reactions. The DNR team, in collaboration with EC-JRC Geel, IFIN-HH Bucharest, and ESRIG Groningen, is therefore proposing to carry out measurement campaigns of (n,2n) and (n,3n) cross sections on actinides using the prompt γ-ray spectroscopy method. The methodology, tried and tested for the study of (n,n') reactions at GELINA, can be adapted to NFS. After a series of tests in 2021 and 2022, a first experiment dedicated to the measurement of the ^{238}U(n, 2n γ) and (n, 3n γ) reactions have been carried out in autumn 2024. One part of the experiment was the study of the (n, 2n) reaction with activation measurement.

Objectives:

The proposed thesis subject concerns the analysis of the data recently recorded at NFS to investigate the ^{238}U(n, 2nγ) and (n,3nγ) reactions.

This involves analyzing experimental data collected during the 2024 campaign at the NFS facility. The aim of the thesis is to extract reaction cross sections with reduced uncertainties. The results from the prompt γ-ray spectroscopy analysis will be compared to the ^{238}U(n, 2n) cross section estimate obtained by activation measurement during the same campaign.

Additionally, the work will involve confronting these experimental results against predictions from the TALYS nuclear reaction code.

Profile of the candidate:

Candidates to the thesis are expected to be familiar with programming languages such as C++ and python, as well as analysis tool such as ROOT. An experience in analyzing data from γ-ray detectors (spectra) will be a valuable asset. The student will work autonomously and discuss their finding regularly with the whole research group. They will also have the opportunity to present their results to collaborators during meetings and national and international workshops or conferences.

[3] https://www.ganil-spiral2.eu/scientists/ganil-spiral-2-facilities/experimental-areas/nfs/