> M2 INTERNSHIP FOR THE STUDENTS OF THE SAP MASTER – 2025

Studies of the ^{238}U(n, 2n) reaction at the new GANIL/SIPRAL2/NFS facility.

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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 focus on 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.

The arrival of GANIL's new SPIRAL2/NFS (neutrons for sciences) facility[3], has opened up a whole new field of investigation. The neutrons delivered by this facility make it possible to study higher-

[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)

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

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 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 internship concerns the analysis of the data recently recorded at NFS, with a focus on the study of ^{238}U(n, 2n) reaction.

First, the intern will become familiar with the context of nuclear data measurements for future reactor research, nuclear data evaluation and measurement, (n, xn) reactions, and γ spectroscopy.

Next, the detection efficiency of the setup will be determined, and the radioactivity of the sample will be used to determine precisely the absolute amount of ^{238}U in the sample. The intern will finally extract γ counts from delayed emission spectra to compute a preliminary (n, 2n) cross section from activation measurement, and compare to predictions from nuclear reaction code such as TALYS.

Profile of the candidate:

Candidates to the internship 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 an asset. The intern will work autonomously and discuss their finding regularly with the whole research group. They might also have the opportunity to present their results to collaborators during meetings.

Following a successful internship, the work could be continued by a thesis in the same team.