Internship M2 2019-2020

Determining the neutron inelastic scattering cross section off 232 thorium from measured (n,xn γ) cross sections

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The activiies of the Nucléaires pour les réacteurs[1] group (Nuclear data for reactors, DNR) register in the topic of nuclear data for future reactors. The precise study and optimization of these new systems and fuel cycles require higher quality evaluated nuclear databases, used in simulations. This improvement implies to work both on experimental aspect and on theoretical nuclear process description. At stakes, there is a need for a significant reduction of uncertainties from new nuclear data. In this context, our team focused on improving the knowledge of the (n,xn) process. To that end, we use the prompt gamma spectroscopy method, which allows us to measure (n,xn γ) reaction cross sections. By combining the experimental results with predictions from models (to fill in missing information), we can deduce the (n,xn) reaction cross section[2].

Our experimental program involves in particular reactions on actinides. The measurements are performed at the “white” neutron beam GELINA (EC-JRC à Geel, Belgique) where we developed the GRAPhEME setup. It is made up of planar HPGe detectors and a fission chamber. A particular attention has been paid to minimize uncertainties linked to measure instruments and the environment. During experimental campaign, samples of ^{235}U[3], ^{232}Th, ^{nat}U were studied. Today, we are working on the high activity nuclei ^{233}U and ^{239}Pu, which are fissile nuclei in the innovative fuel cycles Th-U and U-Pu.

[1] http://www.iphc.cnrs.fr/-Donnees-Nucleaires-pour-les-Reacteurs-.html

[2] M. Kerveno *et al*. European Physical Journal A 51, 167 (2015)
[3] M. Kerveno, J.C.Thiry, *et al.* Phycical review C 87 24609 (2013)

The internship work is about data collected on ^{232}Th. During his PhD thesis, defended in September of 2019, Eliot Party extracted more than 80 (n,n' γ) cross sections. This large data set can be used to deduce, using the known level structure of ^{232}Th, the total inelastic scattering cross section ^{232}Th(n,n'). This observable will then be compared to current evaluations.

First, the student will get to know the general context of the nuclear data measurements and their application for future reactors research (thorium cycle, evaluation, nuclear data measurement, (n,xn) reaction, gamma prompt spectroscopy…). Then, he or she will implement programs to compute the total inelastic cross section, while rigorously taking into account the uncertainties and their propagation. The question of missing information will be addressed, as well as the means to compensate or quantify their effect. Depending of the progress during the internship, a comparison work with prediction from the nuclear reaction code TALYS and evaluated databases could be done.