Toward the improvement of the ^{238}U level scheme thanks to γ-spectroscopy ν

Carole Chatel[1)], Jonathan Wilson[2)], Maëlle Kerveno[1)], Philippe Dessagne[1)], Greg Henning[1)]

1) Université de Strasbourg, CNRS, IPHC/DRS UMR 7178, 23 Rue du Loess, F-67037 Strasbourg, France
2) CNRS, IJClab Orsay, bât 100, 15 rue G. Clemenceau, 91406 Orsay Cedex, France

carole.chatel@iphc.cnrs.fr

Abstract: To improve the accuracy of neutronics simulations of actual and future reactor cores, a better knowledge of the neutron population is required. This population is, among others, driven by (n, xn) reactions, including inelastic scattering. Indeed, these reactions change the number of neutrons in a reactor core and their speed. However, their cross sections are, still nowadays, not precisely known. Hence, the neutron inelastic scattering cross section off ^{238}U features in the High Priority Request List [1]. One method to obtain this cross section is to use the prompt γ-ray spectroscopy coupled to time-of-flight measurements. This allows, from the measured (n,xnγ) cross sections and the level scheme information, to infer the total (n, n') cross section [2]. In the case of the ^{238}U, the knowledge of the level scheme is still very incomplete: the discrete states are assumed to be fully known up to 1.3 MeV only and the average uncertainties on branching ratios in ENSDF [3] are of 8%. Yet, sensitivity calculations performed with the TALYS code [4] showed that modifying the branching ratios of 10% in the input's code can have an impact of up to 4% on (n, n'γ) cross sections [2].
For all these reasons, improving the level scheme knowledge has become of high importance. This can be done thanks to the coupling between the ν-Ball γ-spectrometer [5] and the LICORNE neutron source [6, 7] of the ALTO facility. Indeed, the LICORNE source allows the production of a pulsed quasi-mono-energetic kinematically focused neutron flux thanks to the p(^{7}Li, n)^{7}Be inverse reaction, the produced ^{7}Li beam impinging on a ^{1}H-gas cell. The neutron flux impinged then on the ^{238}U target and the γ produced have been collected thanks to the two rings of 12 HPGE-Clover detectors composing the ν-Ball γ-spectrometer. These 24 detectors allow a data analysis by γ-γ coincidences.
Two ν-Ball campaigns have been led in 2018 and 2022. The analysis of the γ-γ coincidences matrix obtained during the first ν-Ball campaign with a neutron flux of a mean energy of 2.1 MeV is now performed thanks to the Radware software [8]. Until now, 59 γ and 43 levels registered in ENSDF have been confirmed and 55 new γ and 26 new levels have been found. Once finished, analyzing the data acquired during the ν-Ball2 campaign will allow to consolidate and improve the results of the analysis of the data acquired during the first campaign.

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