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Improvements of the knowledge of actinides on the HPRL for nuclear energy

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Neutronics codes accuracy is now driven by the knowledge of their nuclear data used as input, and the structure of nuclei plays a very important role in nuclear reactors, whether for experimental or theoretical physics. Several cross sections are listed on the High Priority Request List (HPRL) [1] for improvements. In this presentation, we will show how improving the knowledge of the nuclear structures of nuclei is important for this purpose through two examples of cross sections listed on the HPRL, the first one via an experimental analysis and the second one via an applied theoretical analysis.

In the first part, we will improve the knowledge of the 238U level scheme by analysing the g-g coincidence matrices of the two nu-Balls campaigns, which coupled the nu-Ball g-spectrometer [3] and the LICORNE neutron source [4, 5] of the ALTO facility, Orsay, France.

This level scheme is important to improve the 238U(n,n') cross section which plays a key role in neutron population and their moderation. When measuring (n, xng) cross sections via prompt g-ray spectroscopy coupled to time-of-flight measurements, structure's information is mandatory to infer the total (n, xn) cross section [2]. Moreover, when calculating the (n, n') cross section, knowledge of the structure is needed to obtain the (n,xng) cross sections. In total, 110 g-transitions and 60 levels registered in ENSDF have been confirmed and 158 new □-
transitions and 58 new levels have been found.

In a second part, we will study the states lying in the second fission well of the 242Pu. This nucleus is created in the current reactors cores and will be present in the future ones. Moreover, 242Pu fission chambers are candidate instruments for on-line measurements of high neutron energy flux such as in the future JHR reactor (CEA, Cadarache). Past neutron cross-section studies are mainly based on resonance analyses performed by Auchampaugh et al. [6,7] and Weigmann et al. [8]. However, no very specific analysis of the resonant structures observed in the 242Pu fission cross section was recently performed. We will revisit the topic by methodically analyzing and modeling Class-II states fluctuations observed in experimental fission cross sections in order to deduce the fission-isomeric energy EII, using complementary features of three nuclear reaction model codes: the CONRAD code [9] to treat Class-II states in the resolved resonance range by introducing Lorentzian shapes in the penetration factor; a home-made version of TALYS [10] to treat the unresolved resonance structures above 1.15 keV using a similar approach; and the combinatorial Quasi-Particle-Vibrational-Rotational
Level Density (QPVRLD) method [11] implemented in the AVXSF-LNG code to generate a sequence of Class-II states compatible with the experimental Class-II state sequence established in this work. This sequence has then been compared to a Constant Temperature Model, from which a fission-isomeric energy EII ranging from 1.90 to 1.95 MeV was deduced.

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Regular Abstract

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