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SFyNCS, a multi-detector to measure gamma rays cascade

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An almost 4π multi-detector, called SFYNCS (γ Strength function for Neutron Cross Sections), was built and commissioned in 2023 at CEA/DAM-Bruyères-le-Châtel. The goal of this new detection system is to undertake experiments studying the radiative deexcitation of nuclei and to find out nuclear level densities (NLD) and γ strength functions (gSF). This consists in measuring with 60 NaI(Tl) crystals, γ-rays energies from γ-cascades of exited nucleus produced in a (d,p) reaction and identified using a highly segmented ΔE-E silicon detector telescope. A measured ($E_{\gamma-rays}$, $E_{excitation}$) matrix is extracted to apply the Oslo method [1] in addition to an A.I. method based on Markov chain algorithm. Both methods giving NDL and gSF will be compared including consideration on the Brink-Axel hypothesis. These two ingredients are crucial for reaction models, for the purpose of getting predictive radiative capture cross-sections on nuclei for astrophysical studies or nuclear energy applications.
We will present the preliminary results we have obtained on the reaction ^{176}Lu(d,pγ)^{177}Lu interesting of the ^{177}Lu nucleus desexcitation. This reaction (d,p) is related to the neutron capture reaction (n,γ), here ^{176}Lu(n,γ)^{177}Lu, well-known in astrophysics through the s-process of the nucleosynthesis. As this latter reaction was studied recently using the DANCE detector at LANL in Los Alamos, we will show comparaisons with these data and a new data evaluation using the gSF and NLD obtained here and from calculations with the QRPA (Quasi-particle Random Phase Approximation) formalism. Perspectives of SFyNCS experiments will be discussed as well as the following of the Markov chain algorithm.

[1] A. Schiller, L. Bergholt, M. Guttormsen, E. Melby, J. Rekstad, S. Siem, Extraction of level density and γ-strength function from primary γ spectra, Nucl. Instr. Meth. A 447 (2000) 498-511.

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