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Gamma-ray cascade study in abundant fission fragments with the EXILL experiment and FIFRELIN simulation

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The poor accuracy of microscopic models in the prediction of fission observables constrains nuclear industry to rely on semi-empirical models, which in turns need systematic and accurate experimental data on a significant number of observables. In the last decade, large efforts were made in the fission community to improve models of the fission process and of the de-excitation of fission fragments. This is performed through reliable Monte Carlo simulations that take into account prompt neutrons and gamma-ray emission. An ultimate aim of such a simulation is to predict e.g. gamma-heating in nuclear reactor. The code developed by CEA Cadarache, FIFRELIN, samples the characteristics of primary fission fragments (before neutron emission). These pre-neutron characteristics are: the mass, nuclear charge, excitation energy, spin, and parity. The code includes the RIPL3 database of nuclear level schemes and nuclear model parameters. The full nuclear level scheme is completed at higher energies by using level density, neutron transmission coefficient, and photon strength function models. In a recent update, conversion electron coefficients are also available at any energy from BrIcc tabulated values. It makes it able to estimate the intensities of gamma-ray transitions in all the fission fragments.

In the EXILL experiment conducted in 2012 and 2013 at the Institut Laue Langevin in Grenoble, a target made of 235U was surrounded by an array of high-resolution gamma-ray detectors and irradiated by an intense cold neutron beam. We have extracted the intensities of the main discrete gamma-ray transitions in a set of fission fragments, using a triple gamma-ray coincidence technique, and we have compared our results to FIFRELIN simulation outputs. Extracted experimental data allows testing the accuracy of the FIFRELIN simulations and choosing the best implemented models (and their parameters) for level densities, photon strength functions and spin distributions. Result of our study on the gamma-ray cascades in the most abundant fission fragment pairs will be presented.

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