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Statistical treatment of the decaying cascade of an excited nucleus - focus on the gamma emission down to the ground state

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Nuclear fission is a complex process and its description is a theoretical challenge. Several questions are still open such as the sharing of the total excitation energy between the fragments as well as their spin distribution. In this framework, experiments [1] were performed at ILL (Institut Laue-Langevin, Grenoble, France) with the EXILL setup to measure the prompt gamma-ray cascade related to the de-excitation of fission fragments. Is it possible to reach the characteristics of fission fragments at scission from the measurement of their gamma-ray cascade and, subsequently, to constrain the fission models?
To simulate the de-excitation phase of the fission fragments we used an upgraded version of the code Kewpie2 [2]. The latter handles the competition between light particles evaporation, fission and gamma-ray emission using classic statistical formalisms, i.e. Weisskopf-Ewing or Hauser-Feshbach for light particles evaporation, Bohr-Wheeler for fission and, Weisskopf for gamma-ray emission. As Kewpie2 was initially devoted to the decay of heavy and super-heavy nuclei, a specific scheme based on Bateman equations was developed to take account of very small probabilities. It allows computing both statistical and dynamical observables such as the survival probability of a decaying nucleus [3] and the fission time distribution [4].
In order to further constrain the statistical code with the new experimental data discussed above, several modifications were made on Kewpie2 to simulate the whole gamma-ray cascade down to the ground state. It requires the implementation of the nuclear level schemes, the improvement of the gamma decay with gamma strength functions, the treatment of the coupling from continuum to discrete levels as well as the whole spin distribution⋯Kewpie2 permits also to incorporate physics coming from microscopic models like level densities which are the most important physical ingredients of statistical formalisms.
We will present the code Kewpie2 and the physicals ingredients needed for the statistical formalisms. Then, the various improvements made to treat the whole gamma-rays cascade down to the ground state will be discussed. Finally, the results of Kewpie2 on the prompt-gamma cascade of fission fragments will be compared to experimental data.

[1] T. Materna et al., Proc. of CGS15 (Dresden), to be published

[2] B. Bouriquet et al., Comp. Phys. Comm. 159, 1 (2004), H. Lu et al., in preparation

[3] Y. Abe et al., Int. J. Mod. Phys. E 16, 491 (2007)

[4] D. Boilley et al., Int. J. Mod. Phys. E 17, 1681 (2008)

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