SPY : a microscopical statistical scission-point model to predict fission fragment distributions. A discussion about the level densities to be used.

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The Scission-Point Yield model (SPY) calculates the fission fragment properties (mass and charge yields, mean excitation, kinetic energy) in the framework of a renewed statistical scission-point model [Wilkins76] without any free parameters [Heinrich06]. As the competition between symmetric and asymmetric fission is related to shell effects in the fragments, it is essential to well describe them up to very deformed shapes. Thus, we improved the Wilkins model, in particular in evaluating the individual potential of each fragment in the framework of microscopic calculations with the Gogny effective nucleon-nucleon force [Berger91]. These calculated potentials are available in the theoretical nuclear database Amedee [Hilaire07] (http://www-phynu.cea.fr/), which contains the mean field potential of more than 7000 nuclei. The probability of a given fragmentation is then related to the energy available at the scission point determined in an absolute form, taking into account a micro-canonical description including the level density of the fragments. A special effort has to be done on level densities since in this approach they are a natural counterbalance to the stronger stabilization of spherical or even-even nuclei, leading to an unphysical distortion of the yield distributions. Different densities have been tested from the simple Fermi gas model to a fully microscopic calculation with the Gogny force for each nucleus, in a consistent way with the individual potentials used to determine the available energy for each fragmentation at scission. The comparison between our calculations and experimental data is very encouraging and allows discussing the possible improvements of this approach.

In conclusion, our aim is to include most detailed and microscopic description of the fission fragment nuclear structure at scission. However, no information on the fissioning nucleus is provided, except its mass, and the dynamics of the process is not explicitly treated. On the other hand, this parameter-free model does not involve any phenomenological adjustment. Therefore, the success of such a model is not much to perfectly fit all the experimental properties of the fission fragments but mostly likely to predict some general trends, like the competition between symmetric and asymmetric fission for fissioning nuclei all over the nuclear chart even for very exotic nuclei which have never been measured.

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