Statistics vs. dynamics in fission: hints from systems of intermediate fissility

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Pre-scission light particle multiplicities have been used in a large variety of nuclei with A~150-250 to probe the dynamics of the fission process. The failure of the standard statistical model in reproducing the rapid increase of the prescission multiplicities with the excitation energy has been considered as the evidence that nuclear fission is a slow process dominated by the nuclear viscosity. An estimate of the fission time scale is commonly achieved by using the statistical model modified to include a fission delay. Systems of intermediate fissility offer the ground for new clues in such studies because they are characterized by an evaporation residues (ER) cross section comparable or larger than the fission cross section, and by a relatively higher probability for charged particle emission in the pre-scission channel. In a theoretical framework in which the estimates of fission time scales as well as of other sensitive parameters (i.e. nuclear viscosity) rely on statistical and/or dynamical model calculations, the additional analysis of particle emission in the ER channel provides additional severe constraints on the model input parameters.

The contribution will offer an overall view of the systems studied so far and will provide new clues for interesting and contradictory physical cases. In particular the analysis of the systems $^{32}S + ^{100}Mo$ at 200 MeV and $^{32}S + ^{126}Te$ at 180 MeV will be discussed. For these systems light charged particle multiplicities have been measured in coincidence with fission fragments and evaporation residues using the 8πLP apparatus at the Laboratori Nazionali di Legnaro. The many observables (particle multiplicities, fission and evaporation residues cross-sections, TKE-Mass distributions) have been compared with statistical and dynamical models predictions. A three-dimensional Langevin dynamical model provides a very good agreement with the full set of data and indicates that one-body dissipation coupled with a shape dependence of the viscosity parameter plays a dominant role in the fission process. It will be further discussed the advantage offered by systems of intermediate fissility in designing experiments aimed at studying the dependence of the dissipation on the temperature of the fissioning nucleus.