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Evaluation of the nuclear temperature in low-energy fission by isoscaling

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Isoscaling is a feature typical of statistical processes. As anticipated by theoretical studies about two decades ago [1], this phenomenon was proved by the analysis of selected fission fragment yields available in the public domain [2]. These comprehensive data provide a field of successful studies to the present time [3].
In this regard we analysed fission fragment yields taken from the data library [4], assigned to certain classifications of low-energy fission processes. Fission fragment yields Y_1, Y_2 within 25 < Z < 70, delivered by the low-energy fission of nuclei in the range from Th to Fm, were analysed according to the relation

$$Y_2(N,Z)/Y_1(N,Z) = \text{const} \cdot \exp(\alpha N + \beta Z)$$

The processed data showed by the majority an exponential dependence of the ratio of related pairs of fission fragment yields versus their charge Z or neutron numbers N. This behavior, denoted as isoscaling,indicates statistcal features in the fission mechanism. Therefore, one expect a dominant role of the symmetry energy of nuclear matter. The isoscaling parameters and were derived by fits to the exponential plots. In the framework of statistical models the isoscaling parameters and are related to the neutron and proton chemical potentials, i.e the nucleonic compositions of the nuclear systems (s) undergoing fission as well as to the intrinsic nuclear temperature T by the equation including the symmetry energy coefficient C_{sym}: α T = 4 $C_{sym}(Z/A)^2 s$

This relation was used for a lot of ratio combinations of fission fragments with pronounced isoscaling features, i.e. which are indicated by a regular trend of the isoscaling parameters on Z or on N. The nuclear temperatures, obtained on such conditions, are in agreement with those evaluated by the isotope thermometry approach [5]. Apart from that, deviations from the regular behavior of the isoscaling parameter on Z (on N) indicate on appreciable contributions of shape deformations and shell effects in addition to the symmetry energy and require involved corrections.

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