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Fusion probability of massive nuclei in reactions leading to heavy composite nuclear systems

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Interaction of massive nuclei shows a considerable reduction in fusion cross sections at the Coulomb barrier according to a comparison of experimental cross sections with the calculated ones obtained using a barrier passing (BP) model. Lowered fusion cross sections are accompanied by a high probability of deep-inelastic and quasi-fission (QF) processes arising on the way to fusion. The detection of evaporation residues (ERs) resulting from the compound nucleus (CN) formation is an unambiguous sign of the complete fusion, whereas fission events do not specify the CN formation since CN-fission strongly interferes with QF events. Theoretical models developed to describe heavy ER cross sections σ_ER treat them as the product of capture cross-section σ_c relating to a composite-nuclear system formation, of CN production probability P_CN, and of survivability against fission when CN decays W_sv. Most of the models reproduce experimental σ_ER quite well, but they give P_CN differed from each other within several orders of the magnitude. Such a difference implies a corresponding distinction in W_sv. Available data on the excitation functions for fission and ERs obtained in projectile-target combinations with very different mass numbers (very asymmetric ones) can be well described in the framework of the BP and statistical model (SM) approximations. These data allow us to choose SM parameters implying that P_CN=1 and σ_c=σ_bp. Thus, fitting the calculated excitation functions to the measured ones with scaling of macroscopic fission barriers one can get W_sv. Fusion suppression corresponding to P_CN<1 appears in less asymmetric combinations and can be derived using W_sv for very asymmetric ones leading to the same or nearby CN and σ_c obtained in experiments or with the BP model calculations. The work attempts to systemize the data on P_CN derived as described above for projectile-target combinations leading to ERs from Pb to heaviest nuclei produced in (HI,xn) reactions.

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