Quasifission dynamics from the theoretical analysis of experimental data of fissionlike reaction products

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Experimental and theoretical investigations of the dynamic processes in heavy ion collisions at the wide ranges of energies and masses of reacting nuclei were made mainly by analyzing the reaction product yields like evaporation residue nuclei after emission of the light particles (neutrons, protons, α-particles) and/or fissionlike fragments.

The hinderance of the compound nucleus formation increases by increasing the masses or by decreasing the mass asymmetry of colliding nuclei, due to strong changing of the peculiarities of the entrance channel dynamics (by the quasifission process of the dinuclear system) and due to the fast fission of a mononucleus into two fragments before reaching its equilibrium state at large angular momentum, to cause of the absence of any barrier against fission. Even if identification of the evaporation residues is relevant, the eventually strong overlap of the mass, kinetic energy, and/or angular distributions of the quasifission, fast fission and fusion fission products does not allow one to reach a complete and correct understanding of the dynamic processes using the detected reaction products. Such an uncertainty also exists in the analysis of the reaction times of processes forming the fissionlike products when the ratio between the yields of true fusion-fission products to the total yield of symmetric fissionlike fragments is comparable with the sensitivity of the experimental detecting system. The true fusion-fission events belonging to the symmetric fragment yield may be lower than such a sensitivity.

Moreover, in the reactions for the synthesis of heavy and superheavy nuclei, the investigations based on the observation of the evaporation residue nuclei become very difficult due to their very low cross section (also lower than 1 pb) either in mass asymmetric reactions (hot fusion reactions) or in more symmetric reactions (cold fusion reactions). Fortunately in many reactions, when the evaporation residue nuclei are stopped in the final detector and they are identified by the chain of the α-decay and fragments of spontaneous fission, the evaporation residue cross section is measured with enough good accuracy and without additional assumption about origination of evaporation residues.

Instead, the uncertainty in the determination of the σ_{ER} cross sections contributed by different residue nuclei formed after the evaporation of light particles from the compound nucleus may be caused by contributions of other possible processes producing similar registered products, for example, the same residue nuclei are formed at emission of the light particles before they reach the equilibrium state.

We will discuss about the above-mentioned kind of investigations and results. Moreover, we will present the results obtained in the study of the ^{48}Ca+ ^{249}Bk reaction for the synthesis of the 117 element, including the evaporation residue cross sections related to the determination of the fission barriers and Γ_n/Γ_f ratios versus the effective excitation energies of the intermediate nuclei along the cascade of the compound nucleus formed in the competition with the quasifission process during the evolution and decay of the initial dinuclear system.