"SUPPRESSION" AGAINST "ENHANCEMENT" IN FUSION REACTIONS LEADING TO THE PRODUCTION OF HEAVY NUCLEI

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A description of fusion of massive nuclei goes beyond the conventional potential-barrier passing models applicable to medium-mass systems [1]. Experiments show that compound nucleus formation or fusion cross sections for two massive nuclei are strongly reduced at incident energies around the Coulomb barrier due to the onset of competing reactions assigned mainly to the quasi-fission (QF) process. Earlier, the manifestation of QF was associated with a large angular anisotropy of fission fragments observed in first experiments [2]. Recently, QF has been clearly revealed in mass-energy distributions of fission fragments obtained in reactions induced by ^{48}Ca on deformed target nuclei [3]. Observation of QF correlates with the significant suppression in the production of evaporation residues (ERs) in the same reactions, which corresponds to about 30% value of the fusion probability for the formation of Ra compound nuclei (CN) [4]. Similar results have been obtained quite recently in ^{48}Ca induced reactions leading to less fissile Pb CN along with significant relative enhancement in the cross section for ERs at sub-barrier energies [5]. Rather unexpectedly the "fusion suppression" has been found quite noticeable even in very asymmetric combinations with ^{19}F and ^{22}Ne leading to Ra CN [4, 6]. The most impressive manifestation of QF is a strongly reduced production of ERs observed in nearly symmetric combinations of fusioning nuclei [7]. The suppression factor plays a decisive role in the production of heavier (the heaviest) nuclei resulted in the decay of strongly fissile CN.

In this connection the "fusion enhancement" based on fission cross sections obtained in reactions induced by ^{29,31}Al [8] and ^{38}S [9] at energies around the Coulomb barrier should be critically evaluated from the point view of its relation to the heavy nuclei production using secondary radioactive beams. At the same time, ^{48}Ca induced reactions (as well as others with lighter and heavier neutron-rich stable projectiles) could be considered as an alternative effective way in the production of heavy nuclei, despite of the "fusion suppression" observed in these reactions.

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