

The entrance channel effect in the reactions of heavy-ion collisions

Wednesday 25 June 2025 14:30 (30 minutes)

An analysis of the energy, mass and angular distributions of the binary reaction products in the heavy ion collisions allows us to construct the mechanisms of their formation in dependence on the beam energy, orbital angular momentum and structure of the colliding nuclei.

The theoretical methods [1] based on the dinuclear system (DNS) concept [2] suggested by Prof. Vadim Volkov are used to calculate the collision dynamics leading to formation of a molecule-like system. The formation of the DNS is considered the doorway state and its characteristics play a crucial role at its evolution, which leads to complete fusion or to its alternative end—quasifission of the DNS into binary fragments without reaching compound nucleus state. The quasifission is a group of deep-inelastic collisions. The large number of the transferred nucleons and strong dissipation of the relative kinetic energy are inherent for the quasifission events.

Recently, in our paper [1] we have proved that the incomplete fusion occurs during multinucleon transfer from the light nucleus to the heavy one in collisions with the large orbital angular momentum. In this case, the centrifugal force increases due to small values of the moment of inertia of the DNS consisting of alpha particle and conjugate nucleus during its evolution. As a result, the centrifugal force causes a hindrance to complete fusion and at the same time breaks this very asymmetric system.

The multinucleon transfer in the opposite direction from heavy nucleus to light one leads to quasifission of the DNS. The possibility of overlap of the mass distributions of the fusion-fission and quasifission products depends on the mass asymmetry of the entrance channel and dynamics of the heavy ion collision.

The nature of the overlap of the mass distributions of the fusion-fission and quasifission products is discussed on the base of the theoretical results obtained at the analysis of the deviations of the mass distributions of the fusion-fission products observed in the experiments performed for collisions of nuclei different mass asymmetry in the entrance channel. The role of the orientation angles of the axial symmetry axis of the colliding nuclei, beam energy and orbital angular momentum on the mass distribution of the quasifission products is demonstrated by the analysis of the theoretical results obtained to interpret the experimental data.

References:

1. A. K. Nasirov et al, Phys. Lett. B 842, 137976 (2023).
2. V.V. Volkov, Phys. Reports, 44, No.2, 93 (1978).

Author: NASIROV, Avazbek (Joint Institute for Nuclear Research)

Co-author: KHUSANOV, Elzod (Institute of Nuclear Physics)

Presenter: NASIROV, Avazbek (Joint Institute for Nuclear Research)

Session Classification: Wednesday