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Emission of fragments in collisions of intermediate-energy heavy ions based on the non-equilibrium quantum hydrodynamic approach

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In the development of the nonequilibrium hydrodynamic approach [1-3], we were able to successfully describe the double differential cross sections for the formati. on of cumulative protons and light fragments of deuterons and tritons emitted at an angle of 400 and studied in [4] for the collision of carbon nuclei in the reaction 12C+12C at an energy of 20 GeV per nucleon on a fixed target, obtained at the U-70 accelerator of the IHEP (Serpukhov). These double differential cross sections reveal scaling for the yields of various fragments depending on their energy

In continuation of the analysis of ITEP (Moscow) experiments on collisions of carbon nuclei with a beryllium target at the FRAGM setup, it was possible to obtain a description of the yields of 11Be and 10B fragments [5] emitted at an angle of 3.50 at an energy of carbon nuclei of 300 MeV per nucleon. In this description, a nonequilibrium hydrodynamic approach and the Goldhaber statistical model were used. Improvement of the agreement for describing the asymmetry of the momentum distribution of the fragment yield was achieved here using the Lifshitz-Slezov asymptot
ic profile function in the coalescence model. Our description of the experimental data turns out to be better than cascade models and the quantum molecular dynamics (QMD) model built into the GEANT4 package.

In the development of the hydrodynamic approach, the possibility of describing experimental data based on the solution of the effective Klein-Gordon equation with dissipation [6] was analyzed, as well as the possibility of describing the polarization of emitted secondary particles [7]. Our approach is applicable to collisions of both light and heavy nuclei, which is evident from a comparison with experimental data and other theoretical approaches.

This can be extended to the energy range of the NICA accelerator complex being built at JINR (Dubna). Already the first comparison with experimental data on the distribution of protons, deuterons and tritons by transverse mass at the rapidity y=1.4 for the collision of argon nuclei at the energy of 3.2 GeV per nucleon with different nuclei in the BM@N experiment [8] turned out to be successful.

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