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Cluster and hypernuclei production in heavy-ion collisions

We investigate the influence of the equation-of-state (EoS) of strongly interacting hadronic and partonic matter created in heavy-ion collisions on the light cluster and hypernuclei production within the Parton-Hadron-Quantum-Molecular Dynamics (PHQMD) microscopic transport approach (PHQMD) [1-5]. The PHQMD is a microscopic n-body transport model based on the QMD propagation of the baryonic degrees of freedom, where the clusters are formed dynamically, via {\bf 'potential' mechanism}, i.e. by potential interactions between nucleons and hyperons, and recognized by by the Minimum Spanning Tree (MST) algorithm which is identifying bound clusters by correlations of baryons in coordinate space.

Additionally, {\bf 'kinetic' mechanisms for deuteron production} is incorporated by catalytic hadronic reactions accounting all isospin channels of the various $\pi NN \leftrightarrow \pi d$, $NNN \leftrightarrow Nd$ reactions which enhances deuteron production as well as considering the quantum nature of the deuteron by mean of its finite size modelled by the finite-size excluded volume effect in coordinate space and projection of relative momentum of the interacting pair of nucleons on the deuteron wave-function in momentum space, leads to a strong reduction of d production, especially at target/projectile rapidities [4].

Whereas in the previous PHQMD calculations we employed a static interaction between nucleons, now we include a {\bf momentum dependence interaction}. The parameters of the momentum dependent potential are fitted to the 'optical' potential, extracted from elastic pA scattering data. The potential is increasingly repulsive up to $E_{kin} \sim 1.5$ GeV, therefore its influence depends on the beam energy. A momentum dependent interaction acts very differently on flow observables like v_1 or v_2 and cluster rapdity distributions and brings the calculations even closer to the experimental data as a comparison with STAR data shows.

We have furthermore implemented {\bf the coalescence approach in the PHQMD } what allows to compare directly and for the same underlying dynamics the cluster yields, created by MST+kinetic mechanisms and coalescence mechanism. We could establish that both methods yield different cluster rapidity distributions. This allows to {\bf determine the cluster production mechanism experimentally}. Finally we will present a solution of the 'ice in the fire' puzzle, the question how cluster can survive the expansion of the hot and strongly interacting fireball at midrapidity.

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