ID de Contribution: **123** Type: **Talk**

Clusters as a prove of the equation-of-state of strongly interacting matter

mercredi 5 juin 2024 10:40 (20 minutes)

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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 via 'potential', 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, '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 interactions between nucleons we include now a {\bf momentum dependence interaction}. The parameters of momentum dependent potential are fitted to the "optical"potential (i.e. Schr\"odinger equivalent potential U_{SEP}), extracted from elastic scattering data in pA reactions. The potential grows up to $E_{kin} \sim 1.5$ GeV and then decreases.

We observe that a static and a momentum dependent interactions, which yield for cold matter the same equation-of-state, influence the observables in heavy-ion reactions in a quite different way. We discuss the influence on flow coefficients, v_1 and v_2, of different clusters as a function of rapidity, on the p_T- transverse momentum spectra as well as on the fragment yield. Finally we compare our results to the HADES and STAR-BES data and find a strong sensitivity of the flow coefficient, especially of elliptic flow coefficient v_2 on the momentum dependence of the potential.

Moreover, to clarify the origin of the deuteron production in heavy ion collisions from SIS to RHIC energies we propose a method to distinguish experimentally between the different possible production mechanisms.

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Classification de Session: Track3-Res&Hyp

Classification de thématique: Resonances and Hyper-nuclei