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(Zoom) Effects of the Hadronic Potentials on Particle Correlation Effects in Heavy Ion Collisions at Intermediate and High Energies

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Determination of equation of state (EoS) for nuclear matter at high baryon density region is a topic of current interest in high-energy heavy-ion collisions and astrophysics. The pion/kaon HBT correlation (also called HBT interferometry) and intermittency are sensitive probes of the nuclear EoS. Within the UrQMD framework, it is found that the correlations of protons, correlated proton pairs with small relative transverse momentum, will be boosted by hadronic interactions, these correlations contribute significantly to an intermittency analysis as performed at experiments. In addition, by adopting different EoSs, HBT correlations for charged pions in central Au+Au collisions at $\sqrt{s_{NN}} = 2.4 - 7.7$ GeV are calculated. The effects of a phase transition at high baryon densities are clearly observed in the explored HBT parameters. The results show that the available data on the HBT radii, R_O/R_S and $R_O^2 - R_S^2$, in the investigated energy region favour a relatively stiff EoS at low beam energies, which then turns into a soft EoS at high collision energies consistent with astrophysical constraints on the high-density EoS of QCD. The specific effects of two different phase transition scenarios on R_O/R_S and $R_O^2 - R_S^2$ are investigated. A phase transition with a significant softening of the EoS below four times the nuclear saturation density can be excluded using HBT data. The results highlight that the pion's R_O/R_S and $R_O^2 - R_S^2$ are sensitive to the stiffness of the EoS and can be used to constrain and understand the QCD EoS in a high baryon density region.

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