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Exploring the partonic phase at finite chemical potential within an extended off-shell transport approach

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We extend the Parton-Hadron-String Dynamics (PHSD) transport approach in the partonic sector by explicitly calculating the total and differential partonic scattering cross sections as a function of temperature T and baryon chemical potential μ_B on the basis of the effective propagators and couplings from the Dynamical QuasiParticle Model (DQPM) that is matched to reproduce the equation of state of the partonic system above the deconfinement temperature T_c from lattice QCD.

The novel transport approach (PHSD5.0) thus incorporates no additional parameters compared to the default version PHSD4.0. We calculate the collisional widths for the partonic degrees of freedom at finite T and μ_B in the time-like sector and conclude that the quasiparticle limit holds sufficiently well. Furthermore, the ratio of shear viscosity η over entropy density s, i.e. η/s, is evaluated using the collisional widths and compared to lQCD calculations for μ_B = 0 as well. We find that the novel ratio η/s does not differ very much from that calculated within the original DQPM on the basis of the Kubo formalism. Furthermore, there is only a very modest change of η/s with the baryon chemical μ_B as a function of the scaled temperature $T/T_c(\mu_B)$. This also holds for a variety of hadronic observables from central A+A collisions in the energy range 5 GeV $\leq \sqrt{s_{NN}} \leq$ 200 GeV when implementing the differential cross sections into the PHSD approach. We only observe small differences in the antibaryon sector ($\bar{p}$, $\bar{\Lambda} + \bar{\Sigma}^0$) at $\sqrt{s_{NN}}$ = 17.3 GeV and 200 GeV with practically no sensitivity of rapidity and p_T distributions to the μ_B dependence of the partonic cross sections. Small variations in the strangeness sector are obtained in all studied collisional systems (A+A and C+Au), however, it will be very hard to extract a robust signal experimentally. Since we find only small traces of a μ_B-dependence in heavy-ion observables - although the effective partonic masses and widths as well as their partonic cross sections clearly depend on μ_B - this implies that one needs a sizable partonic density and large space-time QGP volume to explore the dynamics in the partonic phase. These conditions are only fulfilled at high bombarding energies where μ_B is, however, rather low. On the other hand, when decreasing the bombarding energy and thus increasing μ_B, the hadronic phase becomes dominant and accordingly, it will be difficult to extract signals from the partonic dynamics based on "bulk" observables.

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