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Temperature dependence of transport coefficients of QCD in high-energy heavy-ion collisions

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We quantitatively investigate the temperature dependence of shear and bulk viscosities
of QCD from comparison with ALICE data of Pb+Pb √sNN = 2.76 collisions at the LHC, using our state-of-the-art (3+1)-d relativistic viscous hydrodynamics code [4]. The algorithm for solving the relativistic hydrodynamic equation is based on a Riemann solver with the two shock approximation [1,2] and stable even with small numerical viscosity [1]. We check the energy and momentum conservation in one-dimensional expansion with initial fluctuations of high-energy heavy ion collisions and the correctness of our code in the following test problems; the viscous Bjorken flow for one-dimensional expansion and the Israel-Stewart theory in Gubser flow regime for the three-dimensional calculation [3].

Applying the hydrodynamics code to the hybrid model, hydro+UrQMD model,
we perform comprehensive analyses of ALICE data. Here we use the initial condition, TRENTO and lattice QCD-based equations of state. We find that flow harmonics as a function of transverse momentum Pt is not sensitive to transport coefficients, though centrality dependence of mean Pt and integrated v2 and v3 is sensitive to them. To obtain the detail information of transport coefficients, investigation of rapidity dependence of observables with (3+1)-d hydrodynamic expansion is indispensable. From our numerical computation, we obtain the following temperature dependence of transport coefficients. Finite bulk viscosity is preferable and the bulk viscosity has a peak around the critical temperature. The shear viscosity increases with decreasing temperature in the hadronic phase and takes a minimum value around the critical temperature and increases with temperature in the QGP phase.

[1]Akamatsu,Inutsuka, Nonaka, and Takamoto,J. Comput. Phys. 256,34(2014).
[2]Okamoto, Akamatsu, and Nonaka, Eur. Phys.J. C76, 579(2016).
[3]Okamoto and Nonaka, Eur. Phys. J. C77, 383(2017).
[4]Okamoto and Nonaka, arXiv:1712.00923.

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