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The shear viscosity of parton matter under two-body scatterings

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The shear viscosity (eta) of a quark-gluon plasma in equilibrium can be calculated numerically using the Green-Kubo relation or analytically using several methods, including the Israel-Stewart, Navier-Stokes, relaxation time approximation, and Chapman-Enskog methods. In this work [1], we first examine these analytical methods for isotropic as well as anisotropic two-body scatterings. We confirm that the Chapman-Enskog method is the most accurate while correcting the typos in an earlier work on this subject.

We then apply the Chapman-Enskog method to study the shear viscosity of the parton matter in the center cell of central and midcentral Au+Au collisions at 200AGeV and Pb+Pb collisions at 2.76ATeV from a multi-phase transport (AMPT) model. At the parton scattering cross section of 3 mb that enables the transport model to reproduce bulk observables including the elliptic flow, the average eta/s of the parton matter is found to be very small, between one to three times 1/(4pi). In addition, as a result of using a constant Debye mass or cross section for parton scatterings, the eta/s ratio from the AMPT model increases with time (as the effective temperature decreases), contrary to the pQCD results that use temperature-dependent Debye masses. This can be a direction for future model improvements.

[1] N. MacKay and Z.W. Lin. Eur. Phys. J. C 82, 918 (2022).

Category

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