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Viscous Leptons and Fluid-like Photons in the Strongly Coupled Quark Gluon Plasma

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In the quark gluon plasma (QGP), the transport properties of electromagnetic (EM) probes such as leptons and photons could be modified by the lepton/photon-parton scattering compared with the case in the QED plasma. In order to incorporate the non-perturbative effects from the strongly couple QGP on the lepton/photon-parton collisions, a semi-holographic approach which combines the Boltzmann equation and the gauge/gravity duality is applied to compute the shear viscosity of thermal leptons and photons. It is found that the lepton shear viscosity due to the lepton-quark scattering is inversely proportional to the ratio of electric conductivity of the QGP to temperature up to the leading logarithmic order of the EM coupling and is suppressed compared with the one from lepton-lepton scattering. On the other hand, the photon shear viscosity up to the leading order of the EM coupling is suppressed by the photon-parton scattering, where the suppression is favored by the coupling of the QGP. Such suppression stems from the blue shift of the thermal-photon spectrum at fixed temperature when the coupling of the QGP is increased. On the contrary, the lepton shear viscosity behaves oppositely due to the decrease of electric conductivity of the QGP at stronger coupling. Moreover, in a holographic model breaking conformal symmetry, both the conductivity and the amplitude of the thermal-photon spectrum scaled by temperature decrease rapidly near the deconfinement transition. Accordingly, a sharp enhancement of the shear viscosity of both thermal leptons and thermal photons close to the critical temperature is observed. In conclusion, our findings imply that the thermal leptons and photons in the QGP are less viscous than in the QED plasma. In particular, thermal photons may become fluid-like in the strongly coupled scenario. We argue that it may strengthen the anisotropic flow of direct photons.
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