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Momentum transport coefficients with chiral dependent quark masses in thermal QCD medium

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We have studied the momentum transport coefficients, viz. shear and
bulk viscosity, in a weakly magnetized ($eB << T^2$) deconfined thermal
QCD medium at finite quark chemical potential (μ). The magnetic
field generates anisotropy in the medium, causing the previously
isotropic scalar transport coefficients to become anisotropic and separate into several components. Depending upon the direction of the magnetic field and current, we can have three possible components, namely, longitudinal, transverse, and Hall. We have obtained five shear ($\eta_0, \eta_1, \eta_2, \eta_3$ and η_4) and two bulk viscous components (ζ_0 and ζ_1) using relativistic Boltzmann transport equation under relaxation time approximation. Interaction among partons is incorporated through the quasiparticle mass of quarks and gluons (T, μ, B dependent), calculated using oneloop perturbative thermal QCD.
It is observed that the magnetic field acts differently on left (L) and
right (R)-handed chiral modes of quark. This leads to the lifting of degeneracy in mass of those modes, in contrast to the strong magnetic field case ($eB >> T^2$), where these modes are degenerate. The magnetic field dependence of L and R modes of η_0, η_1 and η_3 is opposite in nature, viz. the L mode magnitude decreases whereas the R mode magnitude increases, with the magnetic field. This is in contrast to η_2 and η_4, for which, both the L and R mode magnitudes
increase with the magnetic field. The bulk viscous coefficients, ζ_0 and ζ_1 increase with magnetic field for both L and R mode. Also, these shear and bulk viscosities get amplified with quark chemical potential for both modes. Shear viscosity to entropy density ratios are found to be greater than $1/(4\pi)$ for η_0, η_1 and η_3, but less than $1/(4\pi)$ for η_2 and η_4. The ratio of bulk viscosity to entropy density for ζ_0 and ζ_1 exhibits a non-monotonic behaviour with temperature, showing minima or maxima around $T \sim 200$ MeV. Furthermore, the Reynolds number for L mode is found to be greater than
that for R mode due to a difference in mass densities.

Category

Theory

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