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Charge and heat transport coefficients of a weakly magnetized hot and dense QCD medium

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We have studied the effects of weak magnetic field and finite chemical potential on the transport of charge and heat in hot QCD medium by determining their response functions, such as electrical conductivity ($\sigma_{\rm el}$), Hall conductivity ($\sigma_{\rm H}$), thermal conductivity (κ_0) and Hall-type thermal conductivity (κ_1) in kinetic theory approach at weak magnetic field and finite chemical potential. The interactions among partons have been incorporated through their thermal masses. It is observed that, with the increase of magnetic field, $\sigma_{\rm el}$ and κ_0 decrease, and $\sigma_{\rm H}$ and κ_1 increase in the weak magnetic field regime, whereas the finite chemical potential increases these transport coefficients. The effects of weak magnetic field and finite chemical potential on aforesaid transport coefficients are found to be more conspicuous at low temperatures, whereas at high temperatures, they have only a mild dependence on magnetic field and chemical potential. We have found that the presence of finite chemical potential further extends the lifetime of magnetic field. This study is important to understand the effects of weak magnetic field and finite chemical potential on the local equilibrium through the Knudsen number, the elliptic flow, and the interplay between charge and heat transports through the Wiedemann-Franz law. The Knudsen number components in the weakly magnetized hot and dense QCD medium retain their values much below unity. Thus, there is sufficient separation between the mean free path and the characteristic length scale for the medium to remain in the local equilibrium state. Further, the elliptic flow gets increased in the presence of the weak magnetic field, whereas the presence of finite chemical potential decreases it. Furthermore, the Lorenz number components in the Wiedemann-Franz law are found to be strongly affected by the chemical potential than by the weak magnetic field. However, with the increase of temperature, the Lorenz number components are observed to increase, confirming the violation of the Wiedemann-Franz law for the hot and dense QCD medium in the presence of a weak magnetic field.

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