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Charge and heat transport in hot quark matter with chiral dependent quark masses

As the strength of the magnetic field (B) becomes weak, novel phenomena, similar to the Hall effect in condensed matter physics emerges both in charge and heat transport in a thermal QCD medium with a finite quark chemical potential (μ). So we have calculated the transport coefficients in a kinetic theory within a quasiparticle framework, wherein we compute the effective mass of quarks for the aforesaid medium in a weak magnetic field (B) limit ($|eB| << T^2$; T is temperature) by the perturbative thermal QCD up to one loop, which depends on T and B differently to left- (L) and right-handed (R) chiral modes of quarks, lifting the prevalent degeneracy in L and R modes in a strong magnetic field limit ($|eB| >> T^2$). Another implication of weak B is that the transport coefficients assume a tensorial structure: The diagonal elements represent the usual (electrical and thermal) conductivities: $\sigma_{\rm Ohmic}$ and κ_0 as the coefficients of charge and heat transport, respectively and the off-diagonal elements denote their Hall counterparts: $\sigma_{\rm Hall}$ and κ_1, respectively. It is found in charge transport that the magnetic field acts on L- and R-modes of the Ohmic-part of electrical conductivity in opposite manner, *viz.* $\sigma_{\rm Ohmic}$ for L- mode decreases and for R- mode increases with B whereas the Hall-part $\sigma_{\rm Hall}$ for both L- and R-modes always increases with B. In heat transport too, the effect of the magnetic field on the usual thermal conductivity (κ_0) and Hall-type coefficient (κ_1) in both modes are identical to the abovementioned effect of B on charge transport coefficients.

We have then derived some coefficients from the above transport coefficients, *namely* Knudsen number (Ω is the ratio of the mean free path to the length scale of the system) and Lorenz number in Wiedemann-Franz law. The effect of B on Ω either with κ_0 or with κ_1 for both modes are identical to the behavior of κ_0 and κ_1 with B. The value of Ω is always less than unity for the entire temperature range, validating our calculations. Lorenz number ($\kappa_0/\sigma_{\rm Ohmic}T$) and Hall-Lorenz number ($\kappa_1/\sigma_{\rm Hall}T$) for L-mode decreases and for R-mode increases with a magnetic field. It also does not remain constant with T, except for the R-mode Hall-Lorenz number where it remains almost constant for smaller values of B.

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