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## Study of chiral dependent charge and heat conductivity and their associated numbers in thermal QCD

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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 ( $\mu$ ). 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 ( $|eB| \ll \Lambda_{\text{QCD}}^2$  up to one loop, which depends on  $\mu$  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 ( $|eB| \gg \Lambda_{\text{QCD}}^2$ ). Another implication of weak  $B$  is that the transport coefficients assume a tensorial structure: The diagonal elements represent the usual (electrical and thermal) conductivities:  $\sigma_{\text{Ohmic}}$  and  $\kappa_0$  as the coefficients of charge and heat transport, respectively and the off-diagonal elements denote their Hall counterparts:  $\sigma_{\text{Hall}}$  and  $\kappa_1$ , 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.  $\sigma_{\text{Ohmic}}$  for  $L$ - mode decreases and for  $R$ - mode increases with  $B$  whereas the Hall-part  $\sigma_{\text{Hall}}$  for both  $L$ - and  $R$ -modes always increase with  $B$ . In heat transport too, the effect of the magnetic field on the usual thermal conductivity ( $\kappa_0$ ) and Hall-type coefficient ( $\kappa_1$ ) 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 ( $\Omega$  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  $\Omega$  either with  $\kappa_0$  or with  $\kappa_1$  for both modes are identical to the behavior of  $\kappa_0$  and  $\kappa_1$  with  $B$ . The value of  $\Omega$  is always less than unity for the entire temperature range, validating our calculations. Lorenz number ( $\kappa_0/\sigma_{\text{Ohmic}}$ ) and Hall-Lorenz number ( $\kappa_1/\sigma_{\text{Hall}}$ ) 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  $B$ .

## **Session**

Heavy Ions and QCD

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