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Wiedemann-Franz Law Violation Domain for Graphene and Nonrelativistic Systems

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Abstract : Systematic and comparative research on Lorenz ratios for graphene and nonrelativistic systems has been studied to identify their Wiedemann-Franz law violation domain. Fermi energy and temperature are the main governing parameters for deciding the values of the Lorenz ratio, which is basically thermal conductivity divided by electrical conductivity times temperature times Lorenz number. Metals as three-dimensional nonrelativistic electron gas are located at higher Fermi-energy by temperature domain, where Lorenz ratio remains one. Hence, they obey the Wiedemann-Franz law. By creating higher doping in a two-dimensional graphene system, one can again reach a higher Fermi-energy by temperature domain and get a constant Lorenz ratio. For both graphene and nonrelativistic systems, the Lorenz ratio goes below one if we go lower Fermi-energy by temperature domain, which is possible for the graphene system by decreasing the doping concentration. Experimentally observed greater than one Lorenz ratio in this lower Fermi-energy by temperature domain or Dirac Fluid domain indicates that non-fluid expressions of Lorenz ratio should be replaced by fluid-type expressions. We have noticed a divergent trend of Lorenz ratio in the Dirac Fluid domain using its fluid-type expression, and it matches the trend of experimental data.

Keywords : graphene, Lorentz ratio, specific heat, Wiedeann- Franz law.
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