Abstract

The high-energetic/ultra-relativistic heavy-ion collision experiments at Relativistic Heavy Ion Collider (RHIC) and at Large Hadron Collider (LHC) have produced the deconfined phase of the matter, at extremely high temperature, in which quarks/antiquarks and gluons are effectively free. This phase (hot QCD matter) is commonly termed as Quark-Gluon-Plasma (QGP). The deconfined phase is characterized by quark, antiquark, and gluonic effective degrees of freedom, and the created medium seen to behave more like a near-ideal fluid (perhaps except near the QCD transition point) and most vortical one too. The quantitative analysis of the experimental observables of the final stage particles from the dissipative hydrodynamical simulation involves the dependence upon the thermodynamic and transport parameters of the hot nuclear matter. On the other hand, intense magnetic fields are produced in the initial stages of non-central asymmetric collisions and can affect the thermodynamic and transport properties of the nuclear matter. In this thesis, an attempt has been made to understand the impact of the magnetic field on the QCD equation of state and transport properties of the deconfined nuclear matter by employing an effective modelling of the magnetized medium. The charged fermions (quarks/antiquarks) are directly coupled to the strong magnetic field through the Landau level dispersion relation and have constrained $1+1$ dimensional motion along the direction of the strong magnetic field. Thus, the strong magnetic field violates the rotational symmetry and induces anisotropy in the medium. The electromagnetic responses of the collisional QGP medium have been analyzed with relaxation time approximation and Bhatnagar-Gross-Krook collisional kernels within the scope of covariant kinetic theory. The effect of the magnetic field on the momentum transport and thermal transport has been studied by estimating the longitudinal viscous coefficients and thermal conductivity in a strongly magnetized medium. Further, the analysis of thermal transport has been extended to the weak magnetic field limit. The interplay of thermal transport and electric charge transport in a weakly magnetized QGP has been studied in terms of Wiedemann-Franz law. Heavy quarks/antiquarks are created in the initial stages of the collisions and are considered as one of the effective probes to characterize the properties of the QGP. Owing to their large mass, a heavy quark/antiquark will not get affected directly by the magnetic field. The measurements of charge-dependent directed flow at the LHC and RHIC might provide insights about the electromagnetic fields in the medium. To that end, the heavy quark drag and diffusion coefficients have been estimated in the magnetized medium. Finally, the analysis of heavy quark transport has been extended to a magnetized bulk viscous medium. The effects of the magnetic field, collision, and equation of state have been seen to have a visible impact on the above-mentioned aspects of the QGP/hot QCD matter.

Keywords : Quark-Gluon-Plasma, Magnetized QCD medium, Effective kinetic theory, Shear and bulk viscosities, Electrical transport, Thermal transport, Heavy quark, Drag and diffusion coefficients.