Abstract

The principal focus of the present dissertation is to explore the properties of relativistic plasmas in the extreme limits of high density (or chemical potential) and temperature. Recent theoretical calculations in the field of Quantum chromodynamics have been confined largely to the domain of high temperature which finds application in relativistic heavy ion collisions. Physics in the other domain of phase space is of paramount importance for the study of astrophysical objects such as neutron stars which demands equal impression due to the possible existence of quark gluon plasma in the core. In this thesis, quantities like the mean free path, emissivity of neutrinos and analysis of the cooling behavior of the star in the relativistic framework have been studied. The relativistic effects on such high density plasma differs from the non-relativistic one due to the inclusion of the magnetic interaction which spoils the normal Fermi liquid behavior by introducing fractional powers and logarithmic terms in energy variable for the aforesaid quantities. The origin of these non-analytic terms can be accredited to the dominance of the transverse or magnetic interaction over the corresponding electric or longitudinal interaction; referred in literature as non-Fermi liquid phenomena. Further, the effect of the external magnetic field has been studied on the specific heat capacity of such matter which too suffers the anomalous non-Fermi liquid corrections in the ultra-degenerate theme. Equipped with these modifications, the pulsar kick velocity has been studied and scrutinized. In the spirit of completeness of the study of the phase diagram, we have studied the energy loss suffered by a heavy quark in a thermalized partonic medium comprising of light quark flavors, gluons as well as charm quarks. Thus, in this thesis, we have made a true effort to study the application of perturbation theory for description of collective excitations of quasiparticles spanning the extremeties of phases relevant for quantum chromodynamic matter and subsequent derivation of quantities of important physical interests.