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QUARK NUMBER SUSCEPTIBILITY IN HARD THERMAL LOOP PERTURBATION THEORY

Content :

Strongly interacting matter at nonzero baryon density and high temperature is a subject of great interest for wide spectrum of physicists. A deep understanding of the different facets of the strongly interacting matter, in particular the physics of color deconfinement, i.e., quark-gluon plasma (QGP) might help us to get a better picture of various astrophysical and cosmological phenomena. In recent years enormous efforts are underway to create and detect QGP in ultrarelativistic heavy-ion collider experiments at RHIC BNL and at CERN LHC. The analysis of data so obtained requires a proper understanding of the dynamics of many particle system in quantum chromodynamics (QCD), the theory of strong interaction. Dynamical properties of many particle system can generally be studied by employing an external perturbation, which disturbs the system only slightly from its equilibrium state, and thus measuring the response/fluctuations of the system to this external perturbation. The fluctuations of conserved quantities, such as baryon number and electric charge, are considered to be signals for QGP formation in such experiments. These fluctuations are closely related to quark number susceptibilities (QNS), which measures the response of the quark number density to an infinitesimal change of quark chemical potential. The QNS plays an important role in locating the critical end point in QCD phase diagram. The QNS has been calculated within the various framework like lattice gauge theory, perturbative QCD , Nambu-Jona-Lassinio (NJL) Model , Polyakov-Nambu-Jona-Lassinio(PNJL) Model , Ads/CFT correspondence , Renormalisation Group approach ,two loop approximately self-consistent \Phi-derivable Hard Thermal Loop (HTL) resummation and in HTL perturbation theory (HTLpt) . We reconsider the QNS calculation within the HTLpt due to the different results obtained in various HTL approaches in the literatures to arrive at a consistent results despite the use of different approximations and approaches. In this paper we first reformulate a HTLpt in the first derivative level of the thermodynamic potential functional by employing an external probe that disturbs the system only slightly from its equilibrium position. Based on this we calculate
various thermodynamic quantities in leading order (LO) in coupling and compare with the existing results. Then we calculate directly the QNS, which is the response to the external disturbance. Further, we establish that these spontaneous fluctuations are related to the correlation functions reflecting the associated symmetries of the

system through the thermodynamic sum rule and also obtain the QNS from the correlation functions. So far this connection within the HTL approximation was not demonstrated earlier and also the equivalence of the results in this two ways, which are complete in the LO of the strong coupling.

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