Title : Study of the Confined and Deconfined Phases of QCD within Quasiparticle Approaches

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Abstract :

At low temperature and baryonic potential, the QCD matter is made of quarks and gluons confined in bigger structures, the hadrons. When these two intensive variables increase, some phase transitions occur and a deconfined medium in which quarks and gluons can move quasi-freely is created.

Nowadays, understanding the different phases that QCD exhibits is thus a fascinating topic both theoretically and experimentally. Indeed, RHIC and LHC experiments have recently pointed out some evidences of such deconfined state : the Quark-Gluon Plasma (QGP). From a cosmological point of view, it is as if we were returning back in time since the QGP is thought to have existed a few microseconds after the Big Bang, at the dawn of the Universe. Also in astrophysics, a deconfined QCD medium is conjectured to be in the cores of the heaviest neutron stars.

Therefore, these domains motivate a lot of theoretical works. In particular, many lattice QCD studies, focusing mostly on the structure of the QCD phase diagram and on the establishment of the QCD equations of state (EoS), are developed in parallel to phenomenological approaches, providing a more intuitive picture of the underlying physical mechanisms.

In this thesis, we develop some quasiparticle approaches to study the confined and the deconfined QCD phases. EoS are presented for different kinds of matter. The thermodynamic of the hadronic phase is addressed within a hadron resonance gas model. In particular, we investigate the glueballs sector for arbitrary gauge groups. Next, a study of the Yang-Mills plasma is carried out in the deconfined regime thanks to the Dashen, Ma and Bernstein (DMB) formulation of statistical mechanics. A peculiarity of our approach is to explicitly take into account the two-body interactions; This latter being computed within a T-matrix formalism. Finally, the thermodynamic of the full QGP, as well as the one of a supersymmetric medium with one supersymmetric generator (i.e. a plasma of gluons and gluinos) are also described thanks to the DMB formulation. All our EoS are compared to recent lattice QCD results.