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Effective Potential Formalism at Finite Temperature in Dual QCD and Deconfinement Phase Transition

Investigation of the QCD phase transition at finite temperature has been studied by using an infrared effective dual version of QCD, where QCD-monopole condensation plays an essential role on the nonperturbative dynamics in the infrared region. Utilizing the path-integral formalism, dual QCD has also been extended to the thermal domain by undertaking the mean field approach. The effective potential at finite temperature has been derived to compute the critical temperature for phase transition which has been shown to be in good agreement with the lattice results. A large reduction of color monopole condensate and glueball masses near the critical point has been shown to lead to a first order deconfinement phase transition in QCD. The disappearance of the QCD monopole condensate at sufficiently high temperature indicates the restoration of the magnetic symmetry and evaporation into thermal monopoles. The vacuum expectation value leads to temperature dependent scalar and vector glueball masses which demonstrates a decrease in monopole condensate and glueball masses with temperature which is an indicative of a first-order deconfinement phase transition in dual QCD. The evaporation of color monopole condensate and the release of the magnetic degrees of freedom in high temperature domain in QCD vacuum has been shown to lead the restoration of magnetic symmetry, which has its intimate connection with the quark-gluon plasma phase of QCD. We also calculate the string tension at finite temperatures. Based on this effective potential at finite temperature, investigation of the properties of hadron bubbles created in the early Universe and discussion about the hadron bubble formation process have been explored. The associated string tension at finite temperature has also been studied demonstrating a continuous vanishing in the vicinity of critical temperature.

Summary

Based on the well known topological properties of non-abelian gauge theories,a dual QCD gauge theory is constructed in terms of magnetic symmetry, which manifest the topological structure of the symmetry group in a non-trivial way. The dynamical breaking of the magnetic symmetry has been shown to impart the dual superconducting properties to the magnetically condensed QCD vacuum which ultimately leads to a unique flux tube configuration in QCD vacuum responsible for enforcing the color confinement. The QCD phase transition at finite temperatures in SU (3) dual QCD formalism has been studied and formulated within the confines of the effective potential at various temperatures in the
imaginary-time formalism. For the analysis of the vital phase transition parameters of QCD, the vacuum expectation value of monopole condensate at finite temperature has been obtained by minimization condition on effective potential. The monopole condensate value in high temperature region, ultimately vanishes at some typical characteristic value of temperature, called the critical temperature (Tc) of phase transition, which is obtained as 0.241GeV , 0.206GeV , 0.166GeV and 0.133GeV for the coupling values of 0.22, 0.23, 0.24 and 0.25 respectively. The disappearance of the QCD monopole condensate at sufficiently high temperature indicates the restoration of the magnetic symmetry and evaporation into thermal monopoles and bring a first-order deconfinement phase transition. The vacuum expectation value leads to temperature dependent scalar and vector glueball masses which demonstrates a decrease in monopole condensate and glueball masses with temperature. The result demonstrate a continuous vanishing of the associated string tension in the vicinity of critical temperature.

Author: Ms PUNETHA, Garima (Kumaun University)

Presenter: Ms PUNETHA, Garima (Kumaun University)

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