Contribution ID: **243** Type: **Oral**

Color Confinement, Chiral symmetry breaking and Phase transition at finite temperature using Field Decomposition Formalism

Utilizing the dual QCD model in term of magnetic symmetry structure of non-Abelian gauge theories , the dynamical breaking of the magnetic symmetry has been shown to impart the magnetically condensed QCD vacuum which leads to the unique flux tube structure in QCD vacuum for color confinement. The color singlet physical spectrum necessary for color confinement is incorporated through color reflection invariance which provides two magnetic glueball, a scalar and an axial vector, that characterize the QCD vacuum. The mass of the scalar mode determines the coherence length, whereas that of the vector mode determines the penetration length of the colored flux. Using the dual QCD Lagrangian alongwith the Zwanziger formalism, the associated non-perturbative dual gluon propagator has been evaluated and used to derive the quark-antiquark static potential for analyzing its color confining properties. As a result, the quark-antiquark static potential clearly shows the dominace of Yukawa term at short distances and the linear term at large distances responsible for the permanent confinement of colored quarks inside the hadrons. The behavior of quark-antiquark static potential for full QCD is also investigated and it has been observed that for large distances polarization effects take over destroying the linearly rising potential by screening the quark-antiquark potential and populating the vacuum with quark pairs. Further, the dynamical chiral-symmetry breaking using Schwinger-Dyson equation has been investigated, where the gluon propagator include non-perturbative effect related to color confinement. A close relation among the color confinement and chiral-symmetry breaking has been observed and has been demonstrated by computing the various dynamical parameters like quark mass, pion decay constant and the quark condensate characterizing the dynamical chiral symmetry breaking. For the study of phase structure of QCD, the deconfinement phase transition in QCD has been investigated at finite temperatures. The effective potential at finite temperatures (thermodynamical potential) has also been formulated by using the path-integral formalism alongwith the mean-field approach and found to have a large reduction of color monopole condensate and glueball masses near the critical temperature by considering the temperature dependence of the self interaction which indicate a first-order deconfinement phase transition at critical temperature. The color monopole condensate vanishes above and the graphical representation of thermal effective potential around the critical temperature lead to restoration of magnetic symmetry in the domain of high temperature. The recovery of the chiral symmetry has also been discussed at finite temperature and a strong correlation between the critical temperature of the chiral symmetry restoration and the strength of string tension has been observed.

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 topological magnetic charges associated with monopoles have been brought into the dynamics by the possible homotopy $\Pi2\ [SU(3)/U(1)\otimes U(1)]$. The dynamical configuration of the resulting dual QCD vacuum and its flux tube configuration have been investigated for analyzing the non-perturbative features of QCD. Utilizing the dual QCD Lagrangian in the dynamically broken phase of magnetic symmetry and applying Zwanziger formalism, the non-perturbative gluon propagator has been derived and used to extract the quark confining potential for both quenched and full QCD. The quenched confining mechanism is responsible for linear confinement and points towards the permanent confinement of the colored quarks inside the hadrons. In full QCD due to light-quark polarization the quark-antiquark potential automatically screens signaling the instability in the flux tube at large inter-quark distances and such screening increases with the increase of infrared cutoff. As a result, the quark-antiquark static potential clearly shows the dominace of Yukawa term at short distances and the linear term at large distances responsible for the permanent confinement of colored quarks inside the hadrons. The behavior of quark-antiquark static potential for full QCD is also investigated and it has been observed that for large distances polarization effects take over destroying the linearly rising potential by screening the quark-antiquark potential and populating the vacuum with quark pairs. The dynamical chiral-symmetry breaking using dual QCD formalism by use of Schwinger-Dyson equation with the gluon propagator, including the dual Meissner effect as the non perturbative seffect related to color confinement has been investigated. A large enhancement of the dynamical chiral-symmetry breaking due to QCD-monopole condensation which supports close relation between the color confinement and the chiral symmetry breaking has been demonstrated. The dynamical quark mass, the pion decay constant and the quark condensate are well reproduced by using the consistent values of the gauge coupling constant and the dual QCD based vector glueball masses in the infrared sector of QCD. Moreover, for the study of phase structure of QCD at finite temperature, the resulting deconfinement phase transition in QCD has also been investigated at finite temperatures. 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, thus, 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 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 might have its link with the quark-gluon phase of QCD. The recovery of the chiral phase transition has been found at high temperature demonstrating a strong correlation between the critical temperature of the chiral symmetry restoration and the strength of the string tension.

Primary author: Ms PUNETHA, Garima (Kumaun University)

Presenter: Ms PUNETHA, Garima (Kumaun University)

Track Classification: Theoretical Physics