Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Description of Gauge Theory Phenomena from Topological Objects

By

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We will explore two of the most interesting phenomena in gauge field theories, confinement and chiral symmetry breaking, using an ensemble of 64 interacting instanton-dyons. Instanton-dyons are components of the finite temperature instantons with non-trivial Polyakov loop ($P \neq 1$). Classical dyon-antidyon interactions are obtained from the streamline approach and included in the ensemble. The dyon interactions with other dyons and with the vacuum drive the Polyakov loop towards the confining value $P=0$.

There are N (Number of colors) types of dyons. Including fermions create fermionic zero modes on only one of the dyon types, and corrections to these zero modes introduce a linear attraction. Changing the boundary conditions of the fermions, changes which types of dyons have the fermionic zero modes. This affects both confinement and chiral symmetry breaking.

From the interacting ensemble of instanton-dyons we numerically obtain the temperature dependence of the Polyakov loop in the quenched case (no fermions) and also the chiral condensates for the case of 2 standard fermions and for the case of 1 periodic and 1 anti-periodic fermion, all for 2 colors. We find that as temperature decreases the ensemble tries to maximize the entropy by making the size of M and L dyons the same. This forces the Polyakov loop towards the confining value and the densities of the dyons toward the same density. This increases the range of the fermionic zero modes, which together with the increased densities, create a non-zero chiral condensate. Changing the boundary condition of one of the two fermions to periodic, restores center symmetry and results in chiral symmetry never being restored. We thus find that the mechanisms that drive the confinement-deconfinement and chiral symmetry breaking transitions are different, but related to each other through the interactions of the instanton-dyons.

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