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Finite Temperature SU(2) Lattice Gauge Theory

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Abstract. We discuss SU(2) lattice gauge theories at non-zero temperature and prove several rigorous results including i) the absence of confinement for sufficiently high temperature in the pure gauge theory, and ii) the absence of spontaneous chiral symmetry breaking for sufficiently high temperature in the theory with massless fundamental representation fermions.

I. Introduction

Non-abelian gauge theories are the central building blocks of modern particle theories and have been widely studied in recent years. Despite this effort, very few physical results have been rigorously derived.

In this paper we consider SU(2) lattice gauge theories and derive several results concerning the finite temperature behavior of these theories.[1] These include the following:

A. In two or more space dimensions, there is a temperature $T_c < \infty$ (depending on the bare coupling and dimension) such that for temperatures $T > T_c$ static quarks cannot be confined.[2]

B. In any dimension, in the theory with dynamical massless fermions in the fundamental representation, there is a temperature $T_{ch} < \infty$ (depending on the dimension and number of fermions) above which chiral symmetry cannot be spontaneously broken.

The plan of this paper is as follows. In Sect. II we introduce our notation and review a variety of background information. This includes the definition of our confinement criteria and the equivalence between the lack of confinement and the spontaneous breakdown of a global $Z(2)$ symmetry. Section III contains our proof of the absence of confinement at high temperature. We use a Peierls argument to demonstrate the spontaneous breakdown of the global $Z(2)$ symmetry. However,

1 Preliminary portions of this work have appeared in [1]
2 Recall that in one space dimension static quarks are confined for all temperatures $T < \infty$