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On the Statistical Mechanics of the Gauge Invariant Ising Model

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Abstract. Some results on the phase structure of the gauge invariant Ising model are derived by using convergent expansions.

1. Introduction and Statement of the Results

The gauge invariant Ising model, with which we shall be concerned in this paper, is one of the Wegner's generalized Ising models [1] and can be viewed as a lattice Higgs model, locally gauge invariant under the group $\mathbb{Z}_2$.

One believes that this model, appearing then as one of the simplest models for a gauge theory on a lattice according to Wilson's ideas [2, 3], can already be useful to obtain some insight into the physics of gauge theories at least in the abelian case.

A general outline and results on such lattice theories, in relation with the present study, may be found in [4, 5].

From certain extrapolation arguments briefly reported in the next section, the following peculiar phase structure is conjectured for this system [1, 6]: a critical line, at which a second order phase transition would take place, separates two regions in the plane of the coupling parameters (β_p, β_l), corresponding to the pure phase domains in the phase diagram of the system. One expects also that a qualitative different particle behaviour marks the difference between the two regions, which could correspond to a region of particle confinement and a region where separated charge excitations are allowed.

Our purpose here is to analyze the first mentioned conjecture concerning the phase structure of the system by the use of convergent expansions, a very familiar technique in statistical mechanics. For the sake of definiteness we shall consider the case of a 3-dimensional lattice.

According to the conjecture and the particular form of the expected phase diagram we determine two regions I and II in the plane (β_p, β_l) where the corresponding expansions converge (Fig. 1).

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