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On the Phase Structure of the Compact Abelian Lattice Higgs Model

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Abstract. This paper studies the vacuum overlap order parameter proposed by Fredenhagen and Marcu in the case of the compact $U(1)$ gauge model with the Wilson action coupled to a Higgs field with fixed length $|\phi| = 1$. The existence of two distinct phases in D space-time dimensions ($D \geq 4$) is established.

1. Introduction

Gauge theories on the lattice are an important branch of research of Quantum Field Theory. They offer many advantages for theoretical and numerical studies, especially since they provide one of the few known consistent non-strictly perturbative methods of regularization of gauge theories. Their most important quality reveals in the analysis and understanding of non-perturbative phenomena, like the Higgs mechanism, the problem of confinement and that of triviality of some four dimensional models involving scalar (Higgs) fields. They have also been used as a starting point to the construction of gauge models on a continuous space-time.

The question we treat here is related to that of the existence of charged states in lattice gauge theories, in particular in models with scalar fields coupled to gauge fields.

In a study of the $\mathbb{Z}(2)$-Higgs model [1] Fredenhagen and Marcu were able to construct in the Coulomb region of its phase diagram, for the first time, charged sectors of the associated quantum system (see also [12]). As a consequence of their analysis, these authors proposed a non-local order parameter to distinguish phases in lattice gauge theories coupled to matter fields. This order parameter, frequently named after his authors or donoted "Voop" (for "vacuum ovelap order parameter"), essentially measures the limit value of projections on the vacuum of a suitably constructed sequence of normalized dipole states with bounded energy. Its particular importance, in contrast to other order parameters used in lattice gauge theories, resides in its direct physical interpretation and particularly in its