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Comments

Symmetry Breaking in Landau Gauge
A comment to a paper by T. Kennedy and C. King

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Abstract. For the non-compact abelian lattice Higgs model in Landau gauge Kennedy and King (Princeton preprint, 1985) showed that the two point function $\langle\phi(x)\bar{\phi}(y)\rangle$ does not decay in the Higgs phase. We generalize their methods to show that for the same range of parameters there are states parametrized by an angle $\theta\in[0,2\pi)$ such that $\langle\phi(x)\rangle^{\theta}_{\text{Landau}}=e^{i\theta}\langle\phi(x)\rangle^{\theta=0}_{\text{Landau}}$ and $\langle\phi(x)\rangle^{\theta=0}_{\text{Landau}}>0$.

1. Introduction

In [1] Kennedy and King conjectured that the translation invariant pure phases of the lattice abelian Higgs model in three or more dimensions are parametrized by an angle $\theta\in[0,2\pi)$ such that

$$\langle\phi(x)\rangle_{\text{Landau}}=c\,e^{i\theta}$$

with $c>0$ in the Higgs region. Since in their paper they use boundary conditions which do not break the global gauge symmetry, they only could show that the two-point function doesn't decay. Using "Dirichlet" boundary conditions as explained below we generalize their methods to prove the following

Theorem 2. *In $d\geqq 3$, for any $\lambda>0$ there are states parametrized by an angle $\theta\in[0,2\pi)$, such that*

$$\langle\phi(x)\rangle^{\theta}_{\text{Landau}}=\langle\phi(x)\rangle^{\theta=0}_{\text{Landau}}e^{i\theta},$$

where $\langle\phi(x)\rangle^{\theta=0}_{\text{Landau}}>0$ is is uniformly bounded away from zero provided $e<e_0$ and $-m^2>R(\lambda)$ in the notation of Theorem (2.3) of [1].

Remark 1. This provides a *local* (in Landau gauge) order parameter for the phase transition established in [1].

Remark 2. We believe that our construction in fact yields $\langle\phi(x)\rangle=\langle\phi\rangle$ to be translation invariant, but in this comment we only prove it for the fixed length model.