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On the Mass Spectrum of the 2+1 Gauge-Higgs Lattice Quantum Field Theory*

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Abstract. We investigate the mass spectrum of a 2+1 lattice gauge-Higgs quantum field theory with Wilson action $\beta A_p + \lambda A_H$, where $A_p(A_H)$ is the gauge (gauge-Higgs) interaction. We determine the complete spectrum exactly for all $\beta, \lambda > 0$ by an explicit diagonalization of the gauge invariant "transfer matrix" in the approximation that the interaction terms in the spatial directions are omitted; all gauge invariant eigenfunctions are generated directly. For fixed momentum the energy spectrum is pure point and disjoint simple planar loops and strings are energy eigenfunctions. However, depending on the gauge group and Higgs representations, there are bound state energy eigenfunctions not of this form. The approximate model has a rich particle spectrum with level crossings and we expect that it provides an intuitive picture of the number and location of bound states and resonances in the full model for small $\beta, \lambda > 0$. We determine the mass spectrum, obtaining convergent expansions for the first two groups of masses above the vacuum, for small β, λ and confirm our expectations.

1. Introduction

We continue our investigation of the energy-momentum spectrum of lattice gauge theories in the Euclidean formulation. For previous results see [1–7] and for an all statistical mechanics approach to particle spectrum see [8, 9]. For spectral results in the time-continuous Hamiltonian version of these models see [10]. For numerical results see [11, 12].

Here we consider a lattice gauge-Higgs theory with Wilson action A; the Boltzmann factor is formally given by

$$e^{-A} \equiv \exp\left\{\beta \sum_{p} \mathrm{Re}\,\chi(g_p) + \lambda \sum_{\langle x,y\rangle \in b} \mathrm{Re}\,\phi^{+}(\mathrm{x}) \mathrm{D}_H(g_{xy})\phi(y)\right\} \tag{1.1}$$

(see [13, 14] for notation) where $\beta \geqq 0$, $\lambda \geqq 0$. The sums occurring in (1.1) are over non-oriented plaquettes P and bonds b of the lattice. χ is the character of the

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