

# 行政院國家科學委員會專題研究計畫成果報告

## Chern-Simons 係數量子修正之研究

計畫編號：NSC 89-2112-M-032-002

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### 一、中文摘要

在國科會的資助下，我完成了以下工作：

1. Hsien-chung Kao, J. -C. Lee, and B. Rosenstein, 2000, " Systematic low temperature expansion in Ginzburg - Landau models," Phys. Rev. B61, 12352 (SCI) NSC-88-2112-M-032-003.
2. Hsien-chung Kao, 2000, "Mass Spectra of N=2 Supersymmetric SU(n) Chern-Simons-Higgs Theories," submitted to Phys. Rev. D .

其中在第二個工作裡，我們分析了 N=2 Supersymmetric SU(n) Chern-Simons-Higgs 系統的質量譜及其各種基態的拓樸性質，我們發現這個系統的質量譜量子力學中角動量加成的模式十分相像，同時類似也可以應用到其他的規範群。

**關鍵詞：**第二類超導體，Abrikosov 渦漩晶格，Chern-Simons 理論

### Abstract

With the support from the National Science Council, I finished the following works:

1. Hsien-chung Kao, J. -C. Lee, and B. Rosenstein, 2000, " Systematic low temperature expansion in Ginzburg - Landau models," Phys. Rev. B61, 12352 (SCI) NSC-88-2112-M-032-003.
2. Hsien-chung Kao, 2000, "Mass Spectra of N=2 Supersymmetric SU(n) Chern-Simons-Higgs Theories," submitted to Phys. Rev. D .

In the second, we analyze the mass spectra of N=2 supersymmetric SU(n) Chern-Simons-Higgs theories and the topology of their ground states. We find that the pattern of the spectra is very similar to that of angular momentum addition in quantum mechanics. Similar analysis can be extended to systems with other gauge symmetry.

**Keywords:** Type II Superconductor, Abrikosov vortex lattice, Chern-Simons Theories

## 二、成果及討論

It is known that in non-Abelian Chern-Simons-Higgs theories, the Chern-Simons coefficient must be integer multiple of  $1/(4f)$  for the theories to be quantum-mechanically consistent. Therefore, it is interesting to see whether the quantization condition is spoiled by quantum effect. In the symmetric phase, the condition is preserved in one and two loop order. In the Higgs phase, the situation is complicated by choices of gauge group and representation of the Higgs fields. When the Higgs fields are in fundamental  $SU(n)$  or  $SO(n)$ , the quantization condition is shown to hold for all  $n$  by carefully subtracting out the contribution of the would be Chern-Simons term. When the Higgs fields are in the adjoint representation, there are many inequivalent degenerate vacua exhibiting different patterns of symmetry breaking and only partial calculations have been done and the results are perplexing.

In this paper, we use an algebraic method to work out the mass spectra and symmetry breaking patterns of general vacuum states in  $N=2$  supersymmetric  $SU(n)$  Chern-Simons-Higgs systems with the matter fields being in the adjoint representation. Supersymmetry is helpful in clarifying some misinterpretation of the mass spectra. Our approach provides with us a natural basis for fields, which will also be useful for further studies in the self-dual solutions and quantum corrections. As the vacuum states satisfy the  $SU(2)$  algebra, it is not surprising to find that their spectra are closely related to the pattern of angular momentum addition in quantum mechanics.

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