行政院國家科學委員會專題研究計畫成果報告

自旋梯中的拓樸序與相變之研究

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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, C.-H. Chang, and X.-G. Wen, 1999, " Binding Transition in Quantum Hall Edge States," submitted to Physical Review Letter.

2. Hsien-chung Kao, 1999, " The Chern-Simons Coefficient in Supersymmetric Non-Abelian Chern-Simons Higgs Theories," Phys. Rev. D 60, 065013.

其中在第一個工作裡，我們分析了分數量子霍爾系統的拓樸不穩定性，我們發現 Haldane 所指的這個拓樸不穩定性其實是對應到某種多電子 binding 的相變。

關鍵詞：量子霍爾效應，Chern-Simons 理論

Abstract

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

1. Hsien-chung Kao, C.-H. Chang, and X.-G. Wen, 1999, " Binding Transition in Quantum Hall Edge States," submitted to Physical Review Letter.

2. Hsien-chung Kao, 1999, " The Chern-Simons Coefficient in Supersymmetric Non-Abelian Chern-Simons Higgs Theories," Phys. Rev. D 60, 065013.

In the first work, we analyze the topological instability in fractional quantum Hall systems. We find that this topological instability, first pointed out by Haldane, corresponds to some kind of many-electron binding transitions in the system.

Keywords: Quantum Hall Effect, Chern-Simons Theories

二、成果及討論

We study a class of Abelian quantum Hall(QH) states which are topologically unstable (T-unstable). The **K**-matrices characterizing those QH states have neutral null vectors. We find that the T-unstable QH states can have phase transitions which cause binding between electrons and reduces the number of gapless edge branches. After the binding transition, the single-electron tunneling into the edge gains a finite energy gap, and only certain multi-electron co-tunneling (such as three-electron co-tunneling for =9/5 edges) can be gapless. Similar phenomenon also appears for edge states on the boundary between certain QH states. For example, edge on the boundary between =2 and =1/5 states only allow three-electron co-tunneling at low energies after the binding transition. Although, only the =9/5 state is studied, we believe the result is quite general and applies to all the T-unstable states.

Experimentally, the =9/5 state is not spin polarized. The tunneling process that causes the binding transition also flips spins for single-layer systems. Thus, strong spin-orbit coupling is necessary to see the binding transition in single layer systems. It might be easier to observe the binding transition in double-layer =9/5.

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