NOVEL PHASES OF TWO DIMENSIONAL ELECTRON SYSTEMS IN HIGH MAGNETIC FIELDS

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Introduction

Recent microwave conductivity studies of clean two dimensional electron systems in higher Landau levels, by the NHMFL group of L. Engel and coworkers, have shown pronounced resonances for certain ranges of filling fraction. These resonances are attributed to the formation of collectively pinned crystalline phases, which can be either Wigner crystals or electron “bubble” crystals (in which the electrons form bubbles that organize into a regular lattice structure). Our recent work [1] has focused on understanding the formation of possible crystalline phases in higher Landau levels, along with their elastic properties and response to ac fields. On a related note, we have also studied the tunneling current-voltage characteristics between bilayer Wigner crystal phases [2], in an attempt to understand in detail the Coulomb gap that appears at low bias.

Results and Discussion

We have performed detailed self-consistent Hartree-Fock calculations of the possible crystalline states as a function of magnetic field, and find that for a certain range of magnetic fields the favored state is an anisotropic Wigner crystal that eventually evolves into a smectic (layered) state near half-filling. The anisotropic state is new, and seems to have been overlooked in previous theoretical studies. The elastic properties of these lattices have been calculated, and serve as input into dc and ac transport calculations.

Our model for tunneling between bilayer Wigner crystals incorporates for the first time the important interlayer interactions, which gap the out-of-phase collective modes excited during the tunneling process. Our results achieve not only a more satisfying theoretical treatment of the problem, but also a better agreement with earlier experimental results of Eisenstein et al.

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References