Experiments on Exciton Condensation in Bilayer Quantum Hall Systems

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ABSTRACT

In high magnetic fields a double layer two-dimensional electron system supports a remarkable electronic quantum fluid when the layers are close enough together and the temperature is sufficiently low. This fluid, which develops when the total number of electrons in the system equals the number of states in a single spin-resolved Landau level, may be viewed as an intinerant ferromagnet or, equivalently, as a BCS-like condensate of interlayer excitons. Among the several interesting anticipated properties of this system, perhaps the most dramatic is the existence of a new form of superfluidity: equal, but oppositely directed, electrical currents should flow without dissipation.

In this contribution, we first review our recent Coulomb drag[1] and interlayer tunneling experiments[2] which strongly support the theoretical picture of the ground state as a phase coherent assembly of interlayer excitons. These experiments have revealed a huge and sharply resonant enhancement of the zero-bias tunneling conductance (which strongly resembles the dc Josephson effect) and the exact quantization of the Hall component of the frictional drag between the layers. In addition, we discuss our latest results on the nature of the phase transition between the incompressible excitonic phase at small layer separation and the weakly-coupled compressible phase at slightly larger separation. In particular, we demonstrate that the stability of the excitonic phase is enhanced by small shifts of electron density from one layer to the other, and offer evidence of unexpectedly strong interlayer correlations in the compressible phase.

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[1] M. Kellogg, *et al*., *Phys. Rev. Lett.* **88**, 126804 (2002); and M. Kellogg, *et al.*, cond-mat/0211502.
[2] I.B. Spielman, *et al.*, *Phys. Rev. Lett.* **84**, 5808 (2000) and *Phys. Rev. Lett.* **87**, 036803 (2001).