Condensate and Quasiparticle Transport in a Bilayer Quantum Hall Excitonic Superfluid

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Bilayer two-dimensional electron systems support an excitonic quantized Hall state when the separation between the layers is sufficiently small and the total number of electrons in the system matches the degeneracy of a single spin-resolved Landau level created by an applied perpendicular magnetic field. In this novel phase of matter, the ground state of the system consists of an exciton condensate in which electrons in one layer are bound to holes in the other. An energy gap separates this condensate from charged quasiparticle excitations. The system possesses many remarkable properties including a quantized Hall effect, a Josephson-like interlayer tunneling, linearly dispersing collective modes, and vanishing Hall resistance when electrical currents flow in opposite directions through the two layers.

In this talk I will describe our recent experiments in which direct control over exciton transport in the condensate is achieved. These experiments rely on the use of the multiply-connected Corbino transport geometry to eliminate complications associated with the conducting edges states at the sample boundary and to directly prove that charge-neutral excitons can easily move through the otherwise insulating bulk of the 2D system. In addition, I will discuss how the transport of charged quasiparticles above the energy gap can proceed alongside the exciton transport in the condensate when the temperature, layer separation, or drive voltage is increased.

These experiments open the way to a variety of new experiments on a unique superfluid, one with a neutral condensate but charged excitations.