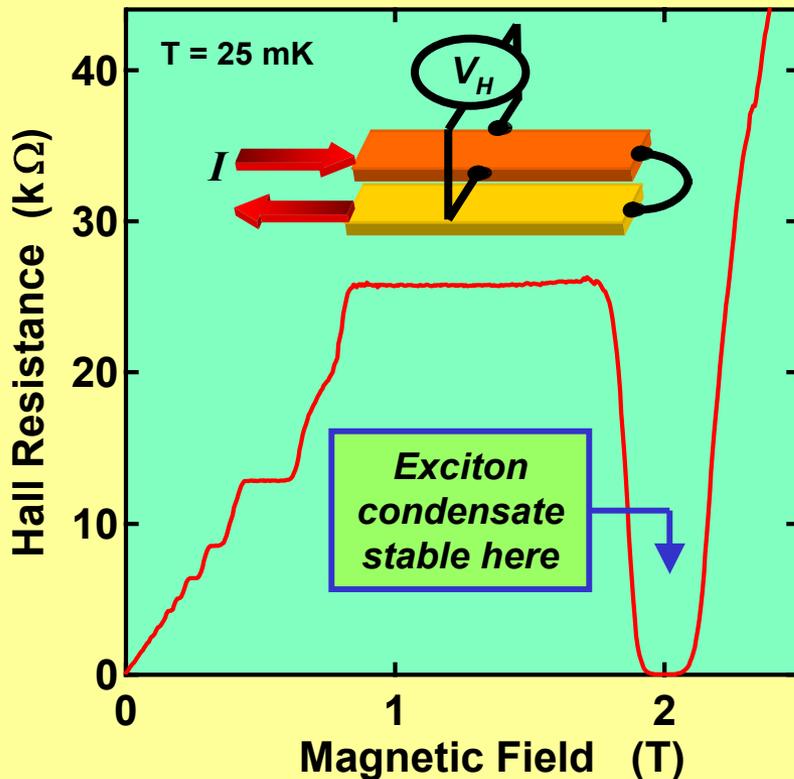
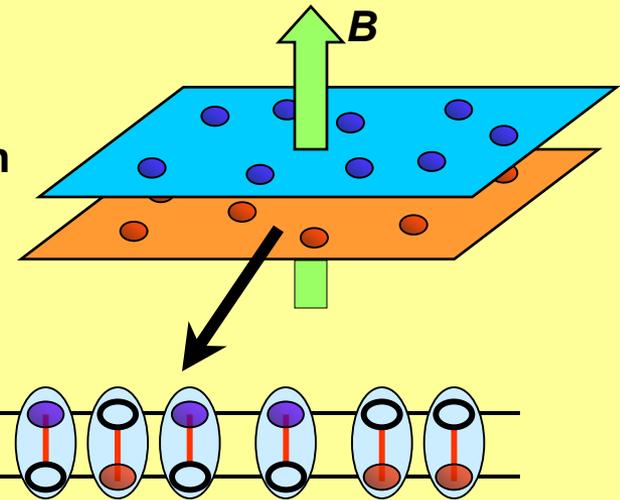


# Vanishing Hall Resistance in a Quantum Hall Superfluid

J.P. Eisenstein - Caltech

DMR-0242946

Two closely spaced sheets of electrons in a large magnetic field  $B$  can spawn a bizarre new state of matter known as an **exciton condensate**. Electrons in one layer are bound to holes in the other. Predicted over 40 years ago, this collective state is expected to be a new kind of **superfluid**.



Since excitons possess no net charge, this superfluid is not a superconductor in the usual sense. Instead, the system is expected to exhibit dissipationless flow for **counter-flowing** electrical currents in the two layers. Our experiments have shown that this effect does indeed occur. The left panel shows that when the excitonic state forms, its Hall resistance in counter-flow vanishes, in spite of the very large magnetic field present. This dramatic result, coupled with our observation of vanishing longitudinal resistance (not shown), strongly supports the notion that this state is a counter-flow superfluid.

# Vanishing Hall Resistance in a Quantum Hall Superfluid

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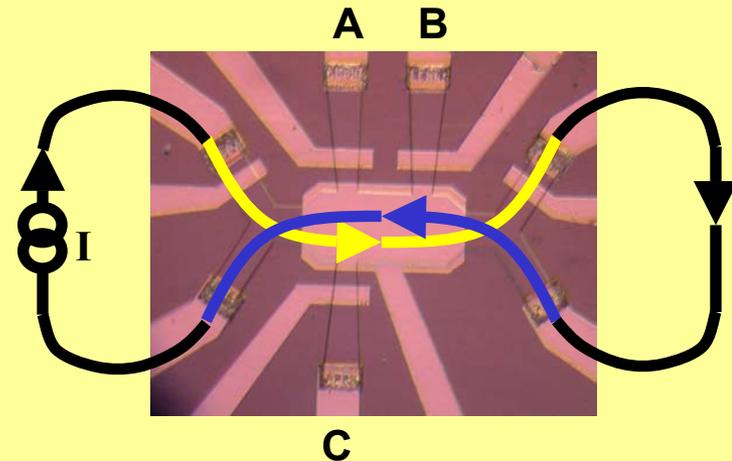
**Related Manuscripts:** “Vanishing Counter-flow Resistivity Tensor in a Quantum Hall Exciton Condensate”, *in preparation*.

“Bilayer Quantum Hall Systems at  $\nu_T=1$ : Coulomb Drag and the Transition from Weak to Strong Interlayer Coupling”, *Physical Review Letters*, **90**, 246801 (2003).

“Observation of Quantized Hall Drag in a Strongly Correlated Double Layer Bilayer Electron System”, *Physical Review Letters*, **88**, 126804 (2002).

**Major Presentations:** “Experiments on Exciton Condensation in Bilayer Quantum Hall Systems”, **plenary** talk at joint EP2DS-15 and MSS-11 Conferences in Nara, Japan, July 2003.

“Evidence for a New Kind of Superfluid”, One of three **invited** Morris Loeb Lectures at Harvard University, February 2003.



Photomicrograph showing counter-flow current configuration. Blue current flows in one 2D layer, yellow in the other. Hall and longitudinal voltages measured using probes A, B, and C. Width of central mesa is 160 microns.