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Exciton Transport and Perfect Coulomb Drag[1]

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Exciton condensation is realized in closely-spaced bilayer quantum Hall systems at $\nu_T = 1$ when the total density in the two 2D electron layers matches the Landau level degeneracy. In this state, electrons in one layer become tightly bound to holes in the other layer, forming a condensate similar to the Cooper pairs in a superconductor. Being charge neutral, these excitons ought to be free to move throughout the bulk of the quantum Hall fluid. One therefore expects that electron current driven in one layer would spontaneously generate a "hole" current in the other layer, even in the otherwise insulating bulk of the 2D system. We demonstrate precisely this effect, using a Corbino geometry to defeat edge state transport. Our sample contains two essentially identical two-dimensional electron systems (2DES) in GaAs quantum wells separated by a thin AlGaAs barrier. It is patterned into an annulus with arms protruding from each rim that provide contact to each 2DES separately. A current drag geometry is realized by applying a drive voltage between the outer and inner rim on one 2DES layer while the two rims on the opposite layer are connected together in a closed loop. There is no direct electrical connection between the two layers. At $\nu_T = 1$ the bulk of the Corbino annulus becomes insulating owing to the quantum Hall gap and net charge transport across the bulk is suppressed. Nevertheless, we find that in the drag geometry appreciable currents do flow in each layer. These currents are almost exactly equal magnitude but, crucially, flow in opposite directions. This phenomenon reflects exciton transport within the $\nu_T = 1$ condensate, rather than its quasiparticle excitations. We find that quasiparticle transport competes with exciton transport at elevated temperatures, drive levels, and layer separations. This work represents a collaboration with A.D.K. Finck, J.P. Eisenstein, L.N. Pfeiffer and K.W. West.

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