2D electron-hole "superconductor": topological excitonic insulator

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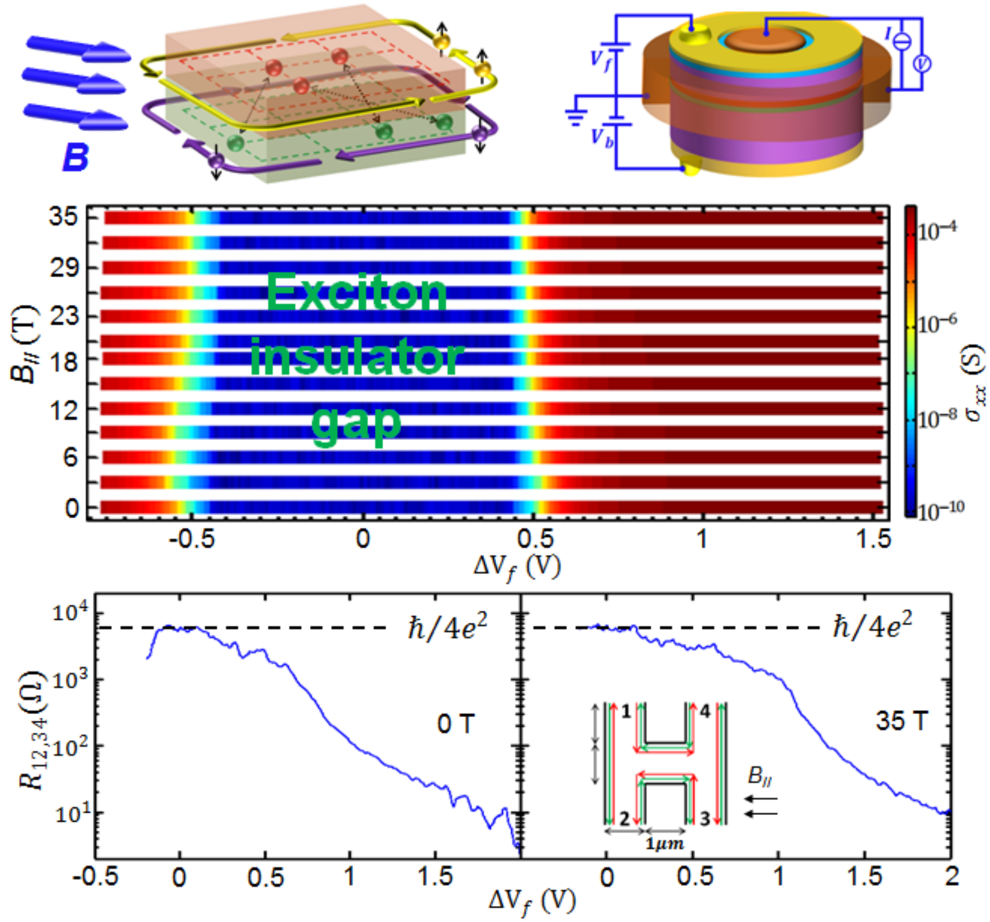
In the 1960s, the exciton insulator (EI) was proposed to be an equilibrium ground state in which electrons and holes become paired through weak correlations, similar to Cooper pairs in a BCS superconductor. This pairing opens a gap at the Fermi energy that transforms a dilute semimetal into an insulator. Recently the possibility of a topological EI has been proposed to explain the quantum spin Hall effect which features opposite propagation of edge states with reversed spins on the boundary of an EI. (see diagram at upper left) Thus far experimental evidence for the existence the EI state and counter-propagating edge states has remained elusive.

MagLab users fabricated macroscopic and mesoscopic double-gate devices in InAs/GaSb bilayer quantum wells, performing conductance measurements at temperatures down to 20 mK and in magnetic fields up to 35 T. Thermally activation conduction revealed the EI bulk energy gap, and non-local transport techniques revealed the edge states.

The data show that a topological Electronic Insulator state is indeed produced in these InAs/GaSb double quantum well devices. Realization of the nontrivial exciton state is a crucial step in exploring exotic phenomena of interacting topological insulators. *Future work can be expected to access other correlated states, including bilayer superfluidity and Bose-Einstein condensation in this tunable system.*



Top: Two depictions of the double quantum well device. Middle: Gate dependence of the conductance for a macroscopic Corbino device under inplane magnetic field from 0 T to 35T. Bottom: Nonlocal transport measurement in meso-H bar under 0 T and 35 T.

Facilities: 35 T, 32 mm Bore Magnet, ^{3}He and dilution refrigerators.

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