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Towards Quantum Spin Hall Effect in InAs/GaSb Quantum Wells

IVAN KNEZ, RUI-RUI DU, Rice University, GERRARD SULLIVAN, Teledyne Scientific Co. — Recently, it has been proposed that inverted InAs/GaSb composite quantum wells (CQWs) should exhibit the Quantum Spin Hall Effect (QSHE), characterized by the energy gap in the bulk and gapless edge modes which are protected from backscattering by time reversal symmetry. We have successfully fabricated a double-gated device on high-quality MBE-grown InAs/GaAs CQWs in the inverted regime, in which we were able to vary the band structure via an electrical field, and tune the Fermi level into mini-gap regime. We observed clear evidence for an energy gap in the inverted regime, with values of the gap consistent with those theoretically predicted; however, the mini-gap exhibits residual conductivity of non-trivial origin, which complicates transport investigation of proposed edge channels. We note that the InAs surface states around the sample edges may play a role in the observed resistivity features. In ongoing work, we pursue Cooper pair injection experiments by proximity to an s-wave superconductor, which should provide a novel probe of the proposed helical edge modes. We will discuss our progress towards observing QSHE in this unique material system. The work at Rice was supported by grants from NSF, Keck Foundation, and Hackerman Advanced Research Program.

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