Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Quantum Transport in Electron Fabry-Perot Interferometers in Quantum Hall Regime

By

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The dissertation describes quantum Hall transport experiments on Fabry-Perot electron interferometers fabricated from GaAs/AlGaAs heterostructure material. The devices consist of an island separated from the two-dimensional (2D) electron bulk via two tunable constrictions. Front gates deposited in the trenches permit to fine tune the device. When tunneling occurs in the constrictions, electrons perform closed orbits around the island, producing an Aharonov-Bohm oscillatory signal in the conductance. Quantized plateaus in longitudinal and Hall resistances allow us to determine the Landau level filling in both the bulk and the constriction.

A comprehensive experimental characterization of quantum Hall and Shubnikov-de Haas (SdH) transport was presented in the first interferometer. Application of front-gate voltage affects the constriction electron density, but the 2D bulk density remains unaffected. Analyzing the data within a Fock-Darwin model, we obtain the front-gate bias dependencies of constriction electron density and the B=0 number of 1D electric subbands resulting from the electron confinement in the constrictions.

By carefully tuning the constriction front gates, we find a regime where interference oscillations with period $h/2e$ persist throughout the transition between the integer quantum Hall plateaus 2 and 3, including half-filling. In our experiment, neither period nor amplitude of the oscillations show a discontinuity at half-filling, indicating that only one interference path exists throughout the transition.

In the second interferometer, etch trench depletion is such that in the fractional quantum Hall (FQH) regime, filling 1/3 current-carrying chiral edge channels pass through the constrictions and encircle an island of the 2/5 FQH fluid. In the fractional regime, we observe magnetic flux and charge periods $5h/e$ and $2e$, respectively, corresponding to creation of ten $e/5$ Laughlin quasiparticles in the island. The observed experimental periods are interpreted as imposed by the anyonic statistical interaction of fractionally charged quasiparticles.

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