The edge-state mediated collective transport in a network of quantum dot array

W. Y. Wei [a], K. T. Lin [b], D. C. Ling [c], C. C. Chi [a], J. C. Chen [a],

[a] Department of Physics, National Tsing Hua University, Hsinchu, Taiwan

[b] Institute of Industrial Science, University of Tokyo, Japan

[c] Department of Physics, Tamkang University, Taiwan

Abstract

We report the edge-state mediated transport property of a one-dimensional quantum dot array, consisting of six quantum dots defined by the surface gating technique in the two-dimensional electron gas formed at the interface of the GaAs/AlGaAs heterostructure. The conductance G in high magnetic field (B) exhibits a series of dip structures on the last quantized plateau, and a series of Coulomb blockade peaks before the conductance channel is closed by biasing the gate voltage to a sufficiently negative value. The dips in conductance evolve with B and reveal a pronounced charging effect, which are gradually smeared with increasing temperature. The Coulomb blockade diamonds in the differential conductance spectrum show nested features distinctly different from what are observed in conventional quantum dot systems. After careful data analysis and theoretical modeling, our results suggest that our sample, which although meant to be a serial quantum dot array by design, actually behaves like a parallel dot array under certain specific B and gate voltage. A novel collective quantum transport in the network of quantum dot array mediated by the edge states is responsible for the observed phenomena.