Crossover from Non-universal Scaling Regime to Universal Scaling Regime in Quantum Hall Plateau Transition

Wan Li (Princeton University, Physics), J.S Xia, C. Vicente, and N.S. Sullivan (University of Florida, Physics), W. Pan (Sandia National Laboratories), D.C. Tsui, L.N. Pfeiffer, and K.W. West (Princeton University, Physics)

Introduction

Experimental results are presented for the quantum Hall plateau-plateau transition in long-range Columbic disordered electron systems in Al$_x$Ga$_{1-x}$As-Al$_{0.32}$Ga$_{0.68}$As heterostructures for $x=0$ and $x=0.21\%$ for temperatures $0.001<T<1.2$ K. A crossover is observed from the high-temperature, non-universal scaling regime to the low-temperature, universal scaling regime.

Experimental

The measurements were carried out using the nuclear demagnetization refrigerator of the NHMFL High B/T facility. Sintered silver contacts were used to cool the 2D electrons in the samples. The diagonal resistance $R_{xx}$ and the Hall resistance $R_{xy}$ were measured using lock-in techniques with $1$ nA excitation. The temperature scaling of was determined from measurements of $(dR_{xy}/dB) \propto T^{-\kappa}$ or from the half-width of $R_{xx}$ using $\Delta B \propto T^\kappa$.

Results and Discussion

The results for the temperature dependence of the derivative $(dR_{xy}/dB)$ are shown in Fig. 1 for the $x=0$ sample. The crossover from $\kappa=0.42$ to $\kappa=0.58$ is observed to occur at $120$ mK.

Conclusions

A cross-over from high-temperature non-universal scaling with $\kappa=0.58$ to the low temperature universal scaling with $\kappa=0.42$ is observed in both samples. This behavior is attributed to a transition from thermionic processes at high temperatures to quantum percolation processes at low temperatures.

Acknowledgements

This research was carried out at the NHMFL High B/T Facility, which is supported by NSF Grant DMR 0654118 and by the State of Florida.