Imaging Electron Flow through Two-Dimensional Electron Gases

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Due in part to their extremely low levels of disorder, GaAs-based two-dimensional electron gases (2DEGs) serve as the basis for fast transistors, prototypes of quantum computing schemes, and research on remarkable electronic states and electrons in nanostructures. Using scanning gate microscopy (SGM) to image electron flow in 2DEGs, we study how disorder affects the microscopic details of electron transport. The images below show the striking differences in flow patterns for electrons emanating from a narrow channel (schematically indicated in black) in three samples with widely varying levels of disorder, characterized by the mean free path ℓ. The flow varies from twisted and diffusive in the shortest mean free path 2DEG, sample A, to straight, smooth branches of flow in the longest mean free path 2DEG, sample C.