Equilibration of integer quantum Hall edge channels studied by scanning gate microscopy

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The concept of one-dimensional (1D) edge channels can be successfully applied to the description of transport phenomena in two-dimensional electron systems (2DES) in the quantum Hall (QH) regime [1]. QH resistance is not sensitive to inter-channel scattering, but there is renewed interest in interactions between co-propagating edge channels [2] mostly in view of possible applications in quantum information technology [3]. Inter-channel transport was studied in the past by several authors (for a review, see [1]), but only in devices with fixed channel interaction length *d*. Here we demonstrate for the first time the use of scanning gate microscopy (SGM) to realize devices in which *d* can be tuned continuously. We shall argue that this level of control is crucial to pinpoint the exact mechanism of edge-edge interaction.

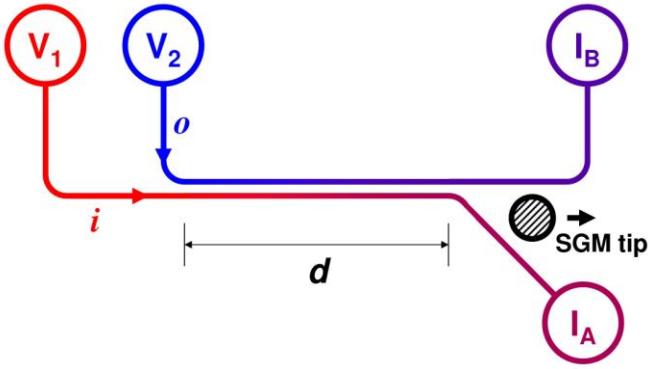

Figure 1 schematically illustrates our experiment: inner (*i*) and outer (*o*) edge channels originate from two distinct voltage contacts at potential V_1 and V_2, respectively. They propagate together for a distance *d* and are then separated and guided to two current contacts I_A and I_B, respectively. In what follows we set $V_1 = V$ and $V_2 = 0$. If we assume that there is no equilibration between the two (spin-degenerate) edge channels, then $I_A = 2\ e^2/h\ V$ and $I_B = 0$. On the other hand, if we assume that the two edge channels equilibrate their voltage imbalance completely, then $I_A = I_B = e^2/h\ V$. Therefore, a measurement of I_A and I_B as a function of *d* and *V* makes it possible to analyze the equilibration behavior.

Devices were realized starting from a high-mobility AlGaAs/GaAs heterostructure. A 6 µm-long 1D channel of two Schottky-gates with a constriction gap of 1 µm was patterned on the sample. Experiments were performed at 300 mK and bulk 2DES filling factor $\nu = 4$ (two spin-degenerate edge channels). The selective backscattering of individual edge channels was achieved by the biased tip of a SGM, as described in detail in Ref. [4]. The inner and outer edge channels meet at the entrance of the 1D channel and travel in close proximity for a distance *d* before they are separated by the action of the SGM tip.

We shall discuss our experimental results based on a theoretical model which takes into account the effect of impurities present in the 1D channel.

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