Manipulating quantum Hall edge channels in graphene by Scanning Gate Microscopy

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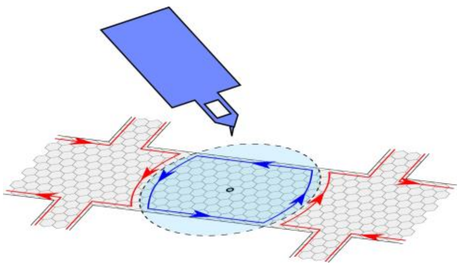
Scanning Gate Microscopy (SGM) employs the biased metallic tip of an Atomic Force Microscope to gate the sample in a region located underneath the tip, with nanometer precision. This modifies the charge carrier concentration in the gated part of the sample. Here we demonstrate that we are able to locally gate a region of choice of a narrow graphene Hall bar in the quantum Hall regime, which allows for the manipulation and deflection of quantum Hall edge channels. By selecting the appropriate parameters, edge channels can be made to interact, equilibrate, and/or backscatter. As a consequence of the gradual spatial variation of the tip potential, which differs significantly from the potential of a more standard top- or split-gate, we see intriguing junctions arise between regions of different charge carrier density, which manifests itself in values of the longitudinal resistance R_{xx} (see Fig. 1) that have not been observed before in devices based on top- or split-gates. The solution of the corresponding quantum scattering problem is presented to substantiate these results.

The SGM approach offers several advantages with respect to more conventional solutions with fixed gates. Being able to move the tip freely gives great flexibility in manipulating the edge channels, which can be done by changing the tip position, the tip-sample distance, and the applied voltage. Possible follow-up experiments will be discussed.



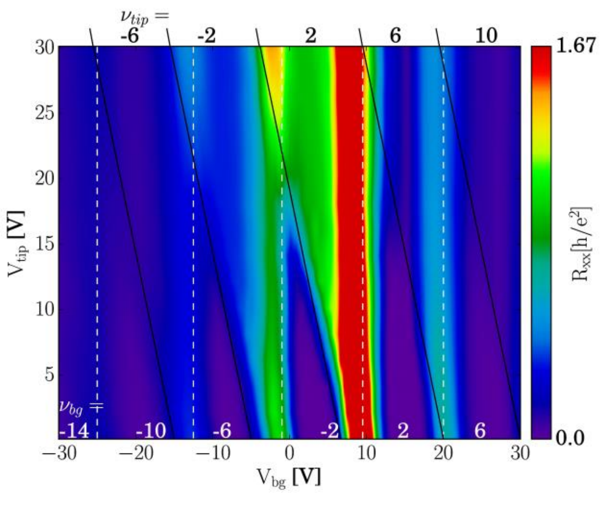


Fig. 1. Top: Sketch of the experimental setup. Right: A 2D map, showing the value of R_{xx} as a function of back gate voltage V_{bg} and tip voltage V_{tip}. The data was collected by sweeping the back gate from -30 to +30 V, while increasing the tip bias in steps of 2 V in-between sweeps. The global filling factors ν_{bg} and the filling factors underneath the SGM tip ν_{tip} are indicated. Magnetic field B = 8 T, temperature T = 4.2 K.