# Selective control of edge channel trajectories by SGM

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Interference phenomena are a fundamental manifestation of the quantum mechanical nature of electrons and have promising applications in solid-state quantum information technology [1]. Two-dimensional electron systems (2DES) in the quantum Hall (QH) regime are especially suited for this purpose given the large electronic coherence length brought by edge-channel chiral transport. In particular, the realization of electronic Mach–Zehnder (MZ) interferometers in QH systems appears at present a sound technology for the implementation of quantum information schemes. Despite this success, the edge topology of the single-channel MZs limits the complexity of these circuits to a maximum of two interferometers [2]. In order to overcome this constraint, new device architectures were recently proposed, where interference paths are built using two different parallel edge channels [1]. In this configuration, control over the interaction between the different edge channels is very challenging owing to the complex edge structure.

In order to address these issues we are exploring the use of scanning gate microscopy (SGM) to control the trajectory and interaction of edge channels based on our previous results on quantum point contact (QPC) devices in the QH regime [3]. Samples were fabricated starting from high-mobility AlGaAs heterostructures and Schottky split-gate QPCs. SGM experiments were performed at 400mK with magnetic field up to 9T. Figure 1 shows QPC conductance (G) as a function of the position of the biased SGM tip ($V_{tip}$= -3V). The (bulk) 2DES filling factor is set to $\nu = 6$ (3 spin-degenerate edge channels) while the QPC gates completely deplete the 2DES underneath (gate-region spin-degenerate filling factor $g_1 = g_2 = 0$). When the biased tip is brought close to the QPC, edge channels are backscattered one by one, and the conductance through the QPC decreases in a step-like manner to 0. The split-gate QPC however also allows to bias the individual gates asymmetrically and pre-select edges that can then be manipulated by the SGM tip. For instance in the case $g_1 = 2$, $g_2 = 1$ only the inner edge channel can be backscattered by the local action of the tip, while the others either flow (under the gate) far from the constriction or have no counterpart for the backscattering process to occur. In this latter case, the conductance value remains $G = 4e^2/h$ even when the tip completely pinches off the constriction region (Fig. 1, orange curve).

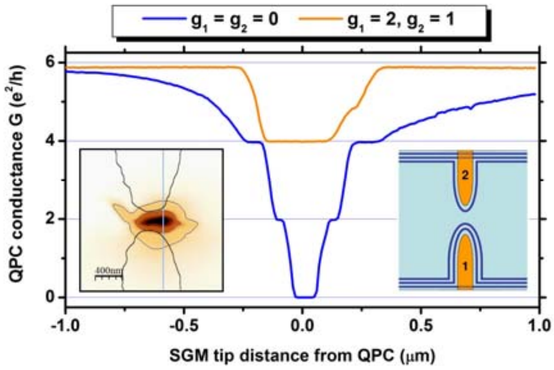


**Fig.1** Conductance profile through the QPC as a function of filling factors g under the QPC gates. The left inset shows a two-dimensional SGM map of G vs. tip position for $g_1$=$g_2$=0. The vertical line indicates the profile position, the QPC border is outlined. The right inset is a sketch of the edge channels for $g_1$=2, $g_2$=1.

We shall show that the SGM tip can be used to selectively control edge trajectories and discuss the impact of our findings as a crucial first step for the implementation of multi-edge beam mixers and interferometers.

## References

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