Imaging Integer and Fractional Quantum Hall Edge States

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We present scanning gate microscopy (SGM) measurements on a quantum point contact (QPC) patterned on top of a high-mobility two-dimensional electron gas (2DEG) in a GaAs-AlGaAs heterostructure. The measurements are carried out at a temperature of 100 mK in a strong perpendicular magnetic field. A local potential perturbation induced by the voltage-biased tip of the microscope is used to probe the underlying 2DEG [1]. The tip acts as a movable gate. Depending on its position, quantum Hall edge channels can be selectively transmitted or reflected [2, 3]. Thus, as a function of tip-position stripes of constant filling factors are resolved. Even filling factors appear as very pronounced plateaus in the maps of the conductance as a function of tip position, as seen in fig. 1a). Odd filling factors can be seen as smaller stripes. At very high magnetic fields we can observe very distinct signatures of fractional filling factors 1b), c), d).

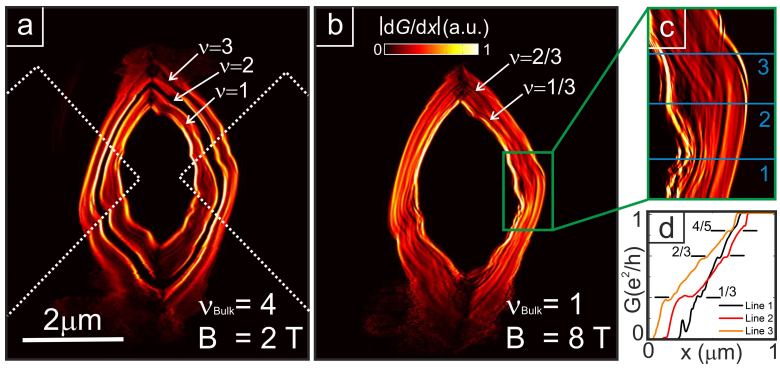

Figure 1: a) SGM image taken at a filling factor of 4 in the bulk. Plateaus at values of 3, 2 and 1 e^2/h can be observed. Dashed lines show the outline of the QPC. b) Same image at a filling factor of 1 in the bulk. Black stripes show filling factors of 1/3 and 2/3. c) Zoom at the position of the green frame in b). Especially in d) clear plateuas at filling factors 1/3, 2/3 and 4/5 are visible.

The measurements give a direct measure for the real space behavior and distribution of quantum Hall edge channels. Putting our results into a theoretical framework we can draw conclusions about the alternating compressible and incompressible stripes, which are formed in the quantum Hall regime [4]. The measurements show the fragile nature of fractional quantum Hall effect edge states and their behavior in the local potential landscape.

[1] N. Paradiso, S. Heun, S. Roddaro, L. Sorba, F. Beltram, G. Biasiol, L.N. Pfeiffer and K.W. West, PRL **108**, 246801 (2012).
[2] B. I. Halperin, PRB **25**, 2185 (1982).
[3] M. Büttiker, PRB **41**, 7906 (1988).
[4] D. B. Chklovskii, B. I. Shklovskii and L. I. Glazman, PRB **46**, 4026 (1992).