Imaging interference as well as integer and fractional quantum Hall edge channels in small constrictions

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The local investigation of high-quality nanostructures at zero and finite magnetic fields with the scanning gate technique is a worthwhile extension of conventional transport experiments. Earlier experiments on branched electron flow have given novel insights into the local details of electron flow in the vicinity of a quantum point contact [1]. We extend these measurements to samples based on two-dimensional electron gases in GaAs with mobilities of about $8 \times 10^6\,\mathrm{cm}^2/\mathrm{Vs}$ [2]. In addition to the previously observed branched flow behavior, we are able to generate and image standing wave patterns forming between the scanning tip and the gates. These patterns are identified with the spatially controlled formation of one-dimensional modes. On the application of a magnetic field normal to the plane of the electron gas magneto-electric subbands form. By moving the tip we can systematically image the depopulation of these subbands in real space and compare the behavior with existing theories. It turns out that at sufficiently high magnetic fields and at dilution refrigerator temperatures we are able to investigate quantum Hall edge channels locally by selective backscattering using the tip. Even in these high-mobility samples, our experiments show the presence of residual disorder in the constrictions. Under certain conditions, fractional edge channels can be observed in the constrictions. We will discuss in which sense our technique is able to spatially resolve the width of incompressible stripes. Scanning the tip at finite source drain voltage gives us new opportunities to investigate the local energy scales of quantum Hall edge channels in constrictions.

References

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