Imaging Fractional Incompressible Stripes in Integer Quantum Hall Systems

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The existence of a fractional order within integer quantum Hall edge channel has been debated for a long time, due to the conflicting results provided by the experiments. In interference experiments, integer edge states seem to behave as monolithic objects with no inner structure [1,2]. Other experiments, however, clearly highlight the role of fractional substructures [3,4].

Recently developed low–temperature scanning probe techniques offer today an opportunity for a deeper-than-ever investigation of spatial features of such edge systems. In the present work, we use scanning gate microscopy (SGM) and demonstrate that fractional features were unambiguously observed in every integer quantum Hall constriction studied. The configuration of our samples is similar to that described in [5]. Experiments were performed at bulk filling factor $\nu=1$. We brought two counter-propagating integer channels into proximity by means of a quantum point contact (QPC) and used the biased SGM tip to tune backscattering. Plateaus are observed in source-drain differential conductance maps whenever the tip induces an incompressible phase at the QPC center. We present SGM maps which directly reveal the width of the most relevant fractional incompressible stripes, as the $\nu=1/3$ shown in the attached Figure (a,b). In our experiments, we observed plateaus corresponding to filling factors 1/3 and 2/5, together with their particle–hole conjugates 2/3 and 3/5. Our results compare well with predictions of the edge–reconstruction theory [6] and may open up exciting developments. For instance, the ability to partition an integer edge and partially transmit one of its fractional components may be the key for the implementation of fractional quasiparticle Mach-Zehnder interferometers.

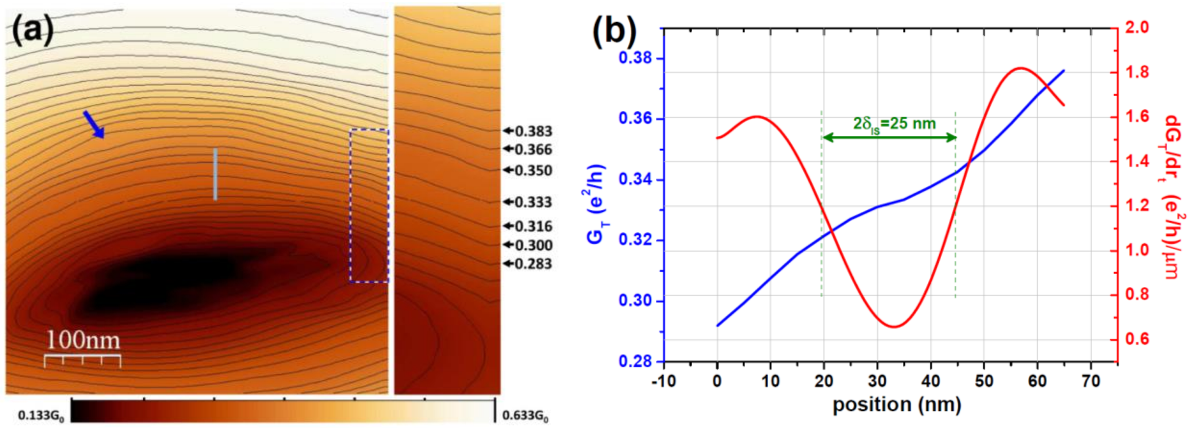

Fig.1: (a) SGM scan at the center of a QPC in a $\nu=1$ QH system. The map shows the G_T values as a function of the tip position. (b) G_T profile along the light blue line in (a), together with its derivative.

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