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Imaging quantum Hall backscattering in graphene

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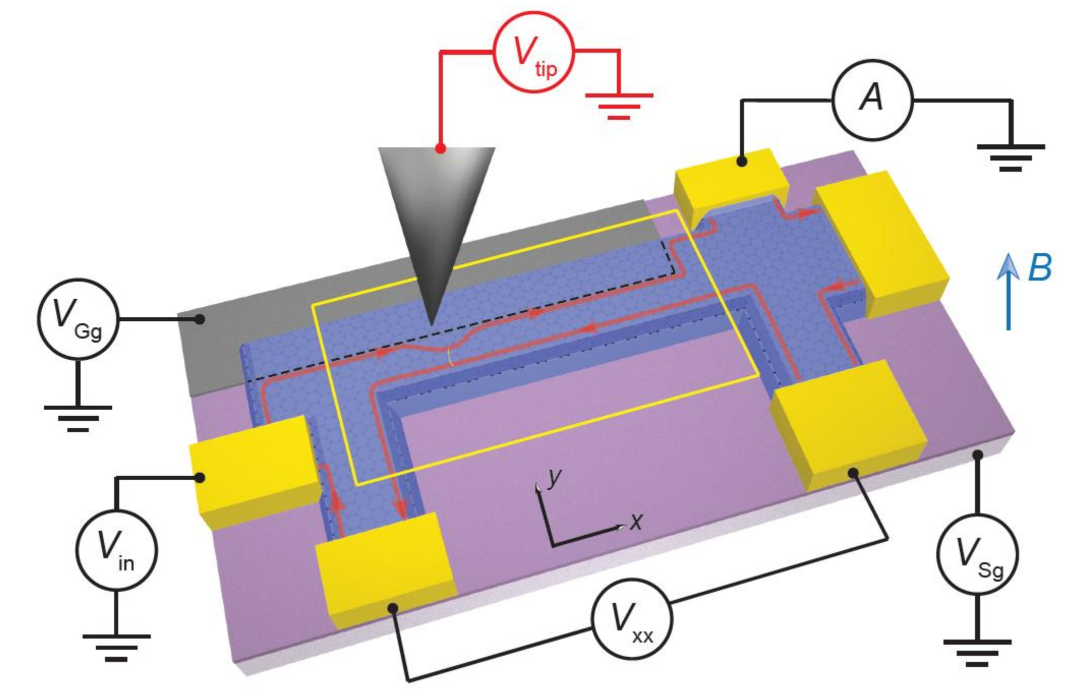
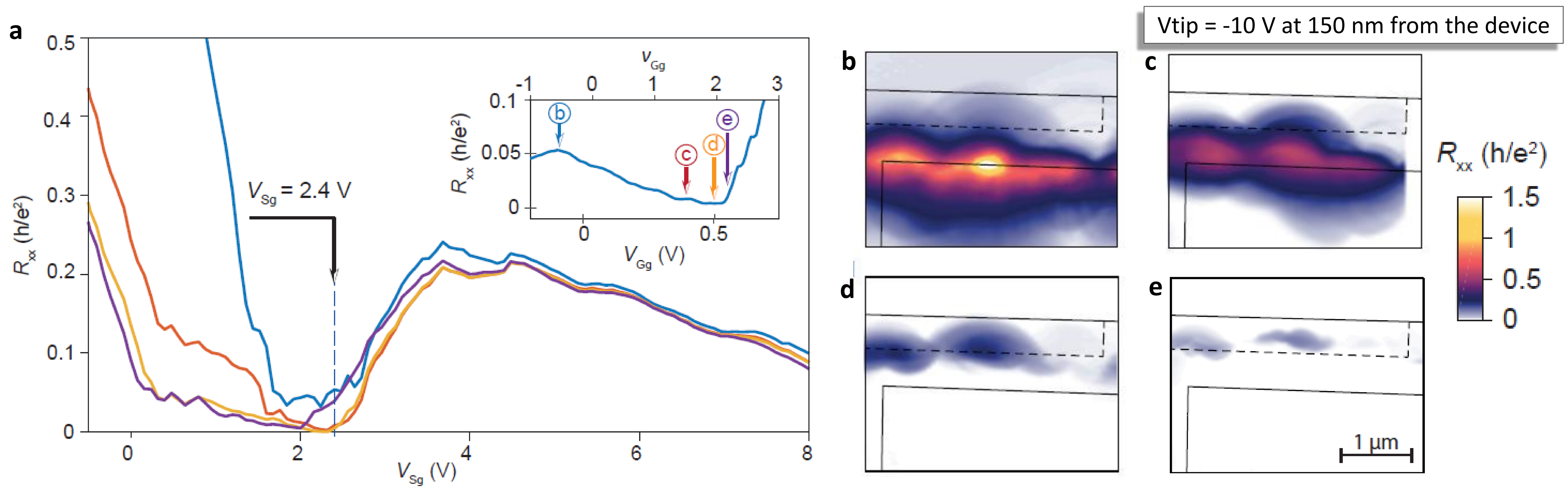
We present scanning gate microscopy (SGM) experiment that provides spatial information on the positioning of the backscattering between chiral quantum Hall edge states in a high-mobility graphene Hall bar. A local graphite backgate allows us to characterize the electrostatic confinement. We identify a series of concentric rings typical of Coulomb blockade transport through a localize state gated by the tip. The diamond-shaped stability diagram at finite source-drain bias demonstrate the key-role of Coulomb blockade in the percolation of quantum Hall channels through a disordered potential landscape.



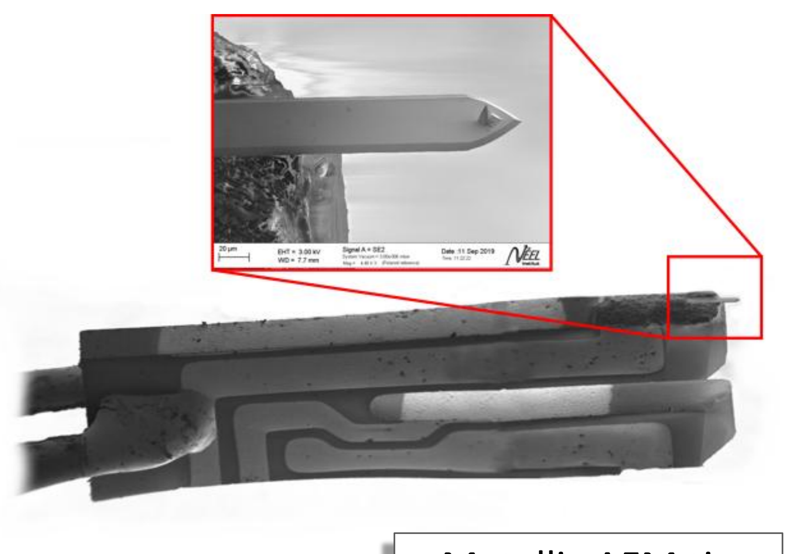
Electrostatic confinement of edge states

Tip-induced backscattering is influenced by the filling factor imposed by the graphite backgate.
Arc structures in SGM maps reflect the positions of disorder induced backscattering points in the bulk [1].



Scanning gate microscopy

Cryogenic AFM with a metallic tip acting as a gate

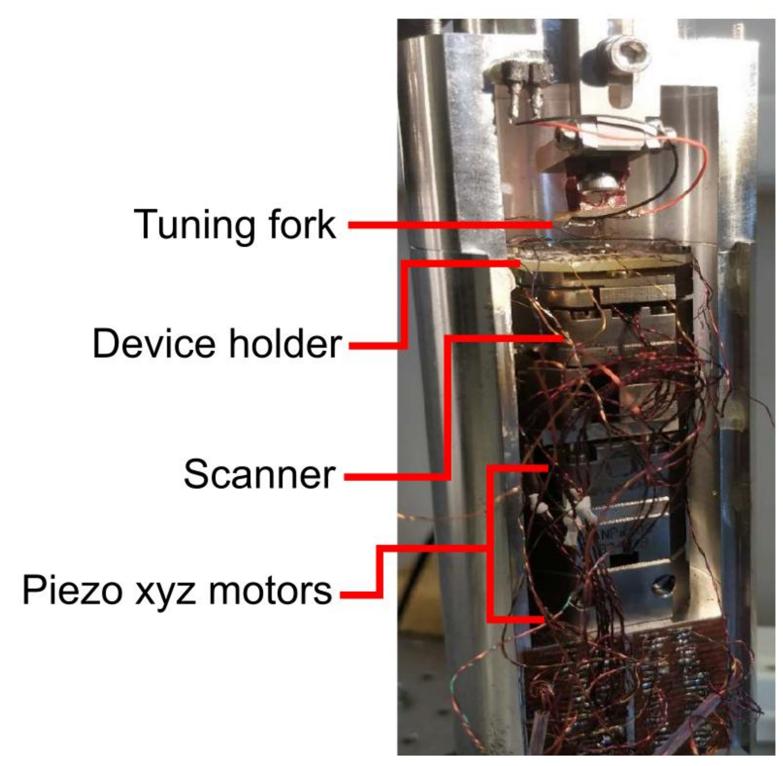


Metallic AFM tip directly glued on a quartz tuning fork

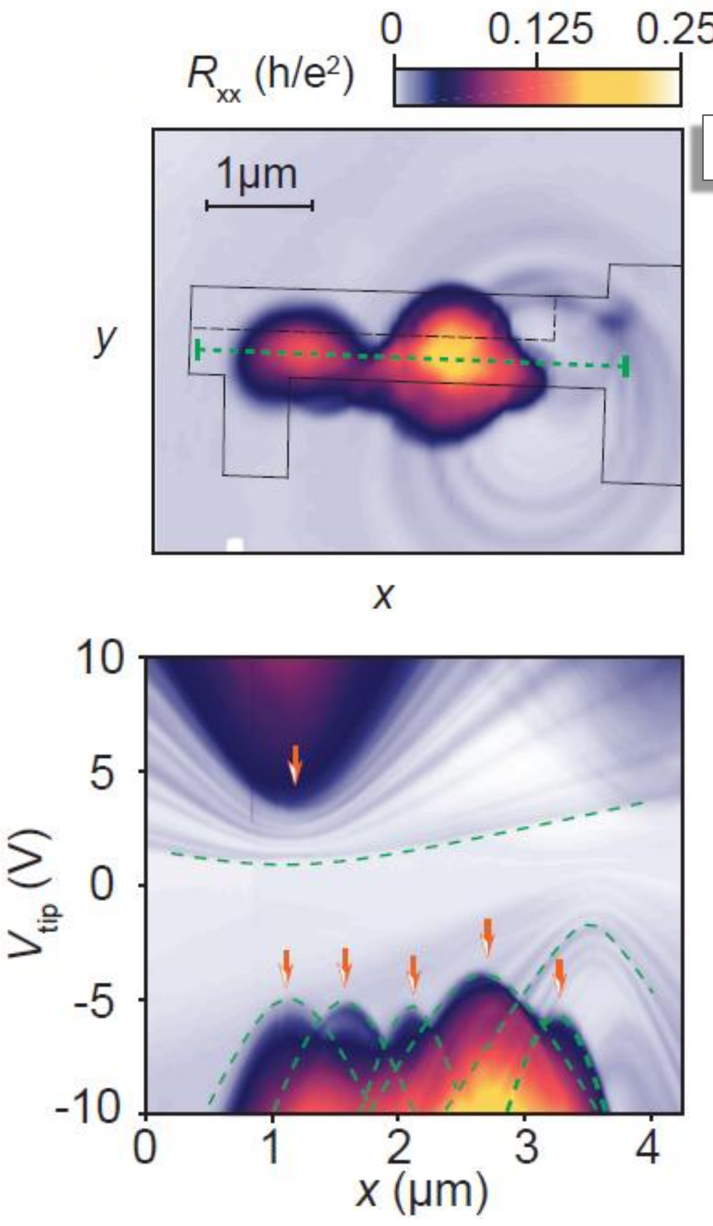
Electrostatic force detection (EFM)

$$\Delta f = \frac{\eta}{2}\frac{\partial^2 C_{ts}}{\partial z^2}(V_{ts} + \Delta\Phi_W/e)^2$$

Head of the cryogenic AFM

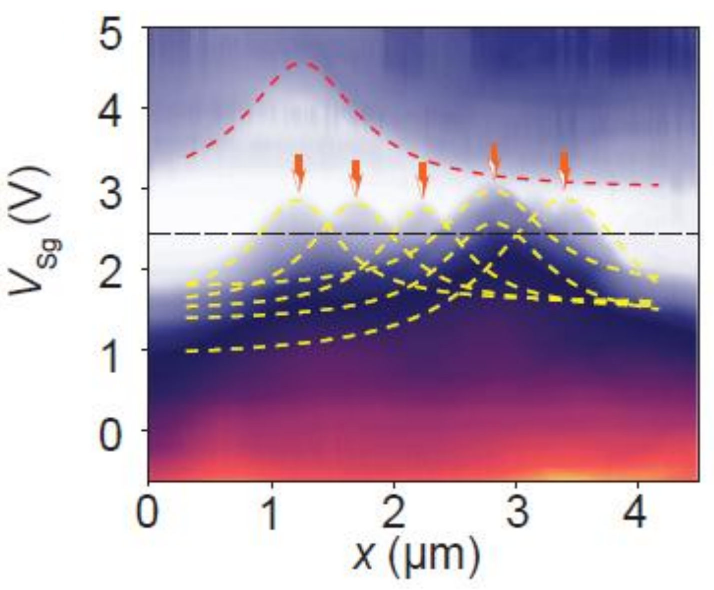


Backscattering onset



Vtip = -8 V at 200 nm from the device

Single line SGM spectroscopies allow to characterize the backscattering process

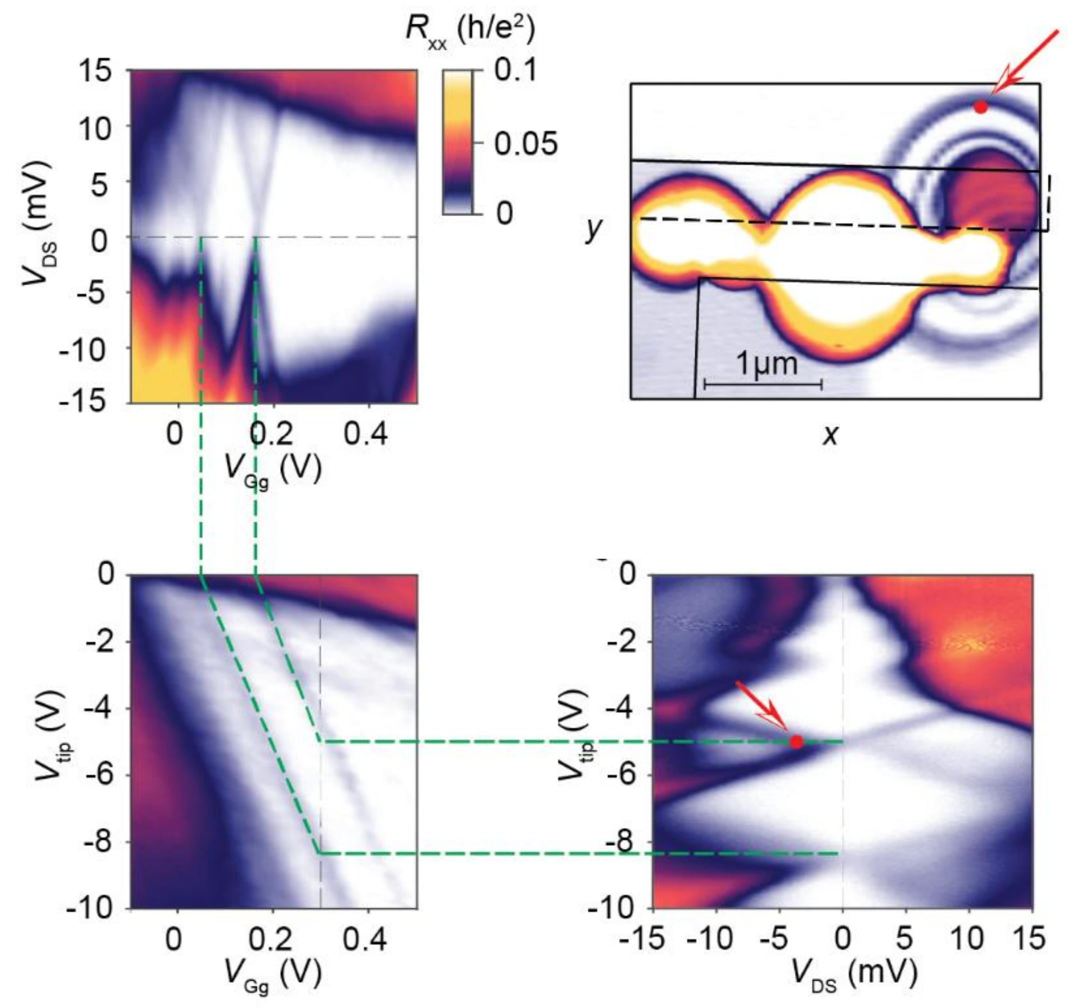


Spatially resolved backscattering points originated from the distribution of localized states in the device. Each point displays hyperbolic lines of constant electrostatic tip action of discrete spectra [2][3].

Lorentzian curves [4] highlighting the role of localized states in the percolation during quantum Hall pateau transitions.

Localized antidot

Coulomb charging of localized state (quantum antidot)



Stability diagram versus local SGM gate measured on a resonance ring (red marker) shows key-role of Coulomb blockade in QH backscattering.

Ring resonances disappear when SGM tip is close to the AD. The electrostatic action of the tip enlarges the AD and suppresses single electron transfer process.

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