Direct visualization of electronic transport in a quantum anomalous Hall insulator

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A quantum anomalous Hall (QAH) insulator is characterized by quantized Hall and vanishing longitudinal resistances at zero magnetic field that are protected against local perturbations and independent of sample details. This insensitivity makes the microscopic details of the local current distribution inaccessible to global transport measurements. Accordingly, the current distributions that give rise to the transport quantization are unknown. Here, I will discuss how we use magnetic imaging to directly visualize the transport current in the QAH regime [1]. As we tune through the QAH plateau by electrostatic gating, we clearly identify a regime in which the sample transports current primarily in the bulk rather than along the edges. Furthermore, we observe a local response of the equilibrium magnetization to electrostatic gating, whose spatial structure is strongly correlated with the observed current density. Combined, these measurements are consistent with the current flowing through incompressible regions whose spatial structure can change throughout the QAH regime.
At sufficiently high currents in the QAH regime and generally outside the QAH regime, we observe a weak response of the magnetization to the applied current. We show that this response can be explained by current-induced heating of the electrons. Effectively this allows us to image local dissipation in the QAH regime. As an example, I will show images of hot-spots localized in the corners of the electrical contacts through which the transport current enters our devices.

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