Negative Delta-T Noise in the Fractional Quantum Hall Effect

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Noise is a fundamentally inescapable ingredient of any electronic device. While at first it may be regarded as a nuisance, it has now been broadly accepted as a key tool to improve our understanding of nanoscale conductors. Electronic noise is typically broken down into two contributions associated with different underlying physical phenomena. Thermal (or Johnson-Nyquist) noise is an equilibrium property, arising at finite temperature from the thermal motion of electrons. Shot noise manifests itself in a non-equilibrium situation, when current flows through a conductor, as a consequence of electrons being transmitted or reflected predominantly on a given side of the device. While this non-equilibrium situation is typically achieved by imposing a bias voltage on the device, an intriguing alternative was recently uncovered. Indeed, one can in principle work at zero voltage bias and instead connect the sample to two reservoirs at different temperatures.

This was realized experimentally using atomic-scale metallic junctions [1], where the authors showed that, while no net current was flowing through the device, as expected, a finite non-equilibrium noise signal was measured, which they dubbed "delta-T noise". This previously undocumented source of noise, distinct from thermoelectric effects, actually corresponds to some form of temperature-activated shot noise: it is purely thermal in origin, but only generated in a non-equilibrium situation.

Here, we propose to investigate the fate of delta-T noise in a prototypical strongly correlated state, namely the edge states of the fractional quantum Hall effect (FQHE). We study the current correlations of fractional quantum Hall edges at the output of a quantum point contact (QPC) subjected to a temperature gradient. Beyond the inherent interest in studying delta-T noise in such systems, it may help better understanding charge and heat transport in situations where strong electronic correlations are operating.

We show that the tunneling of Laughlin quasiparticles leads to a negative delta-T noise, in stark contrast with electron tunneling, a result which arises from the interplay of strong correlations and fractional statistics [2]. Moreover, varying the transmission of the QPC or applying a voltage bias across the Hall bar may flip the sign of this noise contribution, yielding signatures which can be accessed experimentally.

[1] O. Lumbroso, L. Simine, A. Nitzan, D. Segal, and O. Tal. Nature (London) 562, 240 (2018).

[2] J. Rech, T. Jonckheere, B. Grémaud, and T. Martin. Phys. Rev. Lett. 125, 086801, (2020).