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Current dissipation of ultracold atoms in an optical lattice

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We measure the current dissipation rate of fermionic ultracold atoms in an optical lattice. A quantum gas microscope enables high-resolution fluorescence imaging of atoms pinned to lattice sites. Using micron-scale periodic displacements of an underlying harmonic potential to provide an oscillating uniform force, we measure the global current response of the atoms for multiple frequencies within the lowest band. We observe that the current response scales linearly with the forcing, providing experimental verification that data is taken in the linear response regime. Broadening of the current response spectrum for increasing lattice depth, interaction strength, and density provides a measure of the rate of dissipation. This dissipation occurs purely due to fermion-fermion collisions, given the absence of phonons or impurities in our potentials. It is observed to require a finite lattice depth in order to break Galilean invariance, as well as to enable Umklapp scattering events, which play a significant role in the dynamics. Measured dissipation rates collapse onto the predictions of a kinetic theory under the wide range of conditions studied.

Primary authors: Mr ANDERSON, Rhys (University of Toronto); Dr WANG, Fudong (South University of Science and Technology); Mr VENU, Vijin (University of Toronto); Mr XU, Peihang (University of Toronto); Dr TROTZKY, Stefan (University of Toronto); Prof. CHEVY, Frederic (Laboratoire Kastler Brossel, Ecole Normale Superieure); Prof. THYWISSEN, Joseph (University of Toronto)

Presenter: Mr ANDERSON, Rhys (University of Toronto)

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