Nanoscale Devices for Dissipationless, Non-superconducting Wires?

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The discovery of superconductivity enabled the transport of electric charge without dissipation. Sustained, constructive work to develop sophisticated superconducting materials has led to enormous advances in the performance of superconductors and in raising their critical temperature. Interestingly, dissipation-free charge flow exists also in non-superconducting systems. Atoms, molecules, atomic clusters and mesoscopic conducting rings may carry such currents. Quantum-Hall systems also transport current loss-free if biased in a quantum-Hall plateau. Loss-free currents have furthermore been found to flow along the edges of topological insulators. In all systems described, dissipation-free transport is based on sustained quantum coherence and the suppression of inelastic scattering.

Here, we report on our search for further possibilities to realize loss-free charge flow in non-superconducting devices or wires. We present several proposals for nanoscale-devices to initiate a discussion of their properties and underlying principles and to trigger further developments of this novel approach.