Quantum Resistor-Capacitor Circuit with Majorana Fermions

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As electronic circuit is miniaturized on the nanometer scale, quantum coherence takes effect and transport properties get fundamentally different. For a ballistic conductor, Ohm's law breaks down and the conductance is quantized to multiples of h/e^2, where h is the Planck constant and e is the electron charge. For a small resistor-capacitor circuit, the charge relaxation resistance is also quantized to $h/2e^2$. We investigate the mesoscopic resistor-capacitor circuit consisting of a quantum dot coupled to spatially separated Majorana fermion modes in a chiral topological superconductor. The primary goal is to identify the role of each Majorana mode in relaxation resistance and compare it to the case of Dirac fermion mode.

We find substantially enhanced relaxation resistance due to the nature of Majorana fermions, which are their own anti-particles and composed of particle and hole excitations in the same abundance. Further, if only a single Majorana mode is involved, the zero-frequency relaxation resistance is completely suppressed due to a destructive interference. As a result, the Majorana mode opens an exotic dissipative channel on a superconductor which is typically regarded as dissipationless due to its finite superconducting gap.