Failure of conductance quantization in two-dimensional topological insulators due to non-magnetic impurities

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Despite topological protection and the absence of magnetic impurities, two-dimensional topological insulators display quantized conductance only in surprisingly short channels, which can be as short as 100 nm for atomically-thin materials. We show that the combined action of short-range non-magnetic impurities located near the edges and onsite electron-electron interactions effectively creates non-collinear magnetic scatterers, and, hence, results in strong back-scattering. The mechanism causes deviations from quantization even at zero temperature and for a modest strength of electron-electron interactions. Our theory provides a straightforward conceptual framework to explain experimental results, especially those in atomically-thin crystals, plagued with short-range edge disorder.