

Suppression of quantized heat flow by the dielectric response of a compressible strip at the quantum Hall edge

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We develop a unified perturbative framework for energy transport along a chiral quantum Hall edge coupled to a disordered, compressible strip. Treating the strip as a generic linear response environment characterized by its retarded susceptibility, we obtain leading corrections to both the heat flux carried by the edge plasmon and to its spectrum. Two generic regimes emerge: (i) a gapped, local dielectric response with finite-range coupling, producing a negative correction to the quantized heat flux that scales as T^4 at low temperatures together with a convex cubic shift of the plasmon dispersion; and (ii) a hydrodynamic (diffusive) response with relaxation, yielding a crossover from T^4 to $T^{3/2}$ scaling and a change of sign in the correction. We further introduce a microscopic dipolar model in which the edge couples electrostatically to localized dipole moments inside a wide compressible strip. This long-range interaction amplifies the nonlocal dielectric back-action and generates new suppression laws, T^3 or even T^2 for smooth disorder profiles, together with a universal ratio connecting spectral curvature to thermal response. Across all regimes, the total heat flux remains quantized: the apparent deficit of the plasmon contribution reflects reversible heat drag into the compressible strip rather than a breakdown of quantization. The framework thus provides a coherent and quantitatively plausible explanation of the “missing heat flux” anomaly and unifies the thermal and spectral signatures of quantum Hall edge dynamics.