Quantized heat flow in the Hofstadter butterfly

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When subjected to a strong magnetic field, electrons on a two-dimensional lattice acquire a fractal energy spectrum called Hofstadter's butterfly. In addition to its unique recursive structure, the Hofstadter butterfly is intimately linked to non-trivial topological orders, hosting a cascade of ground states characterized by non-zero topological invariants. These states, called Chern insulators, are usually understood as replicas of the ground states of the quantum Hall effect, with electrical and thermal conductances that should be quantized, reflecting their topological order. The Hofstadter butterfly is now commonly observed in van-der-Waals heterostructures-based moiré superlattices. However, its thermal properties, particularly the quantized heat flow expected in the Chern insulators, have not been investigated, potentially questioning their similarity with standard quantum Hall states. Here we probe the heat transport properties of the Hofstadter butterfly, obtained in a graphene / hexagonal boron nitride moiré superlattice. We observe a quantized heat flow, uniquely set by the topological invariant, for all investigated states of the Hofstadter butterfly: quantum Hall states, Chern insulators, and even symmetry-broken Chern insulators emerging from strong electronic interactions. Our work firmly establishes the universality of the quantization of heat transport and its intimate link with topology.

References

[1] A. Zhang, *et al.*, arXiv:2601.05694 (2026)

Figures

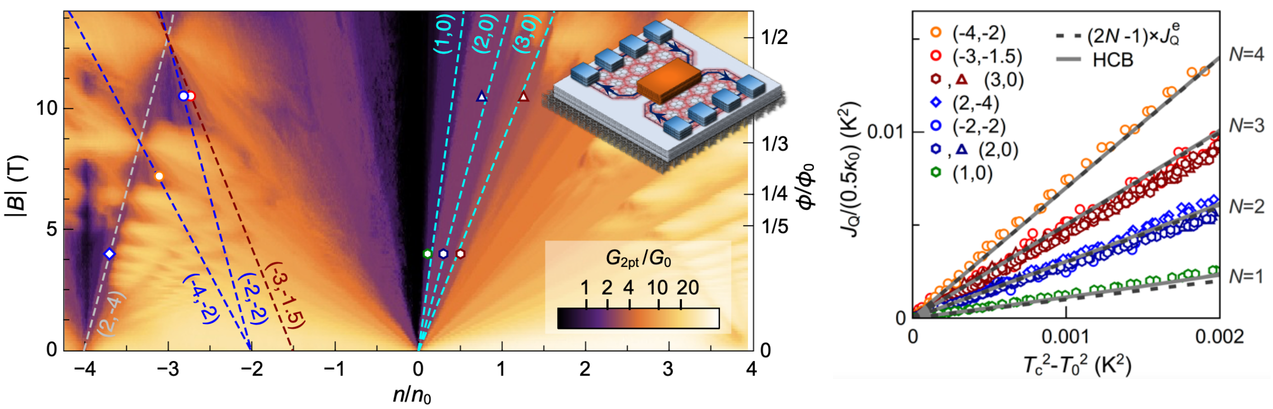

Figure 1: Left: electrical 2-point conductance of our device versus density and magnetic field. Dashed lines indicate the quantized topological insulator states probed in the experiment, labelled by the solutions *(t,s)* of the Diophantine equation. Right: heat flow versus squared temperature, for all states shown on the left panel. Dashed lines: quantized heat flow prediction with *N* channels per edge. Full lines: heat flow prediction including strong interaction effects.