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Quantization of heat flow in the fractional quantum Hall regime

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Quantum mechanics sets an upper bound on the amount of charge flow as well as on the amount of heat flow in ballistic one-dimensional channels. The two relevant upper bounds, which combine only fundamental constants, are the quantum of the electrical conductance $G_e=e^2/h$, and the quantum of the thermal conductance $G_{th}=\kappa_0 T=(\pi^2 k_B^2/3h)T$ – e electron charge, h Planck's constant, k_B Boltzmann's constant, T temperature. Remarkably, the latter does not depend on particles' charge or their exchange statistics, and, moreover, it is expected to be insensitive to the interaction strength among the particles. Yet, unlike the relative ease in observing the quantization of the electrical conductance, measuring (relatively) accurately the thermal conductance is more challenging.

The quantization of G_{th} in 1D ballistic channels was demonstrated for weakly interacting particles: phonons [1], photons [2], and an electronic Fermi-liquid [3]. I will describe our recent experiments with heat flow in chiral edge modes in a strongly interacting system of 2D electrons in the fractional quantum Hall regime. In the lowest Landau level we studied particle states (filling factor, $\nu<½$) and the more complex hole-conjugate states ($½<\nu<1$), with the latter carrying counter-propagating chiral modes: downstream charge and upstream neutral [4]. We verified the quantization of G_{th} of the charged as well as of the neutral chiral edge modes. In the first-excited Landau level ($2<\nu<3$), we studied the main fractional states, $\nu=7/3$, 5/2, 8/3. Concentrating on the even-denominator $\nu=5/2$ state, we found fractional quantization of the thermal conductance $G_{th}=(2+½)\kappa_0 T$, providing a definite mark of a non-abelian nature of the $\nu=5/2$ state, harboring the sought after Majorana excitations [5].

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