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Heat coulomb blockade and teleportation of electrons: two manifestations of the Coulomb interaction in small metallic islands connected with ballistic channels

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What are the laws describing small circuits assembled from several quantum components? Here we address experimentally the elementary case of a ballistic circuit with a single node, realized by a micron-scale metallic island connected only by perfect electronic quantum channels. In this regime, the electrical conductance is simply given by the classical composition of one electrical conductance quantum per channel. However, we observe that a single quantum channel is universally suppressed for the flow of heat, in violation of the widespread Wiedemann-Franz relation between thermal and electrical conductances. This results from the suppression of the fluctuations of the island's charge at low temperature. In the limit case of a single channel, theory not only predicts a full heat blockade, but that no information can be transferred from the many quasiparticles inside the metallic island through the electrically connected channel. A striking consequence is that the quantum state of each electron penetrating inside the island is imprinted into the quantum state of another, indiscernible electron simultaneously emitted. Such a form of electron teleportation is established between well-separated injection and emission locations, through two-path interferences in the integer quantum Hall regime.