Charging effects with ballistic contacts from heat Coulomb blockade to electron state transmission

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Quantum mechanics and Coulomb interaction rule heat and charge transport in small circuits, giving rise to many-body phenomena (Coulomb blockade, Luttinger liquids, Kondo effect…). Whereas many experiments investigate the electrical signatures, the thermal consequences remain barely explored.

I will first present heat quantum transport measurements across ballistic contacts, allowing us to observe the quantum of thermal conductance [1], a very fundamental quantity, and to evidence a form of Coulomb blockade applying to the flow of heat but not of electricity [2].

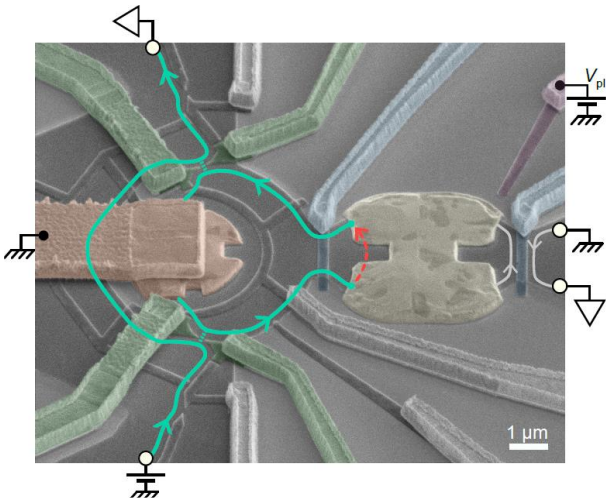

Fig. 1: *E-beam micrograph of an electronic Mach-Zehnder interferometer employed to test the fidelity of the non-local quantum state transmission of electrons across a metallic island (visually represented by a red dashed line).*

Then I will show that this heat Coulomb blockade mechanism provides a mean to transmit the quantum state of electrons. Because of the link between heat, entropy and information, heat Coulomb blockade can suppress unwanted transfer of information to other degrees of freedom. A remarkable consequence is that it allows for transmitting at a distance the quantum state of electrons [3]. This form of electron teleportation was demonstrated across a micrometer-size metallic island, by inserting it in a two-path quantum interferometer [4].

These experiments constitute a first step towards understanding, controlling and exploiting heat quantum phenomena in electronic nano-circuits.

References:

[1] *e.g.* K. Schwab *et al.*, Nature **404**, 974 (2000) ; S. Jezouin *et al.,* Science **342**, 601 (2013)
[2] E. Sivre *et al.*, Nat. Phys. **14**, 145 (2018)
[3] A. Clerk *et al.* Phys. Rev. Lett. **87**, 186801 (*2001*) ; Idrisov *et al.,* Phys. Rev. Lett. **121**, 026802 (2018)
[4] H. Duprez *et al.*, Science **366**, 1243 (2019)