physikalisches Kolloquium

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Quantum thermodynamics in mesoscopic circuits

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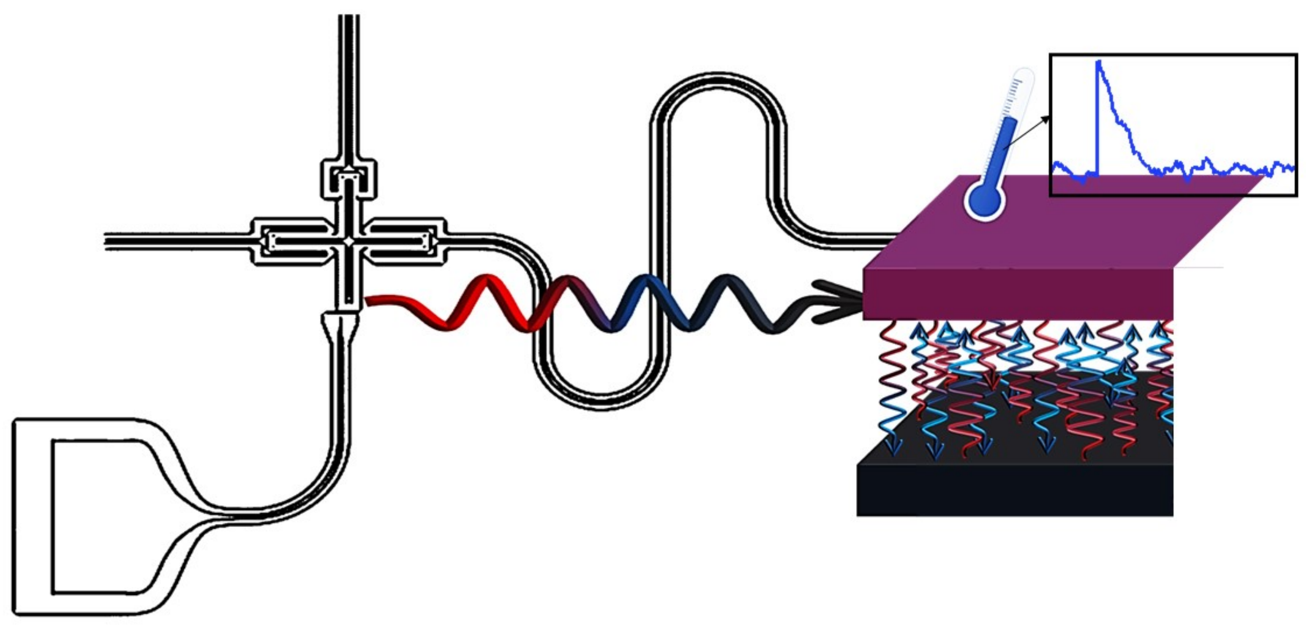
In this talk, we present both experimentally and theoretically our work on phenomena and devices in quantum thermodynamics realized by superconducting and metal circuits on a chip at low millikelvin temperatures. In these modern superconducting circuits, which form open quantum systems, we couple them to engineered heat baths.

Besides fundamental interest, this approach allows us to develop different types of quantum thermodynamic devices like quantum heat valves and rectifiers, refrigerators and heat engines, quantum thermometers, and ultrasensitive calorimeters [1,2,3]. In this talk we will describe our recent and on-going work in these directions. Importantly, we demonstrate detection of equilibrium fluctuations of temperature in a system of about 100 million electrons exchanging energy with phonon bath at a fixed temperature [4]. We show theoretically that this detector is capable of observing single microwave photons in a continuous manner [5]. We propose a cross-correlation measurement technique to enhance the sensitivity of the quantum detector [6].

References
[1] Jukka P. Pekola and Bayan Karimi, Rev. Mod. Phys. 93, 041001 (2021).
[2] Alberto Ronzani et al., Nat. Phys. 14, 991 (2018).
[3] Jorden Senior et al., Commun. Phys. 3, 40 (2020).
[4] B. Karimi et al., Nat. Commun. 11, 367 (2020).
[5] B. Karimi and J. P. Pekola, Phys. Rev. Lett. 124, 170601 (2020).
[6] J. P. Pekola and B. Karimi, Phys. Rev. X 12, 011026 (2022).



A central tool in quantum thermodynamics is a thermometer measuring the heat absorbed in a mesoscopic bath. Here we depict the idea of a calorimetric measurement due to a single absorption event [4].

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