Measuring heat current and its fluctuations in superconducting quantum circuits

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I present recent work of the PICO group on thermodynamics of quantum systems. Superconducting circuit QED (Quantum Electro-Dynamics) presents a prominent platform for this purpose. Here, we investigate a superconducting qubit coupled between two nominally identical coplanar waveguide (CPW) resonators, each terminated by a normal-metal mesoscopic resistor as a heat bath. We observe tunable photonic heat transport through the resonator-qubit-resonator assembly when the temperatures of the two heat baths are unequal. Using a theoretical model here developed, we are able to reproduce experimental data. The reservoir-to-reservoir heat flux depends on the interplay between the qubit-resonator and the resonator-reservoir couplings, yielding qualitatively dissimilar results in different coupling regimes [1].

Importantly, in order to detect noise of the heat current and single microwave quanta, one needs fast and sensitive nanocalorimetry [2]. We present non-invasive rf-thermometry based on proximitized tunnel contact between normal metal and a superconductor [3]. We expect theoretically [4] and test experimentally heat current noise both under equilibrium and non-equilibrium conditions. In the talk I present preliminary experimental results.

Acknowledgements: This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 766025. We acknowledge the facilities and technical support of Otaniemi research infrastructure for Micro and Nanotechnologies (OtaNano).

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