Mastering the thermal transport in mesoscopic systems: from heat logic to photon detection

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Abstract: Since the first studies of thermodynamics, heat transport has been a crucial element for the understanding of any thermal system. Quantum mechanics has introduced new appealing ingredients for the manipulation of heat currents, such as the long-range coherence of the superconducting condensate [1]. The latter has been exploited by phase-coherent caloritronics [2], a young field of nanoscience, to realize Josephson heat interferometers [3], which can control electronic thermal currents as a function of the external magnetic flux. In this talk, I will introduce the main heat transport mechanisms in mesoscopic superconducting systems. In particular, I will report the experimental realization of the first thermal SQUID [3] and of a phase-tunable thermal router [4] able to control the heat transferred between two terminals residing at different temperatures. Thanks to the Josephson effect, our structure allows to regulate the thermal gradient between the output electrodes until reaching its inversion. Together with interferometers, heat diodes, and thermal memories, the thermal router represents a fundamental step toward the thermal conversion of nonlinear electronic devices and the realization of caloritronic logic components [5,6]. Finally, I will show how the marriage of heat mastering and electronic charge control in superconducting systems brings to the realization of new concepts for ultra-sensitive radiation sensors [7]. In particular, I will present theoretical and experimental (preliminary) results on a new category of cryogenic radiation sensors based on the conversion of temperature in a change of superconducting phase (TPC).

References:

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