Thermometry based on proximity superconductivity for ultra-sensitive calorimetry

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We present a radio-frequency thermometer based on a zero-bias anomaly of a tunnel junction between a superconductor and proximitized normal metal [1]. It features noninvasive detection and essentially uncompromised sensitivity down to the lowest temperatures of below 20 mK in contrast to commonly used finite bias thermometers that dissipate orders of magnitude more power and lose their sensitivity at low temperatures. Using this thermometer we demonstrate detection of equilibrium fluctuations of temperature in a system of about 10^8 electrons exchanging energy with phonon bath at a fixed temperature [2]. Moreover, temperature fluctuations under nonequilibrium conditions present a nontrivial dependence on the chemical potential bias of a hot electron source. These fundamental fluctuations of temperature set the ultimate lower bound of the energy resolution of a calorimeter.

[1]B. Karimi and J. P. Pekola *Noninvasive Thermometer Based on the Zero-Bias Anomaly of a Superconducting Junction for Ultrasensitive Calorimetry*, Phys. Rev. Appl. **10**, 054048 (2018).
[2]B. Karimi, F. Brange, P. Samuelsson, and J. P. Pekola *Observing temperature fluctuations of a mesoscopic electron system*, arXiv:1904.05041 (2019).