Extremely Sensitive Microwave Bolometer Suitable for Quantum Sensing

J. Govenius, R. E. Lake, R. Kokkoniemi, V. Vesterinen, M. A. Gunyho, K. Y. Tan, and **M. Möttönen**

QCD Labs, Department of Applied Physics, Aalto University, 00076 Aalto, Finland

Intense development of nanobolometers has taken place for well more than a decade with the aim to reach NEP $= 10^{-20}$ W/$\sqrt{\text{Hz}}$ which is required, for example, in efficient measurements of the galactic terahertz spectrum in space[1]. Furthermore, observation of single photons at increasingly long wavelengths is a long-standing effort. We present a microwave nanobolometer based on superconductor–normal-metal–superconductor Josephson junctions. Using positive electrothermal feedback, we show that we can achieve a single-shot detection fidelity of 0.56 for 1.1-zJ pulses of 8.4-GHz photons[2]. This is more than an order of magnitude improvement over the previous thermal detectors. In our preliminary experiments, we observe that we can reach a sensitivity of NEP $\approx 2 \times 10^{-20}$ W/$\sqrt{\text{Hz}}$ with our detector in the linear mode. Further improvements are expected with the integration of the detector readout with near-quantum-limited amplifiers. This allows the use of non-classical readout signals going possibly beyond the standard quantum limit. In the future, ultrasensitive bolometers and thermometers[3] are expected to play an important role in quantum information processing and quantum thermodynamics.

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