DETECTION OF ZEPTOJOULE MICROWAVE PULSES USING ELECTROTHERMAL FEEDBACK

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Superconducting qubits coupled to microwave transmission lines have developed into a versatile platform for solid-state quantum optics experiments [1], as well as a promising candidate for quantum computing [2]. However, in contrast to optical frequencies, at microwave frequencies we still lack efficient detectors for itinerant single-photon pulses [3].

We focus on thermal photodetectors, which have recently been proposed also as monitorable heat baths for experiments on quantum thermodynamics [4]. Recently, Gasparinetti et al. [5] have demonstrated a temperature sensitivity of 90 μK/$\sqrt{\text{Hz}}$ in the readout of such detectors.

We experimentally investigate and utilize electrothermal feedback in a microwave photodetector developed in Ref. [6]. The feedback couples the temperature and the electrical degrees of freedom in the central component of the detector, a metallic nanowire that absorbs the incoming microwave radiation and transduces the temperature change into a radio-frequency electrical signal. We tune the feedback in situ and access both positive and negative feedback regimes with rich nonlinear dynamics. In particular, strong positive feedback leads to the emergence of two metastable electron temperature states in the millikelvin range. We use these states for efficient threshold detection of 8.4-GHz microwave pulses containing approximately $200 \times h \times 8.4$ GHz ≈ 1.1 zJ ≈ 7.0 meV of energy [7]. To our knowledge, this energy resolution is an order of magnitude improvement over previous thermal detectors.

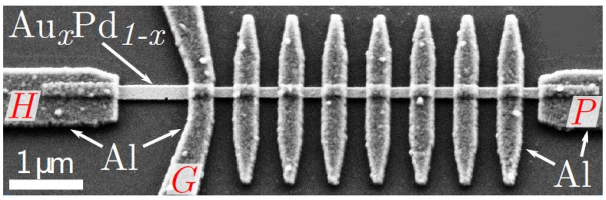

Figure: Micrograph of the bolometer showing a normal-metal Au_xPd_{1-x} nanowire contacted to superconducting Al islands and leads.

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