Bolometer operating at the threshold for circuit quantum electrodynamics

Systems

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2020

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ABSTRACT

Radiation sensors based on the heating effect of absorbed radiation are typically simple to operate and flexible in terms of input frequency, so they are widely used in gas detection[1], security[2], terahertz imaging[3], astrophysical observations[4] and medical applications[5]. Several important applications are currently emerging from quantum technology and especially from electrical circuits that behave quantum mechanically, that is, circuit quantum electrodynamics[6]. This field has given rise to single-photon microwave detectors[7,8,9] and a quantum computer that is superior to classical supercomputers for certain tasks[10]. Thermal sensors hold potential for enhancing such devices because they do not add quantum noise and they are smaller, simpler and consume about six orders of magnitude less power than the frequently used travelling-wave parametric amplifiers[11]. However, despite great progress in the speed[12] and noise levels[13] of thermal sensors, no bolometer has previously met the threshold for circuit quantum electrodynamics, which lies at a time constant of a few hundred nanoseconds and a simultaneous energy resolution of the order of 10h gigahertz (where h is the Planck constant). Here we experimentally demonstrate a bolometer that operates at this threshold, with a noise-equivalent power of 30 zeptowatts per square-root hertz, comparable to the lowest value reported so far[13], at a thermal time constant two orders of magnitude shorter, at 500 nanoseconds. Both of these values are measured directly on the same device, giving an accurate estimation of 30h gigahertz for the calorimetric energy resolution. These improvements stem from the use of a graphene monolayer with extremely low specific heat[14] as the active material. The minimum observed time constant of 200 nanoseconds is well below the dephasing times of roughly 100 microseconds reported for superconducting qubits[15] and matches the timescales of currently used readout schemes[16,17], thus enabling circuit quantum electrodynamics applications for bolometers.

The full article can be found here:
https://www.nature.com/articles/s41586-020-2753-3