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Observation of quantum-limited heat conduction over macroscopic distances[1] MIKKO MOTTONEN, MATTI PARTANEN, KUAN YEN TAN, JOONAS GOVENIUS, RUSSELL LAKE, MIIKA MAKELA, TUOMO TANTTU, QCD Labs, Department of Applied Physics, Aalto University, Finland — The emerging quantum technological devices, such as the quantum computer, call for extreme performance in thermal engineering at the nanoscale. Importantly, quantum mechanics sets a fundamental upper limit for the flow of information and heat, which is quantified by the quantum of thermal conductance. We present experimental observations of quantum-limited heat conduction over macroscopic distances extending to a meter. We achieved this striking improvement of four orders of magnitude in the distance by utilizing microwave photons travelling in superconducting transmission lines. Thus it seems that quantum-limited heat conduction has no fundamental restriction in its distance. This work lays the foundation for the integration of normal-metal components into superconducting transmission lines, and hence provides an important tool for circuit quantum electrodynamics, the basis of the emerging superconducting quantum computer. In particular, our results may lead to remote cooling of nanoelectronic devices with the help of a far-away in-situ-tunable heat sink.

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