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Quantum-Circuit Refrigerator[1] MIKKO MTTNEN, KUAN Y. TAN, SHUMPEI MASUDA, MATTI PARTANEN, RUSSELL E. LAKE, JOONAS GOVENIUS, MATTI SILVERI, QCD Labs, Department of Applied Physics, Aalto University, Finland, HERMANN GRABERT, Physikalisches Institut, Universitt Freiburg, Germany — Quantum technology holds great potential in providing revolutionizing practical applications. However, fast and precise cooling of the functional quantum degrees of freedom on demand remains a major challenge in many solid-state implementations, such as superconducting circuits. We demonstrate direct cooling of a superconducting resonator mode using voltage-controllable quantum tunneling of electrons in a nanoscale refrigerator. In our first experiments on this type of a quantum-circuit refrigerator [1], we measure the drop in the mode temperature by electron thermometry at a resistor which is coupled to the resonator mode through ohmic losses. To eliminate unwanted dissipation, we remove the probe resistor and directly observe the power spectrum of the resonator output in agreement with the so-called P(E) theory. We also demonstrate in microwave reflection experiments that the internal quality factor of the resonator can be tuned by orders of magnitude. In the future, our refrigerator can be integrated with different quantum electric devices, potentially enhancing their performance. For example, it may prove useful in the initialization of superconducting quantum bits and in dissipation-assisted quantum annealing. [1] K. Y. Tan et al., arXiv:1606.04728 (2016).

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Mikko Mttnen
Aalto University

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