Quantum thermal machines based on microwave resonators coupled to a Josephson junction

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We propose a heat engine, an absorption refrigerator, and a thermometer based on microwave resonators coupled to a Josephson junction. These machines have universal efficiencies that only depend on the frequencies of the resonators and can reach the Carnot value at vanishing output power. This leads to intriguing effects such as a separation of heat and work for the heat engine and coherence enhanced cooling for the refrigerator. Their smallness and conceptual simplicity make these machines ideal test-beds to study thermodynamics in quantum systems. Furthermore, we show that the machines are powerful and efficient for realistic system parameters and can be used to sensitively measure temperatures in the milli-Kelvin regime.