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Exploring Experimental Parameters for the Realization of a One-Photon and One-Qubit Heat Engine

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Quantum systems are deeply influenced by thermodynamics on the microscopic level. A common macroscopic system, the heat engine, uses a thermodynamic cycle to produce work. A macroscopic quantum heat engine can be created by coupling a resonant microwave cavity to a single superconducting transmon qubit and varying the magnetic flux over the system, which uses the coupled eigenstates of the cavity and qubit as the work-generating "stroke" of a thermodynamic cycle. This study examines the theory behind such a system, as well as examples of quantum heat engines using other techniques such as trapped ions, for the purpose of determining a useful and realizable set of parameters to create a one-photon one-qubit heat engine in our own laboratory environment. Further, operating the cycle in reverse would create a heat pump, which under appropriate conditions could have the ability to pull energy from a secondary system in a thermally observable way.