

Quantum bath engineering and quantum error correction in circuit QED

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Recent remarkable experimental progress in ‘circuit QED’ has dramatically extended the phase coherence times of superconducting qubits and now allows realization of extremely strong dispersive coupling between these qubits and microwave photons in resonators. This together with the ability to do quantum bath (reservoir) engineering yields a ‘quantum toolbox’ that permits universal control (unitary and dissipative) of qubit and resonator states, the ability to perform quantum many-body simulations, and the ability to test new error correction codes which extend the lifetime of quantum information stored in the collective system beyond the time it could be stored in the best individual component of the system. Paradoxically, some of these successful codes are based on Schrödinger cat states, normally thought to be extremely fragile holders of quantum information. These ‘cat codes’ are members of a general class of quantum error correction codes which store quantum information in coherent superpositions of photon Fock states and which can survive various errors including photon loss, gain and dephasing.