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Autonomously stabilized entanglement between two superconducting qubits[1]

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Quantum error-correction codes are designed to protect an arbitrary state of a multi-qubit register against decoherence-induced errors, but their implementation is an outstanding challenge for the development of large-scale quantum computers. A first step is to stabilize a non-equilibrium state of a simple quantum system such as a qubit or a cavity mode, in the presence of decoherence. Several groups have recently accomplished this goal using measurement-based feedback schemes. A next step is to prepare and stabilize a state of a composite system. Here we demonstrate the stabilization of an entangled Bell state of a quantum register of two superconducting qubits for an arbitrary time. Our result [1] is achieved by an autonomous feedback scheme which combines continuous drives along with a specifically engineered coupling between the two-qubit register and a dissipative bath. Similar bath engineering techniques have recently been used for qubit reset, single qubit state stabilization, as well as for the creation and stabilization of states of multipartite quantum systems. Unlike conventional, measurement-based schemes, an autonomous approach which uses engineered dissipation to counteract decoherence, obviates the need for a complicated external feedback loop to correct errors. Instead the feedback loop is built into the Hamiltonian such that the steady state of the system in the presence of drives and dissipation is a Bell state, an essential building-block for quantum information processing. Such autonomous schemes, which are broadly applicable to a variety of physical systems, will be an essential tool for the implementation of quantum-error correction.

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