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Engineering artificial Hamiltonians with parametric superconducting circuits YAO LU, SRIVATSAN CHAKRAM, NELSON LEUNG, RAVI NAIK, NATHAN EARNEST, James Franck Institute and Department of Physics, University of Chicago, PETER GROSZKOWSKI, JENS KOCH, Department of Physics Astronomy, Northwestern University, ELIOT KAPIT, Department of Physics Engineering Physics, Tulane University, DAVID SCHUSTER, James Franck Institute and Department of Physics, University of Chicago — One major challenge in building a large scale quantum computer is to generate and manipulate interactions between its many qubits. One promising approach is to use parametric flux or voltage modulation to realize effective interactions between different components of superconducting circuits, generating artificial Hamiltonians that are suitable for various quantum computation tasks, which might be difficult to achieve through other means. We propose a parametric superconducting circuit where transmon qubits and resonators are coupled to a flux-modulated parametric coupler. We show that with this device, arbitrary pairs of qubits or resonators in the circuit can be selectively and simultaneously brought into resonance with each other and swap excitations at a controllable rate. This allows for the creation of various artificial circuit Hamiltonians that are suitable for a number of applications such as single qubit state stablization, parametric qubit state readout, autonomous error correction and so on.

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