V-shape artificial atom based on superconducting quantum circuit

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Abstract

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We present an experimental study on two transmons (i.e., small capacitively shunted Josephson junctions) coupled via a large inductance [1]. The resulting circuit exhibits a symmetric and an antisymmetric oscillation [2] which we use as a transmon and ancilla qubit, respectively. We observe a cross-Kerr-like coupling of the two oscillations which is explained by the Josephson nonlinearity [1]. This coupling leads the artificial atom to a have V-shape energy diagram.

We have predicted that such V-shape artificial atom allows to read out the transmon qubit state by using the ancilla qubit frequency [3]. In comparison with the most widely employed readout scheme for superconducting qubits, the dispersive readout in circuit quantum electrodynamics architecture, this approach promises a quantum non-demolition measurement with a significantly stronger measurement signal and without suffering from Purcell effect. In a measurement chain based on a state-of-the-art Josephson parametric amplifier, we predict a QND fidelity of up to 99.9% for a measurement time down to 60 ns [3]. This should allow the measurement of quantum trajectories and the testing of some new concepts of quantum thermodynamics.

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