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Realizing Quantum Computing and Quantum Optics Using Microwave Circuit QED

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In the talk, I will give a review on the microwave circuit QED system (cQED) as one of the promising solid-state based architecture to realize quantum computing. The circuit QED system consists of a Cooper pair box (CPB) located inside a high Q coplanar waveguide resonator, which can induce a strong coherent coupling between microwave photons and a qubit made of Josephson junction. The coupling strength of cQED system can be about 10^4 times as large as that of Alkali atom-based cavity QED. Unlikely from cavity QED, the physical parameters of qubit can be artificially controlled. This led to the first experimental demonstration of a strong coupling of a qubit and a *single* photon, and can make the unexplored regime of quantum optics readily available. We study theoretically the parametric down conversion and squeezing of microwaves, where the qubit is located at one end of the central transmission line resonator. The non-linear susceptibility describing three-wave mixing can be tuned by dc gate voltage applied to the CPB and vanishes by symmetry at the charge degeneracy point. We show that the coherent coupling of different cavity modes through the qubit can generate a squeezed state. Based on parameters realized in recent successful circuit QED experiments, squeezing of 95%~13dB below the vacuum noise level should be readily achievable.

Keywords : Quantum computing, circuit QED, squeezing

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