QUANTUM INFORMATION PROCESING WITH MICROWAVE PHOTONIC STATES IN SUPERCONDUCTING JOSEPHSON CIRCUITS

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Josephson effect is widely used in microwave electronics for building nonlinear and lossless circuit elements. However, the unique combination the nonlinearity and absence of dissipation becomes truly significant in the quantum regime. Here the Josephson circuits function as controllable artificial atoms, which makes them indispensable building blocks for quantum information processing.

In this talk I review recent progress in research on quantum parametric phenomena in superconducting electrical circuits. This research is part of emerging and rapidly growing quantum information technology based on superconducting Josephson junctions - circuit quantum electrodynamics (c-QED). Recent attention to parametric effects in c-QED was motivated by practical needs for ultrasensitive quantum limited amplifiers for detection of extremely weak, of single-photon intensity microwave signals that carry information about superconducting qubits. Exploration of c-QED parametric devices reveals a wide range of remarkable quantum effects, such as dynamical Casimir effect, ultrastrong light-matter interaction, vacuum squeezing, photonic quantum cat states.

I will discuss recent experiments on parametric amplification and frequency conversion, self-sustained parametric oscillations and oscillations with period multiplying. I will also outline a novel approach to quantum information processing within c-QED, which is based on encoding quantum information in parametrically generated photonic cat states.