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Titel des Beitrags: Quantum theory of the dissipative Josephson parametric amplifier
Abstract: Recent research in superconducting quantum circuits operating close to the quantum limit results in the need of a quantum mechanical treatment of losses. Of special interest is the dynamic behaviour of an open quantum system. As an example, a negative-resistance Josephson parametric amplifier is treated. The DC bias voltage is chosen such that a strong interaction between the Josephson junction and the two resonant circuits, the signal and the idler circuit, is achieved. Power exchange occurs between the two considered resonator modes and also between the resonator modes and the DC power supply. Losses in the resonators are modeled by the quantum Langevin method, which describes the losses by coupling the resonators to a heat bath representing a photon gas in thermal equilibrium. The derived dynamic behaviour does not provide signal energy saturation, like classically expected for parametric amplifiers. Introducing a phenomenological multi-photon coupling approach, saturation of the amplified signal is ensured. The time evolution of the signal and noise energy is calculated and numerically evaluated for a specific example in cases of both, the quantum Langevin method with and without the phenomenological multi-photon coupling approach.

Stichworte: Josephson effect; negative-resistance Josephson parametric amplifier; lossy quantum circuits; quantum Langevin method; nanoelectronics;
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