Quantum conductors as non-classical light emitters

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Abstract

Hybrid architectures integrating mesoscopic conductors in microwave cavities have a great potential for investigating unexplored regimes of electron–photon coupling. Quantum circuits can thus be taylored to significantly increase the effective fine structure constant which characterizes matter-light interaction. In this context, producing nonclassical radiation, such as a squeezed vacuum state, is a key step towards quantum communication with scalable solid-state devices. We will discuss how a tunnel junction is able to generate a squeezed steady state in a microwave cavity when excited parametrically by a classical AC voltage source. Photon-assisted tunneling of electrons is accompanied by the emission of pairs of photons in the cavity, thereby engineering a driven squeezed state. The mechanism leading to squeezing differs from parametric amplifiers as it is steered by dissipation. For a tunnel junction, we show theoretically that squeezing can be optimized by a pulse shape consisting of a periodic series of delta peaks. Squeezing is generally enhanced by non-linearities. We also find perfect squeezing in the case of a tunnel junction affected by a strong dynamical Coulomb blockade environment.

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