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# Circuit quantum electrodynamics with semiconductor quantum dots

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Circuit quantum electrodynamics (circuit QED) advanced thanks to the development of the field of quantum circuit which find applications not only as quantum bits for quantum information processing but also in the linear and nonlinear manipulation of quantum microwave fields. Circuit QED with quantum dots (QDs) is a platform where quantum dots act as artificial atoms that interact with microwave photons in superconducting circuits, enabling the study of light-matter interaction at the quantum level.

After providing an overview of the field, I will present theoretical proposals for generating entangled photons and detecting single microwave photons by utilizing coherent nanoconductors as quantum sources and detectors, harnessing the unique properties of superconducting and semiconducting nanostructures in combination with microwave quantum devices.

In a first work [1], we explore a proposal to transfer entanglement from a many-body quantum condensate —specifically, a BCS superconductor—to microwave photons propagating in transmission lines. We demonstrate the potential to generate pairs of frequency-entangled photons from electrons emitted by a superconducting nanoscale quantum device known as a "Cooper pair splitter."In a second work [2], we study quantum dots dispersively coupled to a microwave resonant cavity, enabling Quantum Non-Demolition (QND) detection of individual itinerant microwave photons.

[1] M. Governale, C. Schönenberger, P. Scarlino, and G. Rastelli,
"Entangled Photon-Pair Emission in Waveguide Circuit QED from a Cooper Pair Splitter"PRX Quantum 6, 020339 (2025)
https://physics.aps.org/articles/v18/s70 (Physics Magazine)
[2] S. Matern, A. Biella, P. Scarlino, I. Carusotto, G. Rastelli,
"Quantum nondemolition detection of single microwave photons with quantum dots" (to be submitted)

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