Circuit Quantum Electrodynamics with Semiconductor Quantum Dots

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Abstract: I will present theoretical proposals for generating entangled photons using circuit quantum electrodynamics architecture based on semiconductor quantum dots coupled to microwave resonators.

The emergent field of circuit quantum electrodynamics (circuit QED) implemented with semiconductor QDs (quantum dots) coupled to microwave photon cavities provides an experimental playground to study light-matter interactions in electronic circuits. Compared to other architectures, these systems represent a qualitatively new tool. They open a route to explore correlations between charge transport and emitted radiation.

In particular, a key aspect is the ability to transfer entanglement between different types of entities, such as electrons and photons. This hybrid quantum system can therefore serve as a quantum transducer, connecting engineered quantum systems of varying nature.

I will present proposals for generating entangled photons using: [1] A double QD device operating as a single-electron splitter interferometer, and [2] a BCS superconductor-based Cooper pair splitter to generate frequency-entangled photons in microwave transmission lines (Fig.1).

Our proposals hold promise as a powerful resource for quantum technologies, enabling the on-demand generation of quantum entangled photons in the microwave domain.

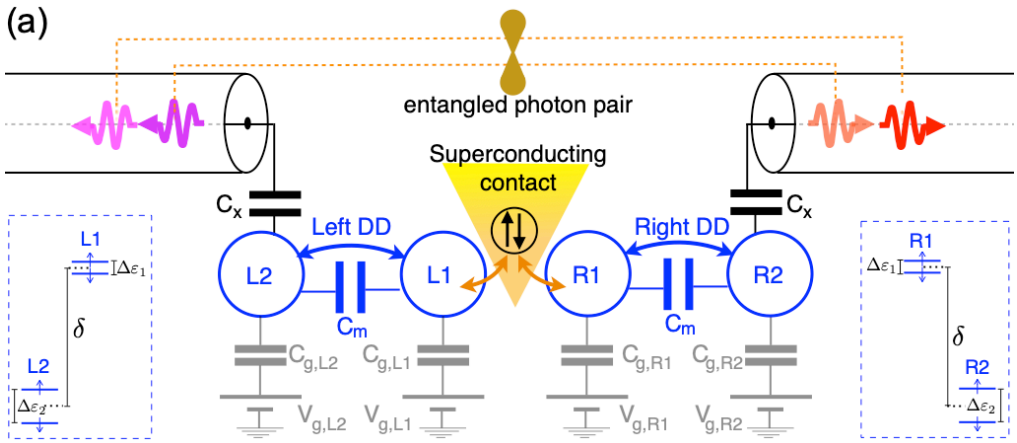

Fig. 1 The Schematic picture of a Cooper Pair Splitter based on two Double Quantum Dots (DD) and example of the entangled photon pair in frequency.

References

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[2] M. Governale, C. Schönenberger, P. Scarlino, and G. Rastelli, "Entangled photon-pair emission in circuit QED from a Cooper pair splitter", arXiv:2407.15109 (2024).