Many-body quantum optics with superconducting circuits

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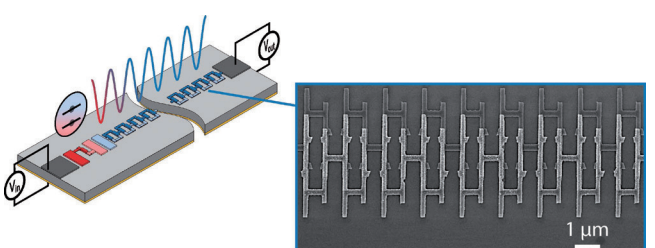
PHD GRANT

LABORATORY : NEEL

The use of superconducting circuits as building blocks for studying light matter interactions at the fundamental level was introduced more than a decade ago and is named Circuit Quantum ElectroDynamics (circuitQED). With this project we want to push these ideas to the next level and build circuits to explore many-body quantum optics. The key element of these circuits is the Josephson junction, two superconductors separated by a thin insulating barrier. Thanks to its huge non linear inductance it can be used for fabricating devices as: quantum two level systems (qubits), quantum limited amplifiers and high impedance transmission lines.



Artistic representation of the circuit. A transmon qubit (red) coupled to a chain of Josephson junctions (blue). In the inset an electronic microscope image of the array of Junctions is shown.

In this work we are interested in studying a qubit strongly coupled to an engineered environment containing many degrees of freedom. To enhance this coupling we need the impedance of the environment to be high. Using an array of 4700 Josephson junctions we can obtain such a high impedance.
We couple the qubit via coupling capacitors to the array and probe the system via microwave transmission measurements. We obtain a strong hybridization of the qubit levels with several modes of the environment obtaining a many-body system.

OUTCOMES

Publications: Probing a transmon qubit via the ultra-strong coupling to a Josephson waveguide. arXiv:1802.00633 (2018)

Oral presentations:

- GMD 26 2016 Groningen (Netherlands)
- APS March Meeting 2017 New Orleans (U.S.A)
- ICQSIM 2017 Paris (France).

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