Ultrastrong coupling regime in superconducting circuits using superinductor materials

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Superconducting circuits offer a versatile platform to control and study light-matter interaction beyond the strong coupling regime. In this context, qubits play the role of artificial atoms, LC resonators act as cavities and the shared capacitance or inductance between elements define the level of coupling [1].

From a circuit design point of view, the coupling coefficient can be engineered to take values of the order of the bare frequencies of the qubit and the resonator ($0.1 < g/\omega < 1$), allowing the study of the so-called ultrastrong coupling (USC) regime. The challenge of obtaining large inductive couplings can be overcome by using either shared Josephson junctions or superinductor materials showcasing large kinetic inductances such as granular aluminium [2, 3].

In this study we report the first experimental steps towards the exploration of novel phenomena and the characterization of the dynamics and coherence of the USC regime [4]. Particularly, we propose a circuit layout composed of a flux qubit galvanically coupled to an LC lumped-element resonator where each element can be probed with an independent feedline (Figure 1). Contrarily to previous studies, our design integrates superinductor materials to reach couplings within the range of the non-perturbative USC regime ($0.3 < g/\omega < 1$).

References

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Figures

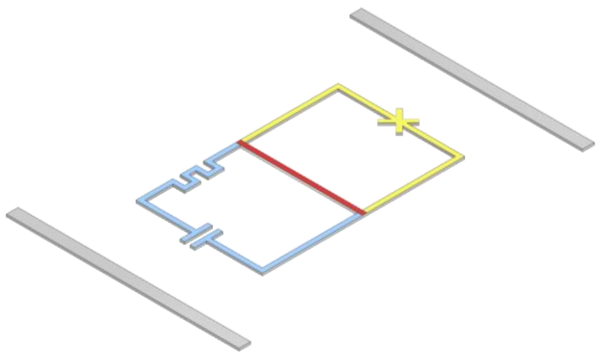

Figure 1: Schematics of the chip design. The qubit (yellow) is coupled to an LC resonator (blue) by means of a shared portion of the circuit (red). Two feedlines are designed to independently probe the qubit and the resonator.