High kinetic inductance platform for multimode circuit QED

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Photonic cavity arrays form the basis of one of the most promising paradigms for quantum simulation to study complex many-body physics. We developed a non-trivial structured photonic environment that could enable a multimode strong and ultra-strong coupling with quantum emitters. This platform consists of a unidimensional metamaterial implemented by an array of coupled superconducting microwave cavities made from thin Niobium Nitride (NbN) thin films. Such disordered superconductor allows to reach a very high kinetic inductance, which presents a two-fold advantage: a) It allows to reach ultra-strong coupling with an artificial atom as the capacitive coupling is proportional to the square root of the resonators' impedance, which can be highly increased thanks to the kinetic inductance; b) It allows to strongly reduce the resonator/metamaterial footprint. We demonstrate control over the platform by engineering the bandstructure of the coupled-cavity arrays in different regimes: trivial, topological (SSH), left-handedness… As a follow up step, we are combining transmon qubits with these structured environments. We show preliminary results of transmon qubits strongly interacting with these high-quality structured baths, displaying atom-photon bound states.