Probing Ultrastrong Coupling by Coherent Amplification of Population Transfer

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Manipulating multilevel coherence in architectures of artificial atoms is a key issue for achievements in both fundamental and applied physics. Fabrication techniques have recently allowed to produce ultrastrong coupling (USC) between light and matter, a regime where previously unexplored non-perturbative phenomena emerge. While experiments so far provided spectroscopic evidence of USC, we propose the dynamical detection of atom-cavity USC [1]. Indeed USC opens a new channel for photon-pair production, whose detection is a smoking gun its existence in Nature. We show how to coherently amplify this channel to 100Unambiguous detection of USC poses strong design constraints on quantum hardware, the requirements being uniquely met by superconducting artificial atoms (persistent current qubits), driven in the the Vee configuration. Besides its fundamental importance, dynamical detection of USC in state of the art systems would be a benchmark for quantum control in distributed networks, exploiting new ideas of adiabatic protocols in this regime.

[1] G. Falci, et al., Fort. Phys. (2016); DOI: 10.1002/prop.201600077, arxiv 1704.00581; G. Falci et al., preprint (2017).
[2] N.V. Vitanov, A.A. Rangelov, B.W. Shore, and K. Bergmann, Rev. Mod. Phys. 89, 015006 (2017).