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Directional emission of a giant atom super-strongly coupled to a Coupled Cavity Array

The introduction of high kinetic platforms in circuit QED allow for realization of coupled cavity array with low disorder, small footprint and large inter-site couplings [1]. This enables the study of challenging regimes of light-matter interaction within the paradigm of waveguide QED [2] e.g., giant qubits coupled non-locally to the waveguide. In this work, we conduct an experiment using a giant atom super-strongly coupled to a 1D bath reproducing the photonic analogue of the Su-Schrieffer-Heeger model [3]. Remarkably, on top of standard atom-photon bound states, the qubit induces mode localization in the waveguide, somehow similar to the formation of a Bound-In-Continuum state [4], when the qubit is tuned in the bandgap of the system. This localization phenomenon can be harnessed to induce directional spontaneous emission of the qubit. We explain the emergence of this qubit-induced localization with a Green-function-based argument [5] and propose a setup in which the qubit is manipulated by exploiting the atom-photon bound state in the bandgap and then the information stored in it is sent out directionally through these localized bath modes. These findings open new direction to manipulate nonclassical excitation in waveguide QED e.g., for routing or state transfer applications.

References:
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