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Single Photon Transport In One-Dimensional Circuit Quantum Electrodynamics Systems JUNG-TSUNG SHEN, SHANHUI FAN, Stanford University — Interesting transport properties of a single microwave photon emerge when a superconducting quantum bit in a cavity is coupled to a one-dimensional waveguide. Here we adopt a real-space model Hamiltonian to give a unified approach which accounts for the recent experimental results, and make new predictions on the properties of single photon transport, such as general Fano lineshape, symmetric vacuum Rabi splitting for leaky cavity at resonance, and one-photon switching capability. We further exploit the large tunability of the qubits to show that further interesting one-photon transport properties can emerge in multiple-qubit system, especially when the transition frequencies are dynamically controlled. In particular, having two qubits coupled to the waveguide gives rise to a transmission lineshape for electromagnetic wave that is analogous to the electromagneically induced transparency (EIT) in atomic system. Furthermore, by cascading these double-qubit structure together to form an array, and by dynamically tuning the transition frequency of the qubits, we show that a single photon pulse can be stopped, stored, and time-reversed in the system, leading to highly non-trivial information processing capabilities on chip. Moreover, with properly designed array, two photons can be stopped and stored in the system at the same time. Finally, the unit cell of the array can be designed to be of deep sub-wavelength scale, thereby realizes the miniaturization of the circuit.

Jung-Tsung Shen
Stanford University

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