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Cooperative Effects for Qubits in a Transmission Line: Experiment A.F. VAN LOO, A. FEDOROV, ETH Zurich, K. LALUMIÈRE, Université de Sherbrooke, B.C. SANDERS, University of Calgary, A. BLAIS, Université de Sherbrooke, A. WALLRAFF, ETH Zurich — The interaction probability between freely propagating photons and atoms or atom-like systems is greatly enhanced in one dimension. Thus a system of many atoms coupled to a one-dimensional continuum of electromagnetic modes is expected to reveal many interesting phenomena - the photons emitted by an atom can be absorbed by other atoms and coherently interact with propagating modes of the continuum. We implement three superconducting qubits coupled strongly to an open transmission line to investigate such light-matter interactions in one dimension. We characterize our system by scattering radiation off the qubits and measuring the transmitted and reflected field. For low driving powers, a single qubit reflects nearly all incident radiation resonant with its transition frequency [1]. When two qubits are tuned such that their emitted radiation has a wavelength close to twice the distance between the qubits we observe interference effects in the reflection and transmission spectra. At high driving powers resonance fluorescence is measured for single qubits and multiple qubits in resonance. These results present first steps towards investigating cooperative effects for multiple qubits in open one-dimensional space.

[1] O. Astafiev *et al.*, Science, **327**, 840 (2010)

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