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**Multi-mode circuit quantum electrodynamics** JEROME BOURASSA, Universite de Sherbrooke, JAY M. GAMBETTA, IQC and University of Waterloo, ALEXANDRE BLAIS, Universite de Sherbrooke — In circuit QED experiments with low anharmonicity superconducting qubits, like the transmon, it has been shown how the many-level structure of the qubits can give rise to non-trivial effects. Examples are the straddling regime [1] and high-power qubit readout induced by qubit nonlinearities [2]. In the same spirit, there are also clear experimental evidences to the effect that higher resonator modes play an important role in setting the size of the qubit-qubit flip-flop interaction mediated by virtual resonator photons [3] and the qubit decay rate due to the Purcell effect [4]. In this talk we explore how these higher modes can be taken into account in a theoretical description of the system, and how they affect the flip-flop and Purcell decay rates.

[1] Houck et al., Phys Rev. A 76, 042319 (2007); Srinivasan et al, V26.00006, 2010 March Meeting.

[2] Reed et al, Phys. Rev. Lett. 105, 173601 (2010), Bishop et al, Phys. Rev. Lett. 105, 100505 (2010), Boissonneault et al, Phys. Rev. Lett. 105, 100504 (2010).

[3] Filipp et al, arXiv:1011.3732v1

[4] Houck et al, PRL 101, 080502 (2008)

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