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.