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Circuit QED: Coupling Superconducting Qubits via a Cavity Bus on a Chip

JOHANNES MAJER, Yale University, Applied Physics

Circuit quantum electrodynamics is a system, which allows us to do new experiments in quantum optics with a superconducting integrated circuit on a chip. In circuit QED, microwave photons are guided and confined by superconducting transmission lines and cavities, and can then be coherently coupled to a transmon qubit. This system leads to much stronger coupling of the “light” and “matter” than is possible with traditional atomic systems. Making use of that strong coupling it is possible to couple two qubits via the cavity[1]. I will show how one can use the cavity as a coupling bus which provides non-local and non-nearest neighbor coupling. The interaction is mediated by the exchange of virtual rather than real photons, avoiding cavity-induced loss. The same cavity is also used to perform multiplexed control and read-out of the two qubits. The coupling is effectively switchable which allows for time domain transfer of the quantum states between the qubits. [1] Coupling superconducting qubits via a cavity bus, J. Majer, J. M. Chow, J. M. Gambetta, Jens Koch, B. R. Johnson, J. A. Schreier, L. Frunzio, D. I. Schuster, A. A. Houck, A. Wallraff, A. Blais, M. H. Devoret, S. M. Girvin and R. J. Schoelkopf. Nature 449 443 (2007)