Towards hybrid quantum circuits: Strong coupling of a spin ensemble to a superconducting resonator

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It seems appealing to combine artificial atoms like supeconducting qubits and natural quantum systems in 'hybrid' quantum circuits that would exhibit long coherence times while allowing rapid quantum state manipulation. The two types of object would be strongly coupled to a superconducting resonator used as a quantum bus. We report here [1] a first steps towards this architecture: the realization of a quantum circuit in which an ensemble of electronic spins is coupled to a frequency tunable superconducting resonator. The spins are nitrogen-vacancy centers in a diamond crystal. The achievement of strong coupling is manifested by the appearance of a vacuum Rabi splitting in the transmission spectrum of the resonator when its frequency is tuned through the nitrogen-vacancy center electron spin resonance. We also observe in the time-domain the exchange of a coherent state between the resonator and the spins.

[1] Y. Kubo et al., Phys. Rev. Lett. 105, 140502 (2010)