Spin-photon hybrids

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Abstract
Solid-state based quantum systems (e.g. single spin systems like NV centers in diamond or phosphor donors in silicon, superconducting qubits, nanomagnets, and nanomechanical elements) are building blocks for devices exploiting quantum phenomena. With different quantum systems available, coupling schemes have moved into focus. In particular, sufficiently strong coupling enables efficient information transfer between the individual sub-systems.

Here, we focus on spin-photon hybrids based on paramagnetic spin ensembles and superconducting microwave resonators. We will quantitatively analyze various planar superconducting resonator geometries regarding their performance in electron spin resonance experiments. This includes the homogeneity of the microwave magnetic field and the numerical analysis of the collective coupling strength between the spin ensemble and the resonator modes. At temperatures in the 30-300 mK regime, we expect and observe strong coupling between microwave resonator and the spin system. Using pulsed, Hahn-echo type experiments, we explore the temporal dynamics of the coupled system and observe a more complex behavior compared to conventional pulse sequences. We present a model describing the observations.