Probing NV Centers using a Loop-Gap Resonator

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Color centers in diamond, specifically nitrogen vacancy (NV) centers, have become a popular choice in hybrid quantum devices because of their optical properties and long spin coherence times. We designed and tested a microwave loop-gap resonator to measure electron spin resonance (ESR) and the spin-cavity coupled state dynamics in NV centers at dilution temperatures. When the spin ensemble and the cavity are on resonance (~5 GHz) we observe a normal mode splitting, demonstrating strong coupling between the cavity and the ensemble. Using spin echo measurements, we also determined the spin relaxation and coherence times, T1 and T2 of the NV centers at 10 mK. Lastly, we discuss the applications of our system in SiV centers, including coherent microwave-to-optical conversion of photons.

Fig. 1. Loop-gap resonator. Left: AC magnetic field profile at ~5 GHz. Right: Amplitude of the AC magnetic field. More than 90% of the total magnetic field energy is confined to the center sample space, yielding an estimated single-spin coupling constant of ~0.3 Hz.