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Development of a spin ensemble-based quantum transducer

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Abstract

We are developing a quantum transducer based on an ensemble of nitrogen-vacancy (NV) centers in diamond. To this end, we have designed a hybrid resonator that integrates both microwave and optical cavities. The microwave resonator, using a dielectric material, has demonstrated a high internal quality factor (~10^4), while maintaining large apertures for free-space optical access. Strong coupling between the resonator and a diamond sample with nitrogen impurities (P1 centers) has been achieved at 10 mK. In parallel, a Fabry–Pérot optical cavity has been successfully stabilized inside a dilution refrigerator at about 13 millikelvin. The cavity length fluctuations have been measured to be about 18 pm (root mean square) without diamond, whereas it becomes larger when a diamond crystal is inserted into the cavity.