GHz-range AC magnetometry with an ensemble of NV centers in diamond using concatenated continuous dynamical decoupling

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Sensitive magnetometry using an ensemble of negatively-charged nitrogen-vacancy(NV) centers has been demonstrated in DC and AC regimes. In particular, sub-picotesla sensitivity has been achieved by applying a pulse sequence based on the Hahn echo in the kHz-range [1]. This method relies on the synchronous applications of pulses with the period of the target AC signal. Therefore, the detection bandwidth is limited by the time spacing between the pulses, typically up to the MHz-range for limited temporal precision. On the other hand, GHz-range AC magnetometry can also be achieved using Rabi oscillations by directly driving the spins provided the target frequency is resonant with the energy level of the spin [2]. This frequency is given typically by the zero-field splitting of 2.87 GHz and the Zeeman shift. However, this method is fragile to the detuning of the energy levels, which is inevitable when increasing the number of spins to achieve high sensitivity. To address this issue, we applied a robust pulse sequence called concatenated continuous dynamical decoupling(CCDD) sequence [3]. In this presentation, we discuss GHz-range AC magnetometry by applying the CCDD sequence to a large ensemble of NV centers. Under the inhomogeneities in the detuning and the driving field, the direct Rabi method leads to a rapid decay of oscillations for weak signals, thereby limiting the lower bound of the measurable amplitude. Our experimental observation confirms that the microwave dressed states generated by the CCDD enable the measurement of weaker signals. These findings provide important insights into sensitive measurement of weak GHz-range AC magnetic fields under ensemble inhomogeneities.

Reference

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[2] S. T. Alsid, *et al*., Phys. Rev. Appl. **19**, 054095 (2023).
[3] A. Stark, *et al.*, Nat. Commun. **8**, 1105(2017).