Interplay Between Dressed and High-Field States in the Weak Orthogonal Field Regime for Quantum Sensing and Coherence Enhancement in NV Centers in Diamond

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Nitrogen-Vacancy (NV) centers in diamond are a leading platform for quantum technologies, but their performance is often limited by magnetic noise and decoherence. We explore an alternative operational regime in which a weak magnetic field (∼5 mT) is applied orthogonally to the NV axis, giving rise to dressed spin states formed by symmetric and antisymmetric superpositions of ms=±1 states, that makes the NV center insensitive at magnetic fields at first order. This experimental configuration protects the measurement from the effect of environmental magnetic noise and useful for temperature measurements [1]. The experimental analysis of this regime is conducted using Optically Detected Magnetic Resonance (ODMR) techniques in continuous wave mode.

We also explore the interplay between dressed and partially dressed states through Free Induction Decay measurements in the weak orthogonal field regime for an NV center ensemble. These dressed states exhibit significantly enhanced coherence, with T_2^* times extended up to 2.9 µs—three times longer compared to the initial $ms = 1$ spin states [2].

Finally, we discuss how such interplay between dressed and partially dressed states can be applied to dual-parameter sensing of magnetic fields and temperature within a narrow bandwidth (<4 MHz) and high-fidelity room-temperature quantum gates.

References

[1] E Moreva, E Bernardi, P Traina, et al., Phys. Rev. Appl. **13**, 054057 (2020)

[2] G Zanelli, E Moreva, E Bernardi, et al., arXiv:2412.17608 (2024)