Enhanced Temperature Sensing with Nitrogen-Vacancy Spin Ensembles in Diamond

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Nitrogen-vacancy (NV) centers in diamond enable the measurement of environmental properties such as temperature, magnetic fields and electric fields, which are of utmost relevance for various research fields from nanotechnology to biosensing, by employing the optically detected magnetic resonance (ODMR) technique.

In the majority of applications, especially for magnetometry, a bias magnetic field **B** is aligned along the NV axis. This alignment removes the degeneracy of the $S_z = 1$ states and optimizes the response to shifts in the resonant frequency, thus achieving maximum sensitivity. However, it has been demonstrated that applying a weak orthogonal field **B** to the NV axis induces superpositions between strong field spin states $|S_z = | + 1>$ and $|S_z = | - 1>$, leading to the $|+ >= 1/\sqrt{2}(|S_z = | + 1> + |S_z = | - 1>)$ and $|- >= 1/\sqrt{2}(|S_z = | + 1> - |S_z = | - 1>)$ dressed 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].

In this work, we investigate this regime for the temperature measurements and demonstrate sensitivity enhancement respect to commonly used technique of simultaneous hyperfine driving in cw-ODMR. 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. We observe an enhancement of the coherence time T2 compared to the usual strong field regime. Finally, we discuss how such interplay between dressed and partially dressed states can be applied to sensing and computation.

References

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