Pursuing many-body dynamics in spin ensembles in diamond

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Over the past several years a new research field has emerged, aimed at studying and utilizing specific naturally occurring defects in diamond, namely nitrogen vacancy (NV) color centers. The unique spin and optical properties of these defects position them as leading candidates for creating single photon emmitters emitters, quantum information building blocks (qubits) and magnetic nanosensors. In this work, we utilize ensembles of NV centers towards the studies of quantum many-body spin physics in realistic solid-state platforms, which has been a long-standing goal in quantum and condensed-matter physics. Separate steps are required in order to reach this goal: First, standard (TEM) electron irradiation is used for the enhancement of N to NV conversion efficiencies by over an order-of-magnitude [1]. Second, robust pulsed [2] and continuous [3] dynamical decoupling (DD) techniques enable the preservation of arbitrary states of the ensemble. These combined efforts could lead to the desired interaction-dominated regime. Finally, we simulate the effects of continuous and pulsed microwave (MW) control on the resulting NV-NV many body dynamics in a realistic spin-bath environment [4]. We emphasize that dominant interaction sources could be identified and decoupled by the application of proper pulse sequences, and the modification of such sequences could lead to the creation engineered interaction Hamiltonians. Such interaction Hamiltonians could pave the way towards the creation of non-classical states, e.g. spin-squeezed states, which were not yet demonstrated in the solid-state, and could eventually lead to magnetic sensing beyond the standard quantum limit (SQL).

References

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