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Quantum control and decoherence of a single spin in diamond[1]

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Nitrogen-vacancy (NV) impurity centers in diamond have recently emerged as a unique platform for investigating quantum dynamics and quantum control of single spins in solid-state environments. NV centers demonstrate an unusual combination of spin-dependent optical properties, individual addressability, and long spin coherence times. The NV spin state can be manipulated both optically and magnetically, and very fast quantum control operations can be performed with high fidelity [1,2]. Due to these uniquely favorable properties, quantum dynamics of a single NV spin can be investigated in great detail. I will present the results of our work on decoherence of NV spins by spin baths of atomic nitrogen impurities (P1 centers) and the spins of ^{13}C nuclei, and discuss different regimes of the decoherence dynamics. We will consider modern dynamical decoupling techniques which aim at preserving coherence of quantum spins, and the experimental implementation of the decoupling protocols, as well as more advanced quantum control of NV spins. Using a variety of analytical and numerical tools, we can characterize and optimize the factors which limit our control over these quantum spin systems [2]. We will also examine how the quantum control approaches can be used to elucidate the quantum dynamics of NV centers and the properties of the spin bath [3].

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[2] V. V. Dobrovitski, G. de Lange, D. Riste, and R. Hanson, Phys. Rev. Lett. 105, 077601 (2010).
[3] G. de Lange, Z. H. Wang, D. Riste, V. V. Dobrovitski, and R. Hanson, Science 330, 60 (2010).

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