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Control of single-spin decoherence by dynamical decoupling and spin bath manipulation

RONALD HANSON, Kavli Institute of Nanoscience Delft, Delft University of Technology, The Netherlands

Controlling the interaction of a single quantum system with its environment is a fundamental challenge in quantum science and technology. We dramatically suppress the coupling of a single spin in diamond with the surrounding spin bath by using high-fidelity double-axis dynamical decoupling [1]. The coherence is preserved for arbitrary quantum states, as verified by quantum process tomography. The resulting coherence time enhancement is found to follow a general scaling with the number of decoupling pulses. No limit is observed for the decoupling action up to 136 pulses, for which the coherence time is enhanced more than 25 times compared to spin echo. Furthermore, we have exploited multi-pulse sequences to enhance the sensitivity of single-spin magnetometry and to measure properties of the decoupling sequences themselves [2]. In this talk, I will present an overview of this work combined with our latest results on coherent manipulation of the spin bath environment.

[1] Universal dynamical decoupling of a single solid-state spin from a spin bath, G. de Lange, Z.H. Wang, D. Ristè, V.V. Dobrovitski, and R. Hanson, Science 330, 60 (2010).

[2] Single-spin magnetometry with multi-pulse sequences, G. de Lange, D. Ristè, V. V. Dobrovitski, R. Hanson, arXiv:1008.4395 (2010).