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Quantum Optics with Spins and Photons in Diamond

YIWEN CHU, EMRE TOGAN, MIKHAIL LUKIN, Harvard University — Quantum control of interactions between photons and solid-state systems has important applications in quantum information, metrology, and the study of material properties. The nitrogen-vacancy (NV) color center in diamond is one such solid-state system that has shown great promise as an optically addressable spin qubit and highly sensitive magnetometer. We present recent work on coherent control of spin-photon interactions in a complex solid-state environment using coherent population trapping (CPT). The intrinsic magnetic field sensitivity of our CPT scheme allows us to measure the instantaneous Overhauser field associated with the ^{13}C bath present in the diamond crystal. We show that this quantum measurement technique can be used to prepare a state of the ^{13}C bath that has much reduced uncertainty in the associated Overhauser field. Such a state is verified by observing a modification and narrowing of the transmission window. The preparation of a more well-defined configuration of the nuclear spin environment could lead to an increase in the coherence times of the NV electronic spin qubit, which in turn has applications in increasing the sensitivity of NV-based magnetometers.

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