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All-optical, arbitrary-basis initialization and readout of a diamond spin qubit[1] C.G. YALE, B.B. BUCKLEY, D.J. CHRISTLE, F.J. HEREMANS, L.C. BASSETT, D.D. AWSCHALOM, Center for Spintronics and Quantum Computation, University of California, Santa Barbara, California 93106, G. BURKARD, Department of Physics, University of Konstanz, D-78457 Konstanz, Germany — The nitrogen-vacancy (NV) center in diamond is a promising spin qubit candidate, in large part due to its optical addressability via a spin-selective intersystem crossing. Here we demonstrate a general all-optical technique to initialize and readout the NV spin state along an arbitrarily-chosen basis using coherent light fields[2] below 10 K, which negates the need for this special addressability. By tuning the NV center's excited-state structure to a lambda (Λ) configuration with a magnetic field, we use coherent population trapping (CPT) to initialize its spin into any desired superposition. We investigate the CPT time dynamics and use quantum state tomography to characterize the resultant state. We also demonstrate spin-state readout along an arbitrarily-chosen basis by measuring photoluminescence emitted during the transient period of the CPT interaction. Since these techniques do not rely on the intersystem crossing, they provide a pathway for all-optical control of other potential defect spin qubits, which may lack the NV center's unique structure.

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