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All-optical spin manipulation methods for a solid-state defect spin[1] C.G. YALE, F.J. HEREMANS, D.J. CHRISTLE, D.D. AWSCHALOM, Institute for Molecular Engineering, University of Chicago, Chicago, IL 60637, L.C. BASSETT, B.B. BUCKLEY, Center for Spintronics and Quantum Computation, University of California, Santa Barbara, CA 93106, G. BURKARD, Department of Physics, University of Konstanz, D-78457 Konstanz, Germany — The nitrogen-vacancy (NV) center in diamond is an optically-addressable defect spin with promising applications in quantum information processing and metrology. Here we discuss all-optical methods of dynamically manipulating the spin state of the NV center by exploiting coherent interactions with light at temperatures below 10 K. We study the spin dynamics of the NV center using coherent pulses of light, and achieve rotations of the spin state at sub-nanosecond timescales[2]. With ultrafast pump-probe spectroscopy and by tuning the excited-state spin Hamiltonian with a magnetic field, we demonstrate arbitrary-axis spin rotations and controlled unitary evolution within the full spin-triplet manifold. These experiments also complement recent work demonstrating optical spin control using coherent dark states[3]. These all-optical techniques provide a probe for decoherence and a pathway toward integrating spin qubits and photonic networks.

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[2]L.C. Bassett*, F.J. Heremans*, D.J. Christle, C.G. Yale, G. Burkard, B.B. Buckley, and D.D. Awschalom, *in preparation*
[3]C.G. Yale*, B.B. Buckley*, D.J. Christle, G. Burkard, F.J. Heremans, L.C. Bassett, and D.D. Awschalom, *PNAS* **110**, 7595 (2013).

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