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Decoherence-protected quantum gates for a hybrid spin register in diamond[1] V.V. DOBROVITSKI, Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands, T. VAN DER SAR, Ames Laboratory and Iowa State University, Z.-H. WANG, Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands, M.S. BLOK, Ames Laboratory and Iowa State University, Ames, Iowa 50011, USA, H. BERNIEN, T.H. TAMINIAU, Ames Laboratory and Iowa State University, D.M. TOYLI, Center for Spintronics and Quantum Computation, University of California, Santa Barbara, D.A. LIDAR, Depts of Electrical Engineering, Chemistry, and Physics, and Center for Quantum Information Science and Technology, University of Southern California, D.D. AWSCHALOM, Center for Spintronics and Quantum Computation, University of California, Santa Barbara, R. HANSON, Ames Laboratory and Iowa State University — Protecting the dynamics of coupled quantum systems from decoherence by the environment is a key challenge for solid-state quantum information processing. An idle qubit can be efficiently insulated from the environment via dynamical decoupling, but quantum gate operations are, in general, disrupted by the decoupling. This problem is particularly salient for hybrid systems, where different types of qubits evolve and decohere at vastly different rates. Here we present an efficient scheme for combining the dynamical decoupling with the quantum gate operation, using the internal resonance in the coupled-spin system. We theoretically demonstrate and experimentally achieve high-fidelity operation of a two-spin register made of the

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