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Environment Assisted Precision Magnetometry P. CAPPELLARO, Nuclear Science and Eng. Dept., Massachusetts Inst. of Technology, G. GOLDSTEIN, J.R. MAZE, L. JIANG, J.S. HODGES, Physics Dept., Harvard U., A.S. SORENSEN, Niels Bohr Inst., Copenhagen Uni., M.D. LUKIN, Physics Dept., Harvard U. — We describe a method to enhance the sensitivity of magnetometry and achieve nearly Heisenberg-limited precision measurement using a novel class of entangled states. An individual qubit is used to sense the dynamics of surrounding ancillary qubits, which are in turn affected by the external field to be measured. The resulting sensitivity enhancement is determined by the number of ancillas strongly coupled to the sensor qubit, it does not depend on the exact values of the couplings (allowing to use disordered systems), and is resilient to decoherence. As a specific example we consider electronic spins in the solid-state, where the ancillary system is associated with the surrounding spin bath. The conventional approach has been to consider these spins only as a source of decoherence and to adopt decoupling scheme to mitigate their effects. Here we describe novel control techniques that transform the environment spins into a resource used to amplify the sensor spin response to weak external perturbations, while maintaining the beneficial effects of dynamical decoupling sequences. We discuss specific applications to improve magnetic sensing with diamond nano-crystals, using one Nitrogen-Vacancy center spin coupled to Nitrogen electronic spins.

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