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Order of Magnitude Improvement in NV Ensemble T2* via Control and Cancellation of Spin Bath Induced Dephasing CONNOR HART, ERIK BAUCH, Harvard Univ, JENNIFER SCHLOSS, Massachusetts Institute of Technology, MATTHEW TURNER, Harvard Univ, JOHN BARRY, RONALD WALSWORTH, Smithsonian Center for Astrophysics — We deploy two complementary techniques, spin bath control and double quantum magnetometry, to attain up to a 14-fold improvement in T_2^* for Nitrogen-Vacancy ensembles in diamond. Depending on the Nitrogen concentration of the sample, three regimes can be differentiated: for low concentrations ($N \ll 1$ ppm), the dephasing is strain-dominated and can be suppressed by working in the NV's double quantum basis $\{-1, +1\}$. In an intermediate regime ($N \simeq 1$ ppm), the combination of double quantum and spin bath control achieves a 14-fold increase in T_2^*. At greater Nitrogen concentrations ($N \geq 10$ ppm), dipolar interactions with electronic Nitrogen spins dominate the broadening which are mitigated by spin bath driving. Our results elucidate sources of dephasing over a range of spin concentrations and outline a direct path forward to improving coherence times for sensing and quantum science.

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