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Measurement and control of single spins in diamond above 600 K[1]

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The nitrogen vacancy (NV) center in diamond stands out among spin qubit systems in large part because its spin can be controlled under ambient conditions whereas most other solid state qubits operate only at cryogenic temperatures. However, despite the intense interest in the NV center's room temperature properties for nanoscale sensing and quantum information applications, the ultimate thermal limits to its measurement and control have been largely unknown. We demonstrate that the NV center's spin can be optically addressed and coherently controlled at temperatures exceeding 600 K and show that its addressability is eventually limited by thermal quenching of the optical spin readout [1]. These measurements, in combination with computational studies, provide important information about the electronic states that facilitate the optical spin measurement and, moreover, suggest that the coherence of the NV center's spin states could be utilized for thermometry. We infer that single spins in diamond offer temperature sensitivities better than 100 $\mathrm{mK}/\sqrt{\mathrm{Hz}}$ up to 600 K using conventional sensing techniques and show that advanced measurement schemes provide a pathway to reach 10 $\mathrm{mK}/\sqrt{\mathrm{Hz}}$ sensitivities. Together with diamond's ideal thermal and mechanical properties, these results suggest that NV center thermometers could be applied in cellular thermometry and scanning thermal microscopy.

[1] D. M. Toyli*, D. J. Christle*, A. Alkauskas, B. B. Buckley, C. G. Van de Walle, and D. D. Awschalom, *Phys. Rev. X* **2**, 031001 (2012).

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