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High-sensitivity diamond magnetometer with nanoscale resolution

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We will discuss our recent work on using isolated electronic spins in the solid-state as sensitive magnetic sensors [1,2]. This novel approach to magnetometry is enabled by the good coherence properties of electronic qubits, such as the spins associated with Nitrogen-Vacancy (NV) centers in diamond, as well as by advanced techniques for their coherent control. The key feature of this solid-state magnetometer is the possibility to confine the sensing spins into a crystal of nanometer size that can be brought extremely close to the magnetic field source, thus achieving high spatial resolution. Our first experiments demonstrate that the resulting magnetic sensor provides an unprecedented combination of ultra-high sensitivity and spatial resolution. The ultimate sensitivity limit is set by the interaction of the spin sensor with its environment and in particular the nuclear and electronic spin bath. As an outlook, we will discuss how engineering, controlling or harnessing the environment can lead to better sensitivity, even beyond the standard quantum limit. Finally, we will outline several exciting applications of the novel magnetic sensors in areas ranging from bio- and materials science to fundamental physics and single electronic and nuclear spin detection.

[1] J. M. Taylor, et al. Nature Phys. 4, 810-816 (2008).
[2] J. R. Maze, et al. Nature 455, 644 - 647 (2008)