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Abstract for an Invited Paper
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Controlling individual electron and nuclear spins in diamond: from quantum registers to applications

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We will discuss our recent work involving the controlled manipulation of individual electron and nuclear spins in a high-purity diamond lattice. Our approach combines ideas from single molecule spectroscopy, quantum optical control techniques and the physics of mesoscopic spin ensembles. It allows us to isolate, polarize and manipulate single nuclear spins and use them to create quantum memory and small quantum registers with exceptional coherence properties, even under ambient room temperature conditions. We will also describe novel applications of these techniques, including new approaches to quantum communication and computation as well as new quantum magnetic sensors with nanoscale resolution. Recent progress towards realization of these ideas will be discussed.