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Title:High-field phenomena of qubits

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Abstract: Electron and nuclear spins are very promising candidates to serve as quantum bits (qubits) for proposed quantum computers, as the spin degrees of freedom are relatively isolated from their surroundings and can be coherently manipulated, e.g., through pulsed electron paramagnetic resonance (EPR) and nuclear magnetic resonance (NMR). For solid-state spin systems, impurities in crystals based on carbon and silicon in various forms have been suggested as qubits, and very long relaxation rates have been observed in such systems. We have investigated a variety of these systems at high magnetic fields in our multifrequency pulsed EPR/ENDOR (electron nuclear double resonance) spectrometer. A high magnetic field leads to large electron spin polarizations at helium temperatures, giving rise to various phenomena that are of interest with respect to quantum computing. For example, it allows the initialization of both the electron spin as well as hyperfine-coupled nuclear spins in a well-defined state by combining millimeter and radio-frequency radiation. It can increase the T(2) relaxation times by eliminating decoherence due to dipolar interaction and lead to new mechanisms for the coherent electrical readout of electron spins. We will show some examples of these and other effects in Si:P, SiC:N and nitrogen-related centers in diamond.