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Spin Readout and Hyperfine Interaction in Few-Electron Quantum Dots

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This talk presents recent experimental progress toward using few-electron quantum dots as spin qubits. First, we have developed a new spin readout technique that is based on the difference in tunnel rate between different spin states[1]. Unlike earlier techniques, it is robust against background charge fluctuations and high-frequency noise, and presently achieves single-shot fidelities up to 90%. Using this readout technique, we have measured the two-electron spin relaxation time as a function of magnetic field strength and orientation, and studied the back-action of the charge detector. Second, we have investigated the effect of nuclear spins on the electron spin state[2]. Transport measurements on a double quantum dot in the spin blockade regime reveal that the delocalized two-electron singlet and triplet states are mixed by an inhomogeneous hyperfine field of about 1 mT. We demonstrate that this mixing can be controlled by changing either the external magnetic field or the interdot tunnel coupling. The transitions between triplet and singlet states in turn lead to current-induced dynamical nuclear polarization. In certain regimes, marked current bistabilities appear as a function of both field and time.

[1]R. Hanson, L.H. Willems van Beveren, I.T. Vink, J.M. Elzerman, W.J.M. Naber, F.H.L. Koppens, L.P. Kouwenhoven, and L.M.K. Vandersypen, Phys. Rev. Lett. 94, 196802 (2005).
[2]F.H.L. Koppens, J.A. Folk, J.M. Elzerman, R. Hanson, L.H. Willems van Beveren, I.T. Vink, H.P. Tranitz, W. Wegscheider, L.P. Kouwenhoven, and L.M.K. Vandersypen, Science 309, 1346 (2005).