Dephasing and gate fidelity of spin qubits with GaAs and Si quantum dots

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Qubit number and error rate are both key parameters to characterize the power of quantum computing, but they are still challenging problems. The underlying physics for the error rate is dephasing due to coupling to the environment noise, magnetic or electrical for the case of spin qubits with quantum dots (QDs). Here I will discuss the spin dephasing measured for QDs made out of GaAs and Si/SiGe and how to suppress the dephasing to raise the gate fidelity in manipulating single spins and two spins. In GaAs QDs the dephasing arises predominantly from the fluctuating nuclear spin bath. This noise is time-correlated and the variance increases with increasing correlation time from msec to 100 sec in the non-ergodic regime. We employ a micro-magnet technique for making the spin-1/2 single qubit and the phase control of the two spin qubits. We show that fast gating with the micro-magnet, fast measurement, and feedback control are all useful to reduce the influence from the magnetic noise and raise the fidelity exceeding 99 %. On the other hand, in Si QDs the magnetic noise is significantly reduced but electrical noise can be crucial instead. We apply the micro-magnet technique for isotopically purified Si/SiGe QDs and obtain the fidelity exceeding 99.9 %, and in addition find that the fidelity is predominantly limited by charge noise. I will discuss influences from charge fluctuations on the gate fidelity in the presence of a micro-magnet induced stray field.