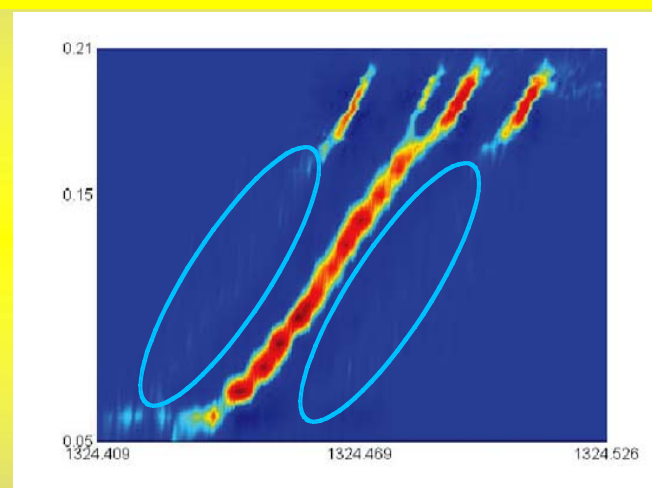
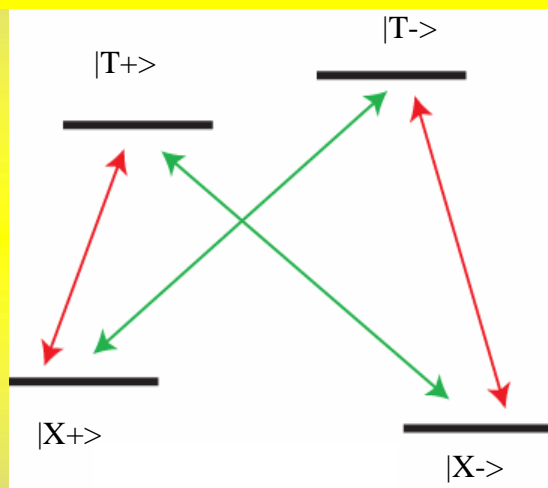


Optically Driven Quantum Dot Electrons for Quantum Computing

Fast optical initialization of electron spin qubits by spin cooling

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In this work, experiments are aimed at exploring the feasibility and fundamental physics associated with using a single electron in a doped quantum dot, produced by the Coulomb blockade, as a spin qubit for quantum information processing. In theory, we have shown that networks of quantum dots coupled by an optically induced transient Heisenberg type interaction can be produced to yield a universal quantum gate.



Energy level diagram for quantum dot spin states. $|X+\rangle$ and $|X-\rangle$ are the spin ground states, the excited states are trions. Optical excitation along either of the red transitions allows for radiative relaxation to the other state by the green arrows. The radiative relaxation results in spin cooling (optical pumping), moving all the probability of state occupation to the terminal spin state of the radiative decay and a loss of optical absorption along the red transition. The figure at the right shows the absorption spectrum as a function of energy (x-axis) and applied bias (y-axis). The blue circles show the disappearance of absorption due spin cooling. The reappearance of the pumped transitions at high bias is the result of tunneling that depolarizes the dot. The spin cooling results in a state fidelity in excess of 98% purity.



Center for the Advancement of Frontiers in Optical Coherent and Ultrafast Science
The University of Michigan and the University of Texas at Austin
NSF Award 0114336