The frontier of spin coherence in silicon nanostructures

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Silicon has remarkable materials properties that have made it the most important material for the construction of current microelectronic devices. Silicon's fundamental properties may also make it an attractive option for the development of fundamental quantum devices for spintronics and quantum information processing. Being able to manipulate and measure spins of single electrons is crucial for these applications.

This talk will discuss recent advances that enable the manipulation and measurement of the single spins in a quantum dot fabricated in a silicon-silicon/germanium heterostructure. We demonstrate that the rate of loading of electrons into the device can be tuned over several orders of magnitude using a gate voltage, that the spin state of the loaded electron depends systematically on the loading voltage level, and that this tunability arises because of the effects of spin-split orbital excited states of the quantum dot. The longitudinal spin relaxation time T1 is measured and found to be as long as 3 sec at a magnetic field of 1.85 T. The ability to manipulate and measure single spins as well as a long spin relaxation time and tunability of the loading are all favorable properties for spintronics and quantum information processing applications.