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Electron Spin Qubits in Si/SiGe Quantum Dots

MARK ERIKSSON, University of Wisconsin-Madison

It is intriguing that silicon, the central material of modern classical electronics, also has properties well suited to quantum electronics. Recent advances in Si/SiGe quantum devices have enabled the creation of high-quality silicon quantum dots, also known as artificial atoms. Motivated in part by the potential for very long spin coherence times in this material, we are pursuing the development of individual electron spin qubits in silicon quantum dots. I will discuss recent demonstrations of single-shot spin measurement in a Si/SiGe quantum dot spin qubit, and the demonstration of spin-relaxation times longer than one second in such a system. These and similar measurements depend on a knowledge of tunnel rates between quantum dots and nearby reservoirs or between pairs of quantum dots. Measurements of such rates provide an opportunity to revisit classic experiments in quantum mechanics. At the same time, the unique features of the silicon conduction band lead to novel and unexpected effects, demonstrating that Si/SiGe quantum dots provide a highly controlled experimental system in which to study ideas at the heart of quantum physics.