

SEMINAR

Thursday, December 1, 2016

9:30 am

ROOM WANG 1004

**Valley Dependent g-factors in Silicon: Role of Spin-Orbit
and Micromagnets**

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Abstract: Spin quantum bits hosted in silicon quantum dots are attractive due to their exceptionally long coherence times and compatibility with the silicon transistor platform. How such microscopic electronic spins are affected by the crystal and interfacial symmetries has been a topic of great interest over the past few decades and has found potential applications in spin based electronics and computation. While the coupling between spin and orbital degrees of freedom has been extensively studied, the interplay between spin and the momentum space valley degree of freedom is a topic of recent interest, and may enable hybrid spin- and valley- tronic devices. In this talk, I will describe recent experiments that have probed valley dependent spin properties in silicon quantum bits. I will present an atomistic modeling framework that can provide a unified description of disparate experimental measurements, and show how material and device properties combine to affect the spins.

I will show that spin splittings in silicon quantum dots are inherently valley-dependent. Interface disorder, such as monoatomic steps, can strongly affect the intrinsic spin-orbit coupling and can cause device-to-device variations in g-factors. I will also describe the anisotropy of the g-factor as a function of the angle of an external magnetic field and compare with recent experimental measurements. I will also show how the anisotropy is affected by integrated micromagnets in silicon qubits that can generate an extrinsic coupling between spin and charge. Finally, I will show how the intrinsic and extrinsic factors affecting the spins can be used to perform electrical rotations of spin qubits.

Bio: Rajib Rahman obtained his PhD degree in Electrical and Computer Engineering from Purdue University in 2009 in the area of computational nanoelectronics. He was a postdoctoral fellow in Sandia National Laboratories in the Silicon Quantum Information Science and Technology group from 2009-2012. Since 2012, he has been employed as a Research Assistant Professor in the Network for Computational Nanotechnology (NCN) at Purdue. Rajib develops and employs atomistic simulation methods to model electronic devices at the nanoscale including quantum dots, photo-detectors, spin qubits, and transistors. Rajib specializes in the quantum mechanical many-body description of spins and their interactions with the solid-state environment. He collaborates with leading experimental groups in academia and in national laboratories in the field of semiconductor quantum computing