CSU PHYSICS COLLOQUIUM

More than Moore

Speaker: Meenakshi Singh
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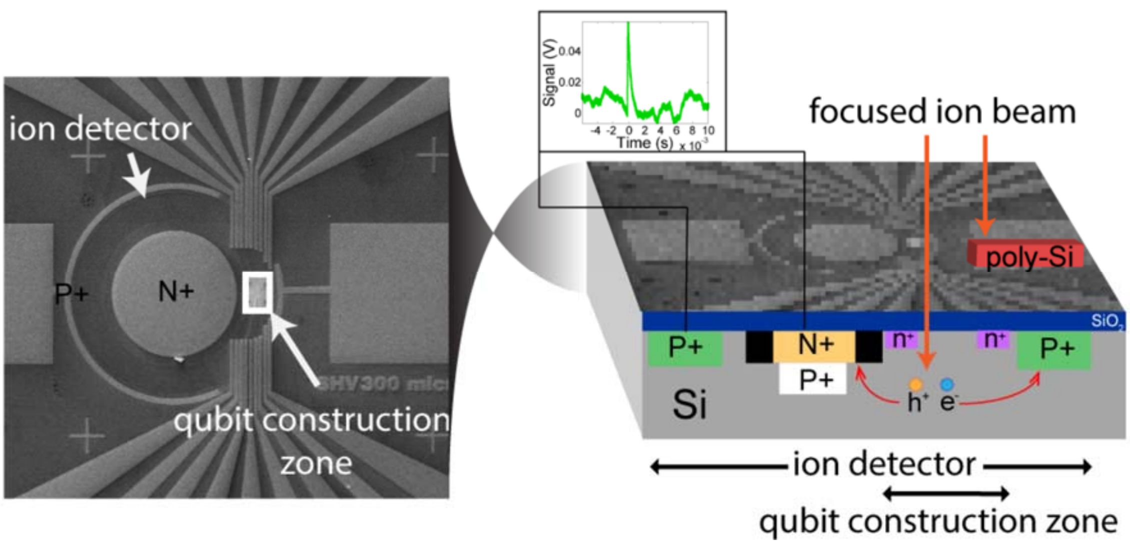
Colorado State University
4:00 PM Monday, November 27, 2017
Refreshments at 3:45 PM
Location: 120 Engineering (Hammond Auditorium)

Abstract

Experts may disagree on the reasons behind its demise – from economics to heat death to quantum mechanics, but, they agree that the end of Moore's Law is near. As the principle powering the information technology revolution for more than half a century, Moore's Law leaves in its wake an urgent need for new paradigms to keep fueling innovation. This talk will focus on two areas of 'more than Moore' computing that are poised to usher in revolutionary science and technology – superconducting spintronics and quantum computing.

Superconducting spintronics: Unlike conventional electronics, which depend on electronic charges, spintronics uses electronic spins. Depending on the context, the use of electronic spins promises higher energy efficiency, enhanced functionality, higher speeds and lower noise compared to its charge based counterparts. Interfacing spintronic devices with superconductors can take these advantages to a new level by harnessing the dissipation free currents of superconductors. In this talk, I will describe our discovery of a long-range proximity effect in ferromagnetic nanowires which sets the stage for such 'superspintronic devices'.

Quantum computing: Quantum computing is the most well-known nonconventional Computing paradigm today. Of the hundreds of qubits being explored, donor spin based qubits are a particularly promising platform for quantum computing. Practical device fabrication using this approach however, requires precise control over the placement and number of donors. The figure shows the technology we have developed to address this twofold challenge. A diode detector next to our qubit (see left panel), in which we demonstrate single ion implant sensitivity (see right panel for detector functioning), allows us to count donor implants in-situ and deterministically control the number of donors. The use of a focused ion beam allows control of donor location. We have demonstrated successful sensing of the donor electron in transport measurements. Our demonstration has opened the door to immediate fabrication of two donor devices, which has been a goal of the donor qubit community for over a decade. These are two of the dozens of ideas being investigated that can enable us to keep following Moore's Law in the figurative sense of 'exponentially improving device functionality' if not in the literal. As we step outside the confines of established technology, it is an exciting time for new exploration.



Bio

Dr. Singh obtained her B. S. in Physics, Mathematics and Statistics from the University of Lucknow in 2004. She graduated from the Indian Institute of Technology with an M. S. in Physics in 2006 and received a Ph. D. in Physics from the Pennsylvania State University in 2012. Her Ph. D. thesis was focused on quantum transport in nanowires. She went on to work at Sandia National Laboratories on Quantum Computing as a post-doctoral scholar. She is currently an Assistant Professor in the Department of Physics at the Colorado School of Mines, where she started earlier this year. She has continuing interests in macroscopic quantum phenomena and quantum coherence. Her current research is focused on emergent phenomena in hybrid systems, quantum entanglement and neuromorphic computing.