Physics Colloquium

Michigan Technological University

Thursday, March 15, 2012
at 4:00 pm in Room 139 Fisher

What Determines the Sign Reversal of Magnetoresistance in a Molecular Tunnel Junction?

Subhasish Mandal
Advisor: Dr. Ranjit Pati

Abstract: The observations of both positive and negative signs in tunneling magnetoresistance (TMR) for the same organic spin-valve structure has puzzled researchers working in organic spintronics. In my talk, I will try to find an answer to this puzzle by exploring the role of metal-molecule interface on TMR in a single molecular spin-valve junction. A planar organic molecule sandwiched between two nickel electrodes is used to build a prototypical spin-valve junction. A parameter-free, single particle Green's function approach in conjunction with a posteriori, spin unrestricted density functional theory involving a hybrid orbital dependent functional is used to calculate the spin-polarized current. The effect of external bias is explicitly included to investigate the spin-valve behavior. Our calculations show that only a small change in the interfacial distance at the metal- molecule junction can alter the sign of the TMR from a positive to a negative value. Apart from this, I will quantitatively present the magnetic proximity effect and its bias dependent nature, which can be used to understand the unexpected magnetism often observed in organic materials that are in close proximity with magnetic substrates.

Modeling of Multi-Island Single-Electron Transistor (SET) Devices.

Madhusudan Savaikar
Advisors: Drs. Paul Bergstrom and John Jaszczak

Abstract: Controlled transport of electrons through tunnel junctions and their confinement by weakly coupled mesoscopic structures has opened up immense possibilities for a new generation of nanoscale devices. These devices exhibit Coulomb blockade characteristics especially at low energies that are the manifestations of charging effects by nano-islands. Here we present the study of charge transport through a long one dimensional chain of gold nano-islands. Semi-classical calculations clearly show that the $I-V$ characteristics are a function of chain-length. The threshold voltage V_{th} required for device switching and the overall device resistance increase with the increase in chain-length. The ratio of V_{th} with number of islands in chain approaches a limiting value with increasing chain-length. Rise in temperature smears out the blockade thereby limiting the usability of bigger islands for the switching action.

Conduction Amongst Mesoscopic Particles

Douglas Banyai
Advisor: Dr. John Jaszczak

Abstract: Simulating the conduction of charge through a disordered network of small particles requires characterizing the junctions between each particle. For large smooth particles we can approximate the geometry of the junction with one that allows an analytic solution for the tunneling current. For particles smaller than ~1 nm, we can use first principles approaches such as density functional theory (DFT). In this work we use the above mentioned methods to gain insight into the behavior of junctions too large for DFT and too small to approximate with bulk properties.

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