

DEPARTMENT OF ELECTRICAL ENGINEERING

Graduate Seminar Guest Speaker

Dr. Michael Lilly
Sandia National Labs

TO INTERACT OR NOT TO INTERACT: USING TUNNELING AND TRANSPORT TO EXPLORE MANY- BODY PHYSICS QUANTUM WIRES

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ABSTRACT

The observation of quantized conductance steps in ballistic semiconductor quantum wires is an early example of the now very broad field of nanoelectronics. Although the physics of plateaus at quantized values of $G_0 = 2e^2/h$ is easily understood using non-interacting quantum mechanics, Coulomb interactions are expected to play a key role in 1D systems. In this talk, transport experiments on single and double quantum wires will be presented. In the first part, the interplay between disorder and interactions in long single wires and wires with a variable density will be tested with a variety of conductance measurements. The second part of the talk focuses on tunneling in a system of vertically coupled quantum wires. These nanostructures are fabricated from bilayer electron samples with electron beam lithography on both top and bottom defining the double wire. Parallel conductance as a function of split gate voltages provide a map of the 1D subband occupations; tunneling measurements can be made with any combination of subbands occupied in each wire. The full tunneling spectroscopy is measured using both a voltage between the wires and a parallel magnetic field to learn about both the energy and momentum dependence of tunneling events. We compare the data to a non-interacting model of tunneling. Deviations from the simple picture may require analysis of the 1D systems as Luttinger liquids. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

BIOGRAPHY

Michael P. Lilly received his B.S. in engineering physics at the University of Illinois in 1991. His thesis work involved liquid helium films and was done under the direction of Robert Hallock at the University of Massachusetts Amherst. From 1996 to 2000 Michael was a postdoc at Caltech working with Jim Eisenstein on 2D electron systems and the fraction quantum Hall effect. In 2000, he joined Sandia National Laboratories and is currently a Principal Member of Technical Staff. His research interests include many-body interactions in 2D systems, interacting nanoelectronic systems and coherence effects in semiconductor systems. In 2006, he will move to the DOE nanoscience Center for Integrated Nanotechnologies (CINT) as a thrust leader in the area of nanoelectronics and photonics.