

**Winter 2006 Colloquium Series**  
**Physics Department**  
**University of Oregon**

**4:00 Thursdays, 100 Willamette**  
**(Reception at 3:45 in the Atrium)**

<p>January 12</p> <p><b>Speaker:</b> <b>Jens Nöckel</b></p>	<p><b>Title: Nobel Prize 2005 for Quantum Optics, and how Roy Glauber correlates with it.</b></p> <p>Abstract: The 2005 Nobel Prize in Physics was awarded in part to the theorist Roy Glauber of Harvard University, "for his contribution to the quantum theory of optical coherence." I'll give an introductory review of Glauber's work in the early days of quantum optics, illustrating the central role of correlations, photon statistics, and the concept of "phase space."</p> <p>(Host: Soper)</p>
<p>January 19</p> <p><b>Speaker:</b> <b>George Evans</b> Economics Department, University of Oregon</p>	<p><b>Title: Inaugural award lecture on the role of expectations in economics</b></p> <p>Abstract: Evans' talk will address the question of how businesses and households forecast the future state of the economy...</p> <p>Host: Dean Joe Stone <b>The talk will be at 4pm in the Gerlinger Alumni Lounge</b></p>
<p>January 26</p> <p><b>Speaker: Ken</b></p>	<p><b>Title: Quantum Simulations of Physical Systems</b></p>

**Brown**  
Massachusetts  
Institute of  
Technology

Abstract:  
Simulating the dynamics of physical systems at a quantum level is a difficult problem. At the heart of this difficulty is the exponential growth of Hilbert space with a linear increase in the number of atoms. A quantum simulator overcomes this difficulty by using a well controlled quantum system to emulate the system of interest. In this talk, I will describe two experiments in the Chuang group that are initial steps towards building a quantum simulator. The first experiment uses an NMR quantum simulator to examine the low-lying energy spectra of superconductors. The second experiment is the development of a planar ion trap that allows one to store and move ions in arbitrary geometries. This flexibility makes planar ion traps an ideal tool for simulating frustrated spin systems.

(Host: Wang)

February 2

**Speaker:**  
**Deniz D. Yavuz**  
Department of  
Physics  
University of  
Wisconsin at Madison  
Madison, WI

**Title: Quantum Computing with Trapped Neutral Atoms**

Abstract:  
Quantum computing has generated much enthusiasm over the last decade due to the possibility of solving exponentially large problems in polynomial time. The fundamental building block of a quantum computer is a quantum bit (qubit) which is a quantum mechanical system that can be in two distinct states. In this talk, I will review our recent experiments where we use single trapped neutral Rubidium (Rb) atoms as qubits. Utilizing laser cooling and trapping techniques, we cool Rb atoms to microkelvin temperatures and trap them in micron sized dipole traps. Using tightly focused laser

beams we demonstrate high fidelity, site specific single qubit gates with negligible cross talk on neighboring sites. We also demonstrate the suppression of Rydberg excitation in a dipole trap which is the first step towards constructing a two-qubit gate for neutral atoms. Our experiments currently have the best figures achieved to date for neutral atom quantum computing. Specifically, we demonstrate a single qubit Hadamard gate time of 200 nanoseconds, a decoherence time of 1 millisecond, and a qubit addressing error between 8 micron separated sites at the level of 0.1%.

(Host: Raymer)

February 9

**Speaker:  
Christopher Daly**

Director, Spatial  
Climate Analysis  
Service Dept. of  
Geosciences,  
Oregon State  
University

**Title: Climate Mapping Activities at  
Oregon State University's Spatial  
Climate Analysis Service**

Abstract:

The Spatial Climate Analysis Service (SCAS) was established at Oregon State University to provide spatial climate research, education, analysis and mapping services for public, private, and educational institutions worldwide. SCAS is committed to producing the most innovative and sophisticated climate maps available. Many of SCAS' mapping activities involve use of the PRISM model, a knowledge-based system that uses point measurements of precipitation, temperature, and other climate elements to produce continuous grids. PRISM grids are used with Geographic Information Systems to construct maps and perform many types of analysis. These data sets are downloaded thousands of times each month from the SCAS web site by a wide array of users. Applications of SCAS products are wide-ranging, and include climatology,

	<p>agriculture, forestry, hydrology, engineering, natural resources, land use, and geography. SCAS is responsible for nearly all major climate mapping efforts at the federal level in the United States and is engaged in international modeling and analysis projects.</p> <p>(Host: Nöckel)</p>
<p>February 16</p> <p><b>Speaker:</b>  <b>Hyunchul Nha</b>  School of Computational Sciences  Korean Institute of Advanced Study  South Korea</p>	<p><b>Title: "Nonlocality" in quantum mechanics: An outlook through continuous variables</b></p> <p>Abstract:  Since the advent of Bell's inequality, a number of experiments have so far demonstrated to some degree nonlocal correlations in contradiction with the local realistic theories, supporting the description of quantum mechanics. Most of the experimental efforts, however, have been devoted to discrete variables, and more importantly, there has been no conclusive evidence in favor of quantum mechanics mainly due to experimental loopholes. In this talk, we will take some theoretical consideration of continuous variables (CVs) as the original EPR argument, and discuss the possibility of a loophole-free test. The EPR state in itself cannot be used as a source of CV nonlocal correlation, because its Wigner function is positive definite. Nevertheless, we show that a nonlocality test is possible using an optical version of EPR state by employing a measurement scheme based on conditional homodyne detection.</p> <p>(Host: Raymer)</p>
<p>February 23</p> <p><b>Speaker:</b></p>	<p><b>Title: Teaching Physics in an Interdisciplinary High School Setting</b></p>

**Todd Duncan**  
Center for Science  
Education/University  
Studies  
Portland State  
University

Abstract:  
Why should all high school students learn about scientific thinking and "modern" physics? I'll offer some insights from teaching "Embracing Einstein's Universe" (an interdisciplinary, high school - college collaborative course) to shed light on this general question.

(Host: Nöckel)

Monday, February 27  
**Note Special day**

**Speaker:**  
**Steven van Enk**  
Bell Labs, Lucent  
Technologies,  
Murray Hill, NJ

**Title: Verifying Entanglement and Reference Frames**

**SPECIAL LOCATION: 123 Pacific**

Abstract:  
I will discuss a recent experiment [Chou et al., Nature **438**, 828 (2005)] that entangled two atomic ensembles 2.8 meters apart. It turns out that verifying entanglement is harder than creating it. I'll mention several different strategies and explain the method we finally settled on. Then I will analyse how a phase reference is used (and *must* be used) in the experiment, and how in general phase references and reference frames play an indispensable role in all quantum communication protocols including teleportation and superdense coding. This allows me to introduce a new type of resource, a refbit, which is a unit of sharing a reference frame.

(Host: Raymer)

March 2

**Speaker:**  
**Keith Schwab**  
Maryland/Cornell

**Title:**  
**Cooper-Pair Molasses: Cooling a nanomechanical resonator with quantum backaction**

Abstract:

We are performing ultra-low temperature experiments with a radio-frequency, nanomechanical resonator coupled to a superconducting single electron transistor, a system which has demonstrated the closest approach to the uncertainty principle for continuous position detection, and the closest approach to the quantum ground state of a mechanical system<sup>1</sup>. Recently, we have used the resonator to detect the asymmetric, quantum noise of the SET, which produces the back-action close to what is required by the uncertainty principle. In addition, we have discovered an unexpected cooling mechanism, analogous to optical molasses, which is a result of resonant Josephson effects in the transistor. I will discuss this experiment in some detail and give an overview of the pursuit of quantum behavior in ever larger structures.

[1] LaHaye, Buu, Camarota, Schwab, "Approaching the Quantum Limit of a Nanomechanical Resonator," Science **304**, 74 (2004).

(Host: Linke)

March 9

**Speaker:**  
**Paul Doherty**  
Exploratorium San  
Francisco

**Title: A Physicist in a Science Museum**

Abstract:

A physicist in a science museum fills a multitude of jobs. At the Exploratorium in San Francisco I create new science demonstrations and try to get them to work as museum exhibits. I work with writers to try to create text to accompany exhibits that is not wrong. I produce webcast programs about science, such as Iron Science Teacher where physics teachers compete to teach science in a show modeled on a Japanese cooking competition. I also teach the

	<p>museum floor staff physics and best of all I work with High School Physics teachers to help them create science lessons. Occasionally, I get to go on special adventures as a science reporter, to places like the Dry Valleys in Antarctica and to Africa to broadcast a total solar eclipse. In this colloquium I propose to tell you some of my tales and to share with you some of the physics demonstrations I have created over the years.</p> <p>(Host: Stan Micklavzina)</p>
<p>March 16</p> <p><b>Speaker:</b> <b>Jens-Christian D. Meiners</b> University of Michigan</p>	<p><b>Title: Mechanics of Single DNA and RNA Molecules</b></p> <p>Abstract: Single-molecule micromechanical studies of DNA and RNA molecules can reveal a wealth of interesting polymer physics, shed light on mechanical aspects of their biological functions, and pave the way to new biomedical applications. I will discuss these three aspects in selected examples, ranging from experiments that look at the thermal fluctuations and relaxation of single DNA molecules under femtonewton forces to the mechanics of protein-mediated DNA loop formation in a mechanically constrained environment, which in turn has significant implications for understanding major aspects of the regulation of gene expression. In the end, I will also discuss our current work towards building an ultrasensitive biosensor using catalytic RNA molecules, which is based on our understanding of the mechanics of these molecules.</p> <p>(Host: Linke)</p>

## List of past Colloquia

- Fall 2004
- Winter 2005
- Spring 2005
- Fall 2005

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