University of Washington

Physics Colloquium Schedule

Autumn Quarter 2006

Mondays, 4:00 P.M. Ronald Geballe Auditorium, Rm. A102
Coffee & cookies at 3:45 P.M. in the lobby

www.phys.washington.edu/colloquia.htm
~Winter Quarter Colloquium Chair: Professor Craig Hogan~

October 1

Larry Dalton (University of Washington Chemistry)
Title: *"Understanding intermolecular interactions in condensed matter: Effects on order and nonlinear optical properties"*
Abstract: A collaboration among physicists and chemists at the University of Washington has led to quantitative "first-principles" prediction of linear and nonlinear optical properties for a variety of nanostructured organic materials and has led to the introduction of a new class of materials. This overall achievement in condensed matter theory has required developing a quantitative understanding of intermolecular electrostatic interactions including their influence on molecular order and medium dielectric properties. It has also required understanding dispersion relationships for linear and nonlinear optical properties. Dramatic (orders of magnitude) improvement in properties such as electro-optic activity have been inspired by advances in theoretical understanding and new processing material processing methodologies, e.g., laser-assisted electric field poling, have been developed and analyzed.
Quantitative comparison of theory and experiment has required the development of new measurement techniques. The practical consequences of these advances will also be briefly discussed.

October 8

Andres Karch (University of Washington Physics)
Title: "*Applied String Theory*"
Abstract: Strongly coupled systems are omni-present in physics and responsible for a variety of interesting phenomena. For particle physicist two recent examples of experimental relevance are the strongly coupled quark gluon liquid at RHIC and jets and showering in hadron colliders. Many more examples can be found in condensed matter physics. These are areas of active research and provide unique theoretical challenges.Certain strongly coupled systems can be solved analytically using their dual description in terms of a higher dimensional gravitational theory. While no relation to experimental data has been established, these solvable examples still have let to many qualitative insights about the behavior of strongly coupled systems in general. In this talk I'll review recent advances concerning transport properties of these solvable theories and give an outlook on potential future applications to RHIC or LHC physics.

October 15

Stephen Nagler (Oak Ridge National Laboratory)

Title: "*Neuron Scattering at the Frontier*"

Abstract: Over the past half century, neutron scattering has emerged as an indispensable technique for understanding the structure and properties of materials of all types. Within the past year the new accelerator based pulsed Spallation Neutron Source (SNS) has begun operation at Oak Ridge. The SNS facility is open to the worldwide user community with time allocated on the basis of scientific merit. It is expected to usher in a new era for neutron scattering, and to have a tremendous impact on basic and applied science across several disciplines: biology, chemistry, condensed matter physics, and materials engineering. In this talk I will give a brief overview of the neutron scattering technique, describe the SNS and the recently upgraded continuous neutron source HFIR, and discuss some of the potential science opportunities expected over the next few years. Time permitting, detailed examples will include some recent research in low dimensional quantum magnetism, including the possible observation of orbitons on a small magnetic cluster.

October 22

Gregory R. Snow (University of Nebraska)

Title: "*The Pierre Auger Observatory: Capturing Messengers from Outer Space*"

Abstract: Large-aperture cosmic ray observatories are opening a new window to the cosmos. A broad-based international collaboration has come together to build the world's largest air shower detector to make an all-sky study of cosmic rays at energies above 10^{19} eV. As yet there are no known sources and no known mechanism for accelerating particles to the highest energies. Energy, direction, and composition measurements will illuminate the mysteries of these particles, the most energetic in nature. The southern hemisphere site of the Auger Observatory is now approaching completion in Mendoza Province, Argentina. Progress and first results will be reported, as well as plans for the northern hemisphere site. Complementary projects (in Nebraska, Seattle, and elsewhere) which enlist high school science teachers and students in the study of extensive cosmic ray air showers will also be described. (partially funded by the GSFEI)

October 29

Martin Greven (Stanford University)

Title: "*Crystal Growth, Neutron Scattering and Spin Correlations: A Tale of two Complex Oxides*"

Abstract: The study of quantum phase transitions in the presence of disorder is at the forefront of research in the field of correlated electron systems, yet there have been relatively few experimental model materials. We have succeeded in the growth of large single crystals of the randomly-diluted spin-1/2 square-lattice Heisenberg antiferromagnet $La_2(Cu,Zn,Mg)O_4$ up to high dilution concentrations. Our neutron scattering measurements of the instantaneous antiferromagnetic (AF) spin correlations, complemented by numerical experiments, demonstrate that this compound is an excellent system for the study of site percolation in the quantum spin-1/2 limit, and they provide valuable quantitative information for tests of theories [1].

High transition-temperature T_c superconductivity develops near AF phases, and it is possible that magnetic excitations contribute to the superconducting pairing mechanism. In order to assess the role of antiferromagnetism, it is essential to understand the doping and temperature dependence of the two-dimensional AF spin correlations. The phase diagram is asymmetric with respect to electron and hole doping, and for the comparatively less-studied electron-doped materials, the AF phase extends much further with doping and it appears to overlap with the superconducting phase: the archetypical compound $Nd_{2-x}Ce_xCuO_{4\pm\delta}$ shows bulk superconductivity above $x \approx 0.13$, while evidence for AF order has been found up to $x \approx 0.17$. However, our recent inelastic magnetic neutron scattering measurements point to the distinct possibility that genuine long-range antiferromagnetism and superconductivity do

not co-exist. Our measurements furthermore demonstrate that the pseudogap phenomenon in the electron-doped materials arises from a build-up of spin cor relations [2].

[1] O.P. Vajk *et al*., Science **295**, 1691 (2002)
[2] E.M. Motoyama *et al*., Nature **445**, 186 (2007)

November 5

Karl van Bibbler (Lawrence Livermore National Laboratory)
Title: *"A Star in the Lab: The National Facility and Science Program"*
Abstract: The National Ignition Facility (NIF) represents the culmination of 40 years of research towards the achievement of inertial confinement fusion. Scheduled for completion in 2009, NIF should produce thermonuclear burn in the laboratory for the first time ever, in the 2010-2012 time frame. NIF also represents a unique opportunity for basic science, particularly laboratory astrophysics, exotic nuclear physics, and materials under extreme conditions. Although high energy density science is still in its infancy and the feasibility of many of these experiments is still under study, the physical states achieved by NIF are unprecedented and compelling.

November 12

Veteran's Day: No Colloquium

November 19

SPECIAL EVENING COLLOQUIUM IN KANE HALL 130 AT 7PM
Walter Kohn (University of California, Santa Barbara)
Title: *"The Power of the Sun"*
Abstract: "The Power of the Sun" is a 56 minute film directed by Walter Kohn., telling the story of photovoltaic solar cells, including their science, history, practical implementation, and future in meeting the world's energy needs. It is appropriate for a general audience including non-scientists and scientists alike, as well as policy makers and all those concerned with energy and environmental issues. The film will be followed by a question and answer session with Professor Kohn.

November 26

Risa Wechsler (Stanford)
Title: "*Lighting Up the Dark: Galaxies as Probes of the Dark Universe"*
Abstract: The picture of our Universe which has emerged from numerous complementary observations over the past decade is a surprising one: most of the matter in the Universe isn't visible, and most of the Universe isn't matter at all. Nevertheless, visible light emitted from galaxies remains the main probe of this dark Universe. I will describe several recent advances towards understanding the connection between galaxies to the underlying dark matter distribution. These combine the results of numerical simulations of cold dark matter with observations of galaxy clustering and of galaxy clusters, including new results from a sample of 14,000 clusters selected from the Sloan Digital Sky Survey. I will also describe how galaxies and galaxy clusters can be used to study the dark energy that dominates our Universe, using a new generation of photometric surveys.

December 3

Jeff Kimble (Caltech)

Title: "*The Quantum Optics Circus -- Flying Photons, Acrobatic Atoms, and Entangled Ensembles*"

Abstract: Since the inception of Quantum Optics more than 50 years ago, remarkable advances have been made in the exploration of the quantum character of light, including the microscopic control of single atoms and photons. Laser operation has been pushed to the conceptual limit of one acrobatic atom in the regime of strong coupling. Single, flying photons can be generated deterministically at the push of a button. Ensembles of atoms can be projected into entangled quantum states by the "click" of a photodetector. Beyond their fundamental significance, such advances are helping to lay the foundation for the new science of Quantum Information, including the realization of complex quantum networks.

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