



Physics Department Colloquia Winter 2007



Colloquia are at **4pm, Thursdays**, in **100 Willamette Hall** and are preceded by coffee, tea, and cookies at 3:40 in the Wilamette Atrium.

Speakers: Information, including maps and directions to the Physics Department, can be found [here](#) (compiled by Graham Kribs, Fall 2006).

[Raghuveer Parthasarathy](#) is the organizer of the Winter 2007 colloquia.

Colloquium Schedule

Date	Speaker
Jan. 11, 2007	Sayantani Ghosh -- UC Merced, Department of Physics ; <i>URLs:</i> [1] , [2] Manipulating Spin Coherence in Semiconductors -- Abstract Host: <i>Raghuveer Parthasarathy</i>
Jan. 18, 2007	Peko Hosoi -- MIT, Department of Mechanical Engineering ; <i>URLs:</i> [1] , [2] , [3] Optimizing Low Reynolds Number Locomotion -- Abstract

Host: *Raghuveer Parthasarathy*

Jan. 25, 2007 **Dugan O'Neil** -- Simon Fraser University, Department of Physics ; *URL:* [\[1\]](#)

Seeking Single Top Quarks in D0 -- [Abstract](#)

Host: *David Strom*

Feb. 1, 2007 **Eric Dufresne** -- Yale University, Departments of Physics, Mechanical Engineering, and Chemical Engineering; *URL:* [\[1\]](#)

Shedding Light on Brownian Motion -- [Abstract](#)

Host: *Raghuveer Parthasarathy*

Feb. 8, 2007 **David Griffiths** -- Reed College; *URL:* [\[1\]](#)

Critical Dipoles and Singular Potentials -- [Abstract](#)

Host: *Mike Raymer*

Feb. 15, 2007 **David Gross** -- UC Santa Barbara; *URL:* [\[1\]](#)

The coming revolutions in fundamental physics -- [Abstract](#)

Host: *Davison Soper*

Feb. 22, 2007 **Jim Remington** -- University of Oregon; *URL:* [\[1\]](#)

Photophysics of Fluorescent Proteins -- [Abstract](#)

Host: *Raghuveer Parthasarathy*

Note: The previously scheduled seminar (*The Science of Optics; The History of Art* -- Charles Falco) has been cancelled.)

Mar. 1, 2007 **David Cobden** -- Univ. of Washington; *URL:* [\[1\]](#)

Nanotubes and nanowires: experiments on interacting electrons in one dimension -- [Abstract](#)

Host: *Raghuveer Parthasarathy*

**Mar. 8,
2007** **Sean Carroll** -- Caltech; *URL:* [\[1\]](#)

Dark Energy, or Worse? -- [Abstract](#)

Host: *Graham Kribs*

**Mar. 15,
2007** **Alan Rempel** -- Univ. of Oregon, Department of
Geological Sciences; *URL:* [\[1\]](#)

The Premelting of Ice -- [Abstract](#)

[Raghuveer Parthasarathy, Department of Physics , University of Oregon.](#)

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Abstracts

Sayantani Ghosh -- *Manipulating Spin Coherence in Semiconductors*

There is a growing interest in exploiting electron spins in semiconductor nanostructures for the manipulation and storage of information for emergent technologies based upon spintronics and quantum logic. Here I provide an overview of recent developments in the area through measurements that focus on the generation and manipulation of spins in conventional semiconductors using all-electrical and optical protocols. These include: (a) Optical manipulation of electron spins in semiconductor microcavities[1]. (b) Electrical control of spin lifetime in oxide-based semiconductors, where spin coherence persists till room temperature[2], providing a basis for developing a realistic spintronic-based device operational under ambient conditions. (c) Current and strain-induced spin polarization [3] in bulk semiconductors.

Peko Hosoi -- *Optimizing Low Reynolds Number Locomotion*

In this talk I will discuss two optimization topics related to low Reynolds number locomotion: optimal stroke patterns in linked swimmers and optimal fluid material properties in adhesive locomotion. In contrast to many optimization problems, we do not consider geometry, rather we optimize the swimming kinematics or fluid material properties for a given geometrical configuration. In the first case, we begin by optimizing stroke patterns for Purcell's 3-link swimmer. We model the swimmer as a jointed chain of three slender links moving in an inertialess flow. The swimmer is optimized for both efficiency and speed. In the second case, we analyze the adhesive locomotion used by common gastropods such as snails and slugs. Such organisms crawl on a solid substrate by propagating muscular waves of shear stress on a viscoelastic mucus. Using a simple mechanical model, we derive criteria for favorable fluid material properties to lower the energetic cost of locomotion.

Dugan O'Neil -- *Seeking Single Top Quarks in D0*

You are: single, non-smoking and produced via the electroweak interaction. We are: 700 physicists interested in having fun and in measuring V_{tb} for the first time. We know you are out there somewhere, please contact us through our 5000 ton mutual friend.

The top quark was discovered in 1995. Physicists are now studying its properties in detail at the Fermilab Tevatron, just outside Chicago. Until now, we have observed only top quark pair production via the strong interaction. However, the Standard Model of particle physics also predicts the production of single top quarks via the electroweak interaction. This mechanism gives us our first chance at a direct measurement of V_{tb} , and the best sample in which to study spin polarization effects in quarks. If only we could find it! Well, there is hope! The D0 experiment has recently announced first evidence of single top quark production. After introducing the D0 experiment and motivating our interest in single top quarks, I'll present the status of our recent efforts to find this elusive signal.

Eric Dufresne -- *Shedding Light on Brownian Motion*

Colloidal suspensions are ubiquitous. Blood, toothpaste, and ink are a few familiar examples. Colloids first captured the imagination of physicists with Einstein's 1905 paper on Brownian motion. Now, colloids are increasingly chosen as model condensed matter systems because of their relative accessibility and versatility. In this talk, I will describe our recent work on optical micromanipulation and colloidal electrostatics. In particular, I will show how Einstein's formulation of the fluctuation-dissipation theorem can be exploited to measure femtonewton-scale forces between colloidal particles.

David Griffiths -- *Critical Dipoles and Singular Potentials*

The Schrodinger equation for a point charge in the field of a stationary electric dipole admits bound states when the dipole moment exceeds a certain critical value. It is not hard to see why this might be the case, but it is surprisingly difficult to calculate the critical dipole moment. One method exploits a

connection between this problem and the infamous inverse x -squared potential on the half-line, an intriguing system that confounds all our quantum intuitions. Resolving its paradoxes involves sophisticated theoretical machinery: renormalization, anomalies, and self-adjoint extensions..

David Gross -- *The coming revolutions in fundamental physics*

I review the present state of knowledge in elementary particle physics and the questions that we are currently addressing. I discuss the experimental revolutions that might occur at the Large Hadron Collider, soon to be finished at CERN. I shall also review the state of string theory. The necessity to go beyond the standard model of particle physics and to understand quantum gravity has led to this ambitious attempt to unify all the forces of nature and all forms of matter as different vibrations of a string-like object. But string theory is still in a pre-revolutionary stage. Although remarkable progress has been achieved in the last decade in understanding the perturbative and non-perturbative structure of string theory, we still lack a fundamental understanding of the theory. Many string theorists suspect that a profound conceptual change in our concept of space and time will be required for the final formulation of string theory.

Jim Remington -- *Photophysics of Fluorescent Proteins*

The discovery and application of the Green Fluorescent Protein (GFP) as a visible molecular label has led to a genuine revolution in cell biology and lately, in optical microscopy. Within GFP a small molecule is encased in a rigid protein shell, which in turn controls the fluorescence emission properties of the small molecule in ways that can never be achieved in solution. I will describe two recent developments in our understanding of the photophysics of the emission process. First is Excited State Proton Transfer (ESPT), in which light drives a naked proton around a tiny circuit whose connections can be controlled by DNA manipulation. Data from structural studies and femtosecond spectroscopy suggest that this system will provide insight into the now 200 year old question as to whether proton migration in pure water (which rate is far faster than diffusion) is stepwise or concerted. Second, photoactivatable fluorescent proteins (PAFPs) have been discovered whose fluorescence can be switched on and off by light of the appropriate wavelength. PAFPs have now permitted the development of a seemingly impossible type of visible light microscope: one capable of nondestructively imaging labeled structures within cells at 10 nm resolution, thus breaking the diffraction barrier by a factor of about 20. I will show you how both the microscope and the PAFPs work.

David Cobden -- *Nanotubes and nanowires: experiments on interacting electrons in one dimension*

The behavior of interacting particles confined to a line (ie, moving in only one dimension, 1D) has long been a theoretical testbed of ideas, but until recently it was viewed as having limited verifiability in the laboratory. Recently this view changed, largely as a result of the discovery a decade ago of

single-walled carbon nanotubes. Nanotubes are molecular quantum wires with 1D electronic dispersion. They have many potential applications which will benefit from a better understanding of their fundamental properties. The single-electron properties of nanotubes, such as the excitation spectra of nanotube quantum dots (that is, essentially particles in a 1D box), have now been well established. On the other hand, the consequences of electron-electron interactions in nanoscale or 1D systems are significant, varied, and still only partially understood. This talk will survey our experiments on nanotubes, and on nanowires of other materials, aiming to probe many-body phenomena in them such as the Kondo effect, the Luttinger liquid, response to either a random or a periodic potential, and the metal-insulator phase transition.

Sean Carroll -- *Dark Energy, or Worse?*

Our universe is accelerating and we don't know why. Together, ordinary matter and ordinary gravity are unable to account for this phenomenon. The simplest explanation invokes "dark energy," a smooth and persistent component of the universe's energy budget, which could be a cosmological constant or a slowly-varying field. Alternatively, Einstein's theory of general relativity could be breaking down on cosmological scales. I will discuss the basic evidence for the accelerating universe, some of the theoretical proposals that have been put forward to account for it, and future observational tests that will help us distinguish between the possibilities.

Alan Rempel -- *The Premelting of Ice*

A solid-liquid interface cannot always be regarded on its own. There must be something on the other side, be it vapor, a second solid crystal, or some other foreign substrate. As the solid-substrate separation decreases, long-ranged intermolecular forces come into play and contribute towards the total free energy of the system. At bulk coexistence, if the free energy is minimized by the insertion of a macroscopic liquid film that separates the solid from the substrate, we say that the solid is wetted by its melt. A reduction in temperature lowers the free energy of the solid relative to the bulk liquid, yet a premelted liquid film will persist so long as the interfacial component to the free energy is reduced by maintaining a larger solid-substrate separation. Equilibrium is achieved precisely at the film thickness where a decrease would liberate less latent heat than the rise in interfacial energy caused by increased proximity with the substrate and the corresponding strengthening of intermolecular interactions. This is how melting begins in all classes of solids. I discuss some of the geophysical implications of the premelting of ice. I pay particular attention to the mechanical consequences of premelting behavior - especially their influence on how dirt freezes and land-based glaciers float.