

University of Washington  
**Physics Colloquium Schedule**  
Winter Quarter 2008



*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](http://www.phys.washington.edu/colloquia.htm)

~Winter Quarter Colloquium Chair: Professor Marcel den Nijs~

**January 7**

**First Day of Classes, no colloquium**

**January 14**

**Speaker: Konstantin Novoselov, University of Manchester**

**Title:** *"QED in a Pencil Trace"*

**Abstract:** When one writes by a pencil, thin flakes of graphite are left on a surface. Some of them are only one angstrom thick and can be viewed as individual atomic planes cleaved away from the bulk. This strictly two dimensional material called graphene was presumed not to exist in the free state and remained undiscovered until the last year. In fact, there exists a whole class of such two-dimensional crystals. The most amazing things about graphene probably is that its electrons move with little scattering over huge (submicron) distances as if they were completely insensitive to the environment only a couple of angstroms away. Moreover, whereas electronic properties of other materials are commonly described by quasiparticles that obey the Schrödinger equation, electron transport in graphene is different: It is governed by the Dirac equation so that charge carriers in graphene mimic relativistic particles with zero rest mass. The very unusual electronic properties of this material make graphene a promising candidate for future electronic applications.

**January 21**

**Holiday, no colloquium**

**January 28**

**Speaker: Eytan Domany, Department of Physics of Complex Systems, Weizmann Institute**

**Title:** *"Predicting outcome in cancer: Hope, Hype, Physics and. . . Biology"*

**Abstract:** Considerable effort has been devoted during the recent five years to identify gene expression signatures that predict aggressiveness and outcome of cancer at the time of its discovery. In breast cancer, different groups used different cohorts of patients and different DNA microarrays to produce short-lists of predictive genes, and reported high success rates. Unfortunately, the predictive lists found by different groups had very few genes in common.

Eytan will review some of this work, point out problematic aspects of it and present PAC-ranking, a method designed to estimate the number of training samples needed to produce a robust predictive gene list.

If time permits, Eytan will describe briefly an ongoing study of colon cancer, where the machine - learning approach taken in the studies of breast cancer was replaced by one that focuses on the underlying biology.

**February 4**

**Speaker:** Paul Yager, University of Washington (Dept. of Bioengineering)

**Title:** *"Stumbling into microfluidics along the road to point-of-care medical diagnostics"*

**Abstract:** For the last 15 years many of us have been working to decentralize medical testing in the way that computing has been decentralized since the 1950s. The primary aim has been to develop small inexpensive widgets capable of measuring the concentrations of molecules of medical importance in small volumes of biological fluids. For years we focused on developing the fluidic equivalent of elementary electronic components, and therein rediscovered the richness of life at low Reynolds numbers. We also have been developing optically-based assays for molecular binding that are rapid, multiplexable, and that could be implemented inexpensively; major efforts have been based on absorption, fluorescence and surface plasmon resonance imaging. Today, under funding from organizations like NIH and the Bill & Melinda Gates Foundation, we're doing our first full systems integration. Ironically, we may soon be able to bringing revolutionary new types of diagnostic capabilities first into the hands of those providing medical care to the poorest people in the world.

**February 11**

**Speaker:** Christopher Jarzynski, University of Maryland

**Title:** *"Nonequilibrium thermodynamics at the microscale"*

**Abstract:** What do the laws of thermodynamics look like, when applied to microscopic systems such as optically trapped colloids, single molecules manipulated with laser tweezers, and biomolecular machines? Over the past decade or so there has been considerable interest and progress in addressing this question. I will give an overview of some of these developments, with a focus on results pertaining to fluctuations far from thermal equilibrium, and I will argue that these developments have refined our understanding of the second law of thermodynamics.

**February 18,**

**Holiday, no colloquium**

**February 25**

**Speaker: Sanjay Reddy (Los Alamos National Lab)**

**Title:** *"The Nuclear Astrophysics of Neutron Stars"*

**Abstract:** Advances in x-ray, gamma-ray and neutrino astronomy now enables us to obtain very detailed information about high energy astrophysical processes. I will describe how nuclear and neutrino physics plays an essential role in the interpretation of data relating to cosmic explosions and neutron star evolution. Core-collapse supernova, x-ray bursts, superbursts, and giant flares are powered by nuclear and weak interaction processes occurring inside neutron stars. Through theory and simulations we can identify and understand specific correlations between the underlying nuclear physics and the astrophysical observations. I will outline how the interplay between theory, simulation and observations has the potential to address fundamental questions relating the nature of matter at supranuclear density, the dynamics of neutrinos in dense environments, and possibly provide insights about physics beyond the standard model.

**March 3**

**Speaker: Gerald A. Miller (University of Washington, Department of Physics)**

**Title:** *"Simple Stochastic Model of Transportation"*

**Abstract:** The central dogma of biology is that "DNA makes RNA makes protein". Proteins are the work-horse of the cell, performing an astonishing array of functions. These include serving as catalysts in all metabolic processes, storing and transporting essential metabolites carbon dioxide and oxygen and regulating the expression of genetic information. Transcription is the process whereby DNA is copied into the messenger-RNA that tells cells how to make protein. A copying protein, RNA Polymerase (Pol II), acts as an enzyme to make the RNA. Recent experimental developments at the UW Medical School enable the study of the space-time dependence of the Pol II as it propagates down the length of the DNA. This process is believed to be random, so we are developing a simple model, using the Fokker-Planck equation, in which the transcription process is described by a three or four phenomenological parameters. The literature suggests that two of these parameters can be strongly influenced via treatment with external chemicals. If so, one could quantify the relation between treatment and cell behavior. This could lead to new kind of therapy.

**March 10**

**Speaker: Eberhard Fetz (University of Washington, Dept. Physiology and Biophysics)**

**Title:** *"Towards Principles of Neural Computation in the Brain"*

**Abstract:** Discovering the operating principles of the brain represents a significant challenge. The unique complexity of the brain would seem to put it beyond the purview of simple physical analysis, but this may reflect the complexity of an autonomous non-linear parallel distributed processing system,

not the absence of underlying principles of neural computation. While neural interactions can be described by "equations of motion", these fail to capture the essential information processing functions that mediate behavior. The properties of biological and artificial neural networks provide a rich basis for pursuing the mechanisms of neural computation. The cerebral cortex has functional subdivisions, each composed of similar columns of neurons that encode sensory and motor representations, leading to models of hierarchical processing of such representations. The parallel distributed processing of information in neural networks has interesting resemblance to holographic mechanisms. A promising candidate for the essential computation performed by cortical columns involves combining bottom-up and top-down information flow to implement memory-based prediction. This predictive coding operation could be performed by cortical columns at all functional levels, from sensory areas through association and motor areas. These topics will be reviewed toward initiating further discussion of possible principles underlying brain function.

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