# Plenary Talks

**Friday, 1:35 PM – BH 166**

**Doyle, Patrick**
Massachusetts Institute of Technology

***``DNA Dynamics in Nanoconfinement and Electric Fields"***

Controlled stretching of DNA molecules is critical for single molecule genomic and polymer physics studies. To date, most devices have relied on hydrodynamic flows to stretch DNA in an unconfined environment. In contrast, we employ electric field gradients to electrophoretically deform DNA. The purely elongational nature of electric field allows us to use very thin nanofluidic channels and thus explore how nanoconfinement can affect stretching. Here we experimentally study DNA stretching dynamics in a nano-slit cross-slot device. We measure three steady-state quantities at varying strain rates: the average extension, the magnitude of extension fluctuations, and the average orientation of the DNA molecules in the electric field. By comparison with the unconfined case, we show that the presence of the nanoconfinement results in a highly-modified coil-stretch transition of the DNA. We develop a model to demonstrate that these experimental observations are directly related to the fact that the confinement alters the conformational energy landscape of the DNA molecules.

**Friday, 2:20 p.m. – BH166**

**Reed, Mark A.**
Departments of Electrical Engineering and Applied Physics
Institute for Nanoscience and Quantum Engineering
Yale University

***``CMOS Nanowire Biosensor Systems***

Nanoscale electronic devices have the potential to achieve exquisite sensitivity as sensors for the direct detection of molecular interactions, thereby decreasing diagnostics costs and enabling previously impossible sensing in disparate field environments. Semiconducting nanowire-field effect transistors (NW-FETs) hold particular promise, though contemporary NW approaches are inadequate for realistic applications. We present here a number of top-down fabricated nanowire approaches that are compatible with complementary metal-oxide-semiconductor (CMOS) technology that has not only achieved unprecedented sensitivity, but simultaneously facilitates system-scale integration of nanosensors. These approaches enable a wide range of label-free biochemical and macromolecule sensing applications, such as specific protein and complementary DNA recognition assays, and specific macromolecule interactions at <femtomolar concentrations. An important achievement is the introduction of real-time, unlabeled detection capability which allows for fundamental studies of cellular activation, cell type discrimination through the monitoring of live, stimulus-induced cellular response, and live

cell peptide-specific immunoresponse. A critical limitation of nanowire sensors is the Debye screening issue which has to date prevented their use in clinical applications and physiologically relevant solutions. We will present an approach that solves this longstanding problem, and demonstrate the detection at clinically important concentrations of cancer biomarkers from whole blood samples.

**Friday, 3:40 p.m. – BH166**

**Karnik, Rohit**
Department of Mechanical Engineering
Massachusetts Institute of Technology

***``Analysis of Single Molecules and Particles by Active Control in Nanofluidic Devices"***

Nanofluidics involves flow of ions, molecules, and fluids in channels with dimensions approaching molecular length scales. In particular, nanofluidic devices offer the capability of single molecule detection by monitoring change in ionic current through nanopores or nanochannels during translocation (passage) of a molecule through the pore. This current signal can yield information about the size, charge, conformation, and molecular interactions within the pore. However, nanopore sensors can typically perform only a single measurement on a molecule, precluding observation of dynamic events and also limiting the ability of the pore to sensitively distinguish between different molecules. To enhance the discrimination ability of nanopore sensors, we are developing methods for active manipulation of single molecules in nanofluidic devices. As a first step, we have demonstrated multiple measurements on the same DNA molecule by active feedback control: upon detection of a translocation signal the voltage bias was reversed, which allowed for hundreds of measurements on the same molecule. Multiple measurements allowed for statistical averaging of the translocation signal, which increased the ability of the pore to distinguish between DNA molecules of different lengths. This approach may lead to rapid single molecule and single particle assays including DNA fragment sizing and enzymatic digestion assays, analysis of colloidal or polymer suspensions, and sizing of biomolecules.

**Saturday, 10:00 a.m. – BH166**

**Pritchard, David E.**
Green Professor Physics, MIT; developer of Mastering Physics

***``What Are Students Learning, and From What Activity?"***

What knowledge are students learning? If so, what instructional activities are they learning from? What student habits are helpful or detrimental to learning? What learning do they remember at graduation? We must be able to answer these questions in order to improve our educational process scientifically. Fortunately the use of electronic tutors and electronic data recording in more traditional courses makes available data that answer some of these questions. I will also describe a software tutor that really helps students learn.

Finally I shall address a key question - what do we really want students to learn? Given that most teachers want students to become more expert-like, I will describe a pedagogy, "Modeling Applied to Problem Solving" that has achieved this result. These studies were done in introductory college physics.

For a preview of the research see http://relate.mit.edu

**Saturday, 10:45 a.m. – BH166**

**Halas, Naomi J.**
Rice University

***``Optically-directed Nanobiomedicine: merging nanotechnology with light for improved diagnostics and new therapeutics"***

Stanley C. Moore Professor of Electrical and Computer Engineering, Professor of Physics and Astronomy, Professor of Chemistry, Professor in Bioengineering and Director, Laboratory for Nanophotonics, Rice University, Houston, TX, USA 77005

Just beyond the wavelengths of visible light, the near infrared region of the optical spectrum provides a window into the human body. In this region of the spectrum, known as the "water window", light penetrates several inches into body, making virtually all soft tissue of the body optically accessible. This has opened up the possibility of developing optical addressable diagnostic methods, devices, even therapies that are essentially noninvasive. An example of this is Optical Coherence Tomography, an emerging technology useful for near infrared imaging of tumors. Our work over the past several years has involved the development of nanoshells, a plasmonic nanoparticle we designed that selectively absorbs or scatters light in this special wavelength region. We have developed a suite of applications for plasmonic nanoparticles to address challenges in human health that include drug and gene delivery, enhancing the resolution of bioimaging modalities, and a novel, nanoengineered cancer therapy, currently in clinical trials. In my talk I will describe the physical principles behind these applications, and why this approach may expand our vision for combating disease and improving human health.

**Saturday, 11:30 a.m. – BH166**

**Nordlander, Peter**
Rice University

***``Plasmonic Nanostructures: Artificial Molecules"***

The recent observation that metallic nanoparticles possess plasmon resonances that depend sensitively on the shape of the nanostructure has led us to a fundamentally new understanding of the plasmon resonances supported by metals of various geometries. This picture- "plasmon hybridization",[1] reveals that the collective electronic resonances in metallic nanostructures are mesoscopic analogs of the wave functions of simple atoms and molecules, interacting in a manner that is analogous to hybridization in molecular orbital theory. The new theoretical insight gained through this approach provides an important conceptual foundation for the development of new plasmonic structures that can serve as substrates for surface enhanced spectroscopies and subwavelength plasmonic waveguiding and other applications. The talk is comprised of general overview material of relevance for chemical applications interspersed with a few more specialized "hot topics" such as plasmonic interference effects,[2] Quantum effects,[3] and single molecule SERS and LSPR sensing [4].

[1] H. Wang *et al.*, Acct. Chem. Res. 40(2007)53
[2] J.A. Fan *et al.*, Science 328(2010)1135, J.B. Lassiter *et al.*, Nano Lett. 10(2010)3184
[3] J. Zuloaga *et al.*, Nano Lett. 9(2009)887, ACS Nano 4(2010)ASAP
[4] D. Ward *et al.*, Nano Lett. 8(2008)919, K.S. Mayer *et al.*, Nanotechnology 21(2010)255503

# APS Contributed Talks

## Saturday, 8:00 a.m.

### BH160:

**``Rectification in Doped Mott Insulators Junctions"**
***Florian Sabou*, *John Marston***

We discuss junctions made from doped Mott insulators [1] as a way to achieve rectification at high frequencies. To simulate such a junction we use a model of spinless electrons moving in one dimension, the t-V chain, and control the chemical potential on the two halves of the chain to create a p-n junction [2]. For short chains the many-body Schrodinger equation can be integrated numerically exactly, and we find that when subjected to an oscillating electromagnetic field such a device exhibits rectification with a preferred direction for charge transfer. Rectification is a function of both the frequency and the size of the oscillating electric field. [1] J. Orenstein and A. Vishwanath, ``Doped Mott Insulators. Breaking through to the other side," Nature Physics 6, 566 (2010). [2] E. Manousakis, ``Photovoltaic effect for narrow-gap Mott insulators," Phys. Rev. B82, 125109 (2010.

### BH161:

**``Investigating Early Stage Crystal Growth Process Using Blotless Microfluidic Cryo-TEM"**

***Jinkee Lee*, *Arijit Bose*, *Anubhav Tripathi***

We study the early stages of calcium carbonate crystal growth using blotless microfluidic chip integrated cryogenic transmission electron microscopy (cryo-TEM). We also explore the interaction of polymer additives on crystal growth process ($CaCl_2$ (0.01M) + $Na_2$ $CO_3$ (0.01M) (+ polymer additives) $\rightarrow$ $CaCO_3$ +2 NaC). Three types of carboxylated hyperbranched polyglycerol were used as the polymer additives for retarding crystallization $CaCO_3$. A blotless microfludic CEVS is newly designed to capture crystal growth process at time scales on .5 to 100 seconds. This computer controlled CEVS removes blotting and relaxation step which generally takes at least 3 second. The chemical reaction can be allowed to occur both on the TEM grid as well inside the microfluidic channel. Our results show that upon mixing $CaCl_2$ and $Na_2$ $CO_3$ solutions, emulsion like amorphous structure are initially formed. Subsequently, in 1 -2 seconds, these structures decompose into CaCO3-veterite nanoparticles. The polymer additives are shown to retard this crystallization processes even 12 seconds. The crystalline or amorphous diffraction patterns were collected to verify this finding. This new CEVS system can be used broadly to study early time structures in nanoscale systems under the very controlled conditions for chemical, biological and pharmaceutical researches and industries.

## Saturday, 8:20 a.m.

## BH160:

**``Gravitational Wave Emission from the Single-Degenerate Channel of Type Ia Supernovae"**

***Robert Fisher*, *David Falta*, *Gaurav Khanna***

The thermonuclear explosion of a C/O white dwarf as a Type Ia supernova (SN Ia) generates a kinetic energy comparable to that released by a massive star during a SN II event. Current observations and theoretical models have established that SNe Ia are asymmetric, and therefore -- like SNe II -- potential sources of gravitational wave (GW) radiation. We explore detonation-powered GWs as a potential probe of the explosion mechanism of SNe Ia. We establish an upper-bound GW amplitude and expected frequency range based upon the nearly-universal energetics and nucleosynthetic yields of SNe Ia. We calculate a refined estimate of the GW signal from the single-degenerate channel of SNe Ia using three-dimensional hydrodynamical simulations that undergo a gravitationally-confined detonation (GCD). The GCD mechanism predicts a strongly-polarized GW signal from the single-degenerate channel of SNe Ia that would be detectable in the band around 1 Hz from planned GW observatories, at distances up to several Mpc. If observable, GWs may offer a direct probe into the first few seconds of a SN Ia, and yield insights into its underlying detonation mechanism not possible in the optical portion of the spectrum.

## BH161:

**``Nanowire-nanopore transistor sensor for DNA detection"**
***Ping Xie*, *Qihua Xiong*, *Ying Fang*, *Quan Qing*, *Charles Lieber***

Nanopore sequencing, as a promising low cost, high throughput sequencing technique, has been proposed more than a decade ago. Due to the incompatibility between small ionic current signal and fast translocation speed and the technical difficulties on large scale integration of nanopore for direct ionic current sequencing, alternative methods rely on integrated DNA sensors have been proposed, such as using capacitive coupling or tunnelling current etc. But none of them have been experimentally demonstrated yet. Here we show that for the first time an amplified sensor signal has been experimentally recorded from a nanowire-nanopore field effect transistor sensor during DNA translocation. Independent multi-channel recording was also demonstrated for the first time. Our results suggest that the signal is from highly localized potential change caused by DNA translocation in none-balanced buffer condition. Given this method may produce larger signal for smaller nanopores, we hope our experiment can be a starting point for a new generation of nanopore sequencing devices with larger signal, higher bandwidth and large-scale multiplexing capability and finally realize the ultimate goal of low cost high throughput sequencing.

## Saturday, 8:40 a.m.

## BH160:

**``Statistical Equilibria of Turbulence on Surfaces of Different Symmetry"**

***Wanming Qi*, *John Marston***

We test the validity of statistical descriptions of freely decaying two-dimensional turbulence by performing direct numerical simulations (DNS) of the Euler equation with hyperviscosity on two surfaces of different symmetry, namely, the square torus and the sphere. DNS shows, at long times, a dipolar coherent structure in the vorticity field on the torus but a quadrapole on the sphere [1]. We look for a theoretical explanation in the truncated Miller-Robert-Sommeria theory that conserves the fine-grained enstrophy, while also respecting conservation laws that reflect the symmetry of the domain. This theory is shown to be equivalent to the phenomenological minimum-enstrophy principle [2]. Finally, the theoretical results agree with DNS, and the calculation reveals how the conservation of zero angular momentum forces the sphere to have one more dipole pair than on the torus. [1] J. Y-K. Cho and L. Polvani, ``The emergence of jets and vortices in freely evolving, shallow water turbulence on a sphere," Phys. Fluids 8, 1531 (1996). [2] A. Naso, P. H. Chavanis, and B. Dubrulle, ``Statistical mechanics of two-dimensional Euler flows and minimum enstrophy states," Eur. Phys. J. B (2010).

## BH161:

**Translocation dynamics of hybridized DNA oligomers studied by solid-state nanopores**

***Venkat Balagurusamy*, *Paul Weinger*, *Xinsheng Ling***

We have earlier detected 12-base hybridizations in trimer DNA complexes formed by three single-stranded DNA oligomers hybridized at their ends sequentially, using nanopores of \sim 10 nm diameter. These complexes are connected to a polystyrene bead at one end to slow down their translocation [1]. These experiments tested the feasibility of HANS (Hybridization-assisted nanopore sequencing) approach for DNA sequencing. HANS uses oligomers of DNA bound to a long single-stranded DNA in order to obtain the positional information of the bases that make up the long target DNA molecule. Subsequently, we have carried out translocation experiments at different voltages with nanopores \sim 5 nm diameter. The measured time lapses between the passage of consecutive double-strand DNA segments in a trimer complex allow us to study the translocation dynamics. The measured mean-first-passage time between two consecutive hybridization segments is found to be consistent with theoretical estimates.[1] V.S.K.Balagurusamy, P.Weinger and X.S.Ling, *Nanotechnology* **21**, 335102 (2010).

## Saturday, 9:00 a.m.

### BH160:

**``Hyperfine Interaction Estimation of Nitrogen Vacancy Center in Diamond"**

***Yutaka Shikano*, *Shu Tanaka***

A nitrogen vacancy center, NV center, in diamond is studied as a promising candidate for a qubit in quantum information technology, especially as quantum storage devices, since the electron spin can be optically initialized, read out and transferred its quantum information to the $C^{13}$ nuclear spin by the hyperfine interaction. However, it is difficult to evaluate the hyperfine interaction when we do not know the relative position of the $C_{13}$ nuclear spin. We theoretically propose a new experimental protocol using the weak measurement technique without knowing the relative position of the nuclear spin. In this presentation, we will present its advantage and the extension to the quantum media conversion systems.

### BH161:

**``Actin -- myosin interaction"**

***Cynthia Prudence*, *Yana Reshetnyak*, *Oleg Andreev***

Muscle contraction is resulted from the interaction of myosin with actin and ATP. The study of kinetics of binding of myosin subfragment 1 (S1) to F-actin revealed the two step binding, which were modeled by initial binding of S1 to one actin monomer (state 1) and then to the second neighboring monomer (state 2). The results of time-resolved cross-linking of S1 and F-actin upon their rapid mixing in stopped flow apparatus directly demonstrated that myosin head initially binds through the loop 635-647 to the N-terminus of one actin and then through the loop 567-574 to the N-terminus of the second actin (Andreev & Reshetnyak, 2007, J. Mol. Biol. 365(3), 551-554). The computational docking of S1 with F-actin demonstrated that both actin monomers are located in the same strand of F-actin with the first and second actins being close to the pointed and barbed ends of F-actin, respectively. The closing of the main cleft in 50 kDa of S1 might prevent binding of S1 with two actins since the distance between loops 635-647 and 567-574 became too short to interact with N-termini of two actins simultaneously. Depending on degree of saturation of F-actin with S1s there are two structurally different complexes are formed: at complete saturation each S1 binds only one actin and its cleft is closed while at partial saturation S1 interacts with two actins and its cleft is opened. The transition between one- and two-actin binding states of myosin accompanying with opening the cleft in central domain of S1 might be associated with force generation. The formation of actin-myosin interface would be associated with the energy release that might be used in part for the generation of force in muscle

## Saturday, 9:20 a.m.

## BH160:

### ``Controllable binding of polar molecules and meta-stable of 1-D dipolar gases with attractive dipole forces"

***Robin Cote***

The recent achievements in the formation and manipulation of ultracold polar molecules have opened the gate to exciting new studies in several fields of physical sciences. Polar molecules could find uses in quantum information science and in precision measurements while dense samples could provide a fertile ground for novel quantum gases because of their long-range and anisotropic interactions. Until now, stable dipolar gases were though to require a repulsive dipole-dipole interaction, such as provided by dipoles aligned and perpendicular to the vector joining them. However, to observe interesting new correlations and condensed matter phases, attractive interactions are needed. Here, we explore how meta-stable one-dimensional (1-D) samples of ultracold polar molecules could be created with attractive long-range dipole-dipole interaction. We show that a repulsive barrier due to a strong quadrupole interaction can stabilize a gas of ultracold KRb molecules and even lead to long-range wells supporting bound states. The properties of these wells can be controlled by external electric fields, allowing the formation of long chains of KRb polymers, and the further study of Luttinger liquid transition.

## BH161:

### ``Explorations of climate predictability based on long term global sea surface temperature observations"

***Constantin Andronache***

While the detailed weather prediction is limited to about two weeks, skilful seasonal forecast is possible in the presence of slow varying boundary conditions (BC) of the atmosphere. Such conditions are satisfied by the sea surface temperature anomalies (SSTA) over large oceanic regions. These BC typically evolve on a much slower time scale than daily weather events and atmospheric predictability can be increased significantly. SSTA tend to have persistence or long memory, due largely to the thermal inertia of the oceans, caused by their heat storage capacity. The ocean communicates its thermal inertia to the atmosphere largely via the surface turbulent fluxes of sensible and latent energy. We use the NOAA Extended Reconstructed Sea Surface Temperature (SST) to investigate sources of predictability at seasonal time scale. We show that: 1) SSTA has a memory or persistence that depends largely on regional location in the global ocean, with the largest values in tropical Pacific; 2) A given SSTA distribution from a particular month, can have corresponding similar configurations in the past, largely due an oscillatory behavior of major SSTA perturbations; 3) Correlation of SSTA from different regions of the global ocean provide a valuable mean to explore climatic teleconnections.

# AAPT Contributed Talks

## Saturday, 8:00 a.m.

### BH163:

### Demo or Rsearch Strand/NE/AAPT Contributed talks: section 1

**Martini, Karl**
Western New England College

**``Self-assembled Monomolecular Soap-films"**

**Abstract**: Ever thought that it would be cool to demonstrate self-assembly of a monomolecular film only nanometers in thickness and measure its thickness with tools and supplies that every teacher has easy access to? This talk will re-familiarize the audience with examples that are now more than 100 years old. Specifically I will show during the talk the assembly and thickness measurement (using only a ruler) of a lipid monolayer (soap film). Many biological structures (like cell walls) use similar lipid bi-layers. This activity can be done as a laboratory exercise in any High school class or as a demonstration experiment to students of the sciences.

### BH165:

### Global Warming Strand / NE/AAPT Contributed talks: section 1

**Glanz, Peter**

**``Global Warming 101 - How are the Computer Model Predictions Going?"**

**Abstract:** The catastrophes that await us in the next 50 years include flooding, pestilence, raging firestorms, more numerous hurricanes and tornadoes, rising sea levels and melting ice caps. These are predicted by the 20 or so computer models used by the IPCC as well as by Al Gore and Michael Mann. Let's put these models to the test of scientific experimental verification and see how well they hold up. What is your prediction of the outcome?

## Saturday, 8:20 a.m.

## BH163:

## Demo or Rsearch Strand/NE/AAPT Contributed talks: section 2

**Najmabadi, F. M.**
Mass Bay Community College

**``A Comparison Study Between Fabricated Nanotubes, and Naturally Formed Tubes by Bacteria, as well as in the Wings of Butterflies."**

**Abstract**: In this short paper a comparison study is made, between the dimensions of the nanotubes fabricated in the lab, their nano- and optical properties. It has been reported that bacteria Shewanella can produce semiconducting nanotubes, which lead to creating new nano-electronic devices, with photoconductive properties. The search is on for other bacterial species with better bandgap response. In separate studies, it is shown that the structure of the wings of morpho butterflies can support optical guided modes, and they have selective chemical vapor responses.

## BH165:

## Global Warming Strand / NE/AAPT Contributed talks: section 2

**Gould, Laurence I.**
University of Hartford

**``Threats to Science Education: A Critical Inquiry of the Claims & Methods used in Promoting Anthropogenic "Global Warming"**

**Abstract:** Although there continues to be an increasing number of scientists and public figures around the world who are challenging the dominant political- and media-driven claims of dangerous anthropogenic "global warming" (AGW)*, flawed methodology used by AGW proponents continue to threaten science education. This general talk will explain what are some of the methodological errors which have continued to advance that threat.

* other aliases: "climate change", "global climate disruption"

## Saturday, 8:40 a.m.

### BH163:

## Teaching and Technology strand / NE AAPT Contributed talks: section 1

**Yakov E. Cherner, Yakov E.**
ATeL , Swampscott, MA

**``Adaptive Web-based Virtual Laboratories on Physics and Technology and Authoring Tool for Their Customization"**

**Abstract:** Paper will present a collection of web-enabled simulation-based virtual labs on such areas as classical mechanics, heat and thermodynamics, fluid physics, optics, and wireless communications. These labs are designed to enhance the understanding of technical concepts and underlying fundamental principles. Virtual labs contain expandable sets of virtual experiments (VE), learning resources and assessment activities. An easy-to-use Web-based authoring tool that enables instructors with no-programming experience to produce appealing and pedagogically sound interactive virtual activities is available as well. Each VE focuses on a particular task and comprises such components as main and auxiliary simulations, learning objectives, assignment, step-by-step instruction for students, embedded assessment, prerequisites, excerpts from interactive lessons and technical manuals, etc. The virtual labs can be link with related hands-on labs to form hybrid (or blended) laboratories.

More details and demos can be found at http://www.atelearning.com/root/elearningtools.php
Presented work is partially supported by grants from the National Science Foundation

### BH165:

## High School Research Strand/ NE/AAPT Contributed talks: section 1

**Formato, James**
Thayer Academy

**``TOPS program at MIT"**

**Abstract**: Looking to offer something more than a summer research position to your undergraduates? The TOPS program is for undergraduate physics majors who are considering a career in teaching but who may yet be fully committed to the educational field. TOPS undergraduates work with experienced physics teachers to develop lesson plans for middle and high school students. They then teach a weeklong course to middle schoolers and a two-week course to high schoolers under the observation of experienced teachers. This presentation will give a detailed account of the scheduling, personnel, space and material needs at TOPS. TOPS is in its ninth year and is funded by the National Science Foundation and the Center for Ultra cold Atoms at MIT

## Saturday, 9:00 a.m.

## BH163:

## Teaching and Technology strand / NE AAPT Contributed talks: section 2

**Lojewska, Z. and Ushe, Fides**
**Springfield College, Springfield, MA**

**``Integrating Physics and Mathematics for Middle School Grades."**

**Abstract:** The presentation will focus on the course *Integrating Physics and Mathematics for Middle School Grades* that was conducted at Springfield College during 2009/2010 academic year for in-service teachers from the Pioneer Valley Region in Massachusetts. The course was offered as a result of a grant from the Massachusetts Mathematics and Science Partnership Program (MMSP) through the Pioneer Valley STEM Network (PVSTEMNET). Concepts of force, motion, work, and power, and forms of energy and energy transformation were explored in a physics laboratory setting and the data were modeled using mathematical functions that included linear, quadratic, and exponential. The experimental component of the course utilized CPO equipment and the modeling was facilitated with the use of graphing calculators and software such as EXCEL, and Data Studio (PASCO). We will share some projects that the teachers carried out in their classrooms after participating in the course.

## BH165:

## High School Research Strand/ NE/AAPT Contributed talks: section 2

**Taylor, Tomasz**
Northeastern University

**``Physics Theorynet: Physics Professors Connect with New England High School Students and Teachers"**

**Abstract:** Physics Theorynet is an outreach program sponsored by the National Science Foundation, involving particle theorists and cosmologists visiting high school s in the greater Boston area, including Rhode Island and New Hampshire. Physicists give presentations, perform demonstrations and run question and answer sessions during regular class hours and afterwards. Students are exposed to frontier issues in modern physics and are given an opportunity to have curiosity-based questions answered in real time. They can also learn about university life and the working life of people in physics.

## Saturday, 9:20 a.m.

## BH163:

**Teaching and Technology strand / NE AAPT Contributed talks: section 3**

**Cook, Richard and Hanson, Helen**
Brown University

**``Teaching Orientation for New Graduate Students"**

**Abstract:** In a typical university physics department, the educational focus is on the undergraduates. Emphasis is put on the faculty-undergraduate relationship and new faculty are expected to be able to teach effectively with the necessary skills as a mentor and advisor for undergraduate and graduate students. But when is the standard faculty member educated on education? Usually, the rest and only exposure to teaching is during graduate school as a teaching assistant. Over the past four years, the Department of Physics at Brown University has been implementing a teaching orientation program for the incoming graduate students. The original focus of the program was the improvement of the quality of education in the department but it has evolved to include peer mentoring and regular collective activities resulting in a new sense of community and a better overall graduate experience. The curriculum introduces students to the concept of a teaching philosophy, how to prepare lectures, and the intricacies of grading. We will be discussing the success and failures of the program

## BH165:

**High School Research Strand/ NE/AAPT Contributed talks: section 3**

**Donovan, Don**
**(Thayer Academy)**

**``Eastern Mass. Physics Olympics:"**

Each Spring 8-10 schools get together for a friendly competition. Students will compete in events like Mousetrap Powered Car Drag Race, Inertia Ball, Physics Bowl, and The Naked Egg Drop. I will be giving a short presentation on what the Physics Olympics is all about and how to get your high school team involved. Remember that it's Physics Phun for Everyone!

## Saturday, 9:35 a.m.

## BH165:

## High School Research Strand/ NE/AAPT Contributed talks: section 4

**Donovan, Don**
(Thayer Academy)
**Garber, Gary**
(BU Academy)

**``Summer Research at Thayer Academy/ The Junior Research Seminar at BU Academy"**

A high school lab experience is usually more of an activity than an experiment. Conclusions are already made before the experiment is done. Most labs are done to confirm a concept or lesson. Most students, even those planning on majoring in a science in college, leave high school without any true lab experience, or knowledge of how a research laboratory works, or what a "real" scientist does.

The experience of interning in a college or university lab is a tremendous opportunity for a high school student. The exposure to actual research and the tools used in a real laboratory are a great addition to a high school student's experience.

Having a student involved in a lab is one of the best motivators I have seen. Not only do the students have a hand in real science work, but they also have the interaction with professors, undergraduates and graduate students. This early exposure to a variety of levels of academic and research progress gives the high school student a more clear idea of what collaboration is. It also helps them picture themselves in their academic future.

# AAPT Workshops

## Saturday, 1:00p.m. – BH166

### Modeling Applied to Problem Solving – an Adoptable Pedagogy

Dave Pritchard, Carie Cardamone

This workshop will introduce participants to a modeling-based approach to problem solving, a pedagogy that enables students to attain significant expert-like improvement of their problem solving skills that transfers to a subsequent E&M course, as well as significantly more expert-like attitudes towards science, particularly in Problem-Solving self confidence. The workshop goal is to enable participants to introduce some or all of this pedagogy into their courses with the help of our open source integrated version of LON-CAPA, ANDES, and a Wiki-Text that incorporates MAPS into a standard introductory mechanics syllabus. Workshop participants will sample the various teaching materials for in-class use and will participate in some innovative activities for class. The integrated environment will be demonstrated. We seek users/collaborators for part or all of our materials, which can be freely modified.

### Phenomenal Physics-A Guided Inquiry Curriculum for Conceptual Physics Instruction at the High School and College Level

J. Russell Harkay PhD, Prof. of Physics, Keene State College

The word inquiry has become a buzzword of late, often used by equipment vendors as a promotional tool. As a result, we might ask what IS guided inquiry and what is its place in the classroom? How does it differ from laboratory instruction? Are limitations imposed by this methodology and how might we minimize those? Is there evidence of effectiveness? Can inquiry "turn on" unmotivated students? Some concrete "do's" and "don'ts" for successful inquiry instruction are presented.

Using exercises gleaned from a textbook authored by the presenter and developed by himself and the PP research Team with the aid of NSF grant Project INSPIRE, participants explore a hands-on mode of instruction that can lead to remarkable levels of retention and, most importantly, interest in the subject and total lack of apprehension. The curriculum, with only minor modifications in application, can be used effectively by high school teachers offering conceptual physics courses, and at the college level in the areas of teacher preparation and conceptual "General Education" courses. Many have been used effectively in the middle school setting. The exercises, many of which have more quantitative extensions, have also been implemented as a substitute for more traditional laboratory exercises for both algebra and calculus-based introductory physics courses. One of the beauties of the approach is its minimal cost and use of readily available materials. The curriculum is not without a sense of humor, enhancing its acceptance by even the most "physics phobic" students.
Instruction manuals and take-home teaching materials provided.

**Greenhouse effect------- the "GAME"**

Karl M. Martini, Western New England College

This activity is a low tech, crude simulation - no computers or calculators needed - of what is going on in a radiative atmosphere. It will contain all the important effects and ideas, including feedbacks that we should take note of. It is build on a one dimensional (vertical) model of the Sun – Atmosphere – Earth system.

This game was devised to be a hands-on, engaging process to teach students that are not science majors, i.e. students that are often math challenged, about the relevant issues and effects of global atmospheric warming . The required math is implicit in the simple game rules. The playing of the game constitutes the recursive approach to equilibrium. By changing parameters while playing the game topics like the greenhouse effect, radiative energy balance and approaches to equilibrium are discovered.

(Actually a slight change in words and parameters will map this game into many situations where an equilibrium is approached: cooling, radio-activity, also topics in kinetics in chemistry or basic market behaviors are a few of the possibilities that come to mind)