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## Greetings from the Chair

Welcome to the 12th edition of the Physics Department newsletter. This past year was productive and stimulating. I am particularly grateful to my colleagues for engaging in a series of discussions about charting the course of physics at Brown. Our Department graduates are some of the best and brightest students at the University, and we aim to move forward in ways that build upon our strengths in teaching and research. Our faculty are working at the frontier of many exciting areas of physics, which are attractive to students and provide multiple opportunities for overlap on campus with other disciplines.

Last fall we welcomed the largest incoming class of graduate students (21) in more than twenty years. In May, we awarded 15 doctoral degrees and 26 bachelor's degrees to a remarkable class of very accomplished students. A growing student body coupled with a pressing need for more research space presents challenges, but the energy and level of activity in the Department is invigorating.

Our faculty has been prominent. Two were selected to act as spokespersons on large collaborative research projects. Greg Landsberg is serving a two-year term as physics coordinator for the Compact Muon Solenoid (CMS), a detector at the Large Hadron Collider. His role is considered one of most important positions in the CMS collaboration. Richard Gaitskell has been re-elected by members of the LUX Collaboration as a co-spokesperson with Thomas Shutt of Case Western Reserve. The LUX Experiment is searching directly for particle dark matter signals at the Sanford Lab in South Dakota. The following pages contain more news about faculty achievements during the past year, including Humphrey Maris's acceptance of the Fritz London Memorial Prize at the Low Temperature Physics Meeting held in Beijing last August. Anastasia Volovich won a prestigious DOE Early Career Award, which will further propel her theoretical research on scattering amplitudes in quantum field theories and gravity.

Last summer, Brown hosted the American Physical Society's biannual meeting of the Division of Particles and Fields, a five-day conference that attracted nearly 500 physicists from around the globe. Our department's particle and astrophysics faculty organized this very successful event, with David Cutts, Ulrich Heintz and Meenakshi Narain assuming lead roles in the planning and management of the meeting. Other scientific gatherings of note during the past year were the Fifth New England String Meeting, organized by the high energy theory group, and the Eleventh Workshop on Non-Perturbative Quantum Chromodynamics at l'Institut d'Astrophysique de Paris, co-directed by Chung-I Tan with Berndt Mueller of Duke.

The third annual Brown Degree Day was held last April, and we are currently engaged in planning the fourth Degree Day program, scheduled for Saturday, April 28. More details will follow, and the Department looks forward to bringing alumni back to campus to talk with our students. In the meantime, please visit our new web site!



*Jim*

James M. Valles, Jr.

# Undergraduates

## 2011 Undergraduate Degree Recipients



**Back row:** Eli G. Crumrine, Daniel N. Munger, Laurentiu Rodina, Albion J. Fitzgerald, Jonathan E. Beller, Elijah R. Shelton, David G. Sheffield **Front row:** Benjamin L. Howard, Erin G. Teich, Edward T. Parker, Andrew T. Bakowski, Erik L. Stayton, Kyle F. Cackett, Meagan R. Slater, Maura E. Lynch, Adin R. McIlroy **Not Present in Photo:** Max M. Abrahams, Alexander P. DiRe, David N. Honsberger, Matthew A. Jacobs, Noah L. Levin, Sorawis Sangtawesin, Sonia M. Vignale, Ryan Zelen

## Class of 2011

Twenty-six physics concentrators, one of the Department's largest graduating classes, received bachelor degrees in May, and half of the class graduated with honors. Eleven graduates earned a magna cum laude designation, and nearly 20% of the graduating class was elected to Phi Beta Kappa. Several students chose a double concentration, earning degrees in philosophy, computer science, mathematics, economics and literature and culture in English in addition to their degrees in physics. Yet another remarkable graduating class!

### 2011 UTRA Students

*The UTRA program provides opportunities for collaboration between students and faculty and allows students to gain insights into the structure of academic work in a particular field.*

**James Benson**  
**Alexander Berg**  
**Caitlin Carpenter**  
**Minjae Cho**  
**Adam Coogan**  
**Karri DiPetrillo**  
**Michael-Patrick English**  
**Emmet Golden-Marx**  
**Jesse Golden-Marx**  
**Chenming Jiang**

**Jared Lafer**  
**William Lockhart**  
**Wooyoung Moon**  
**Daniel Munger**  
**Mark Nagy**  
**Marianna Neubauer**  
**Ho-Jin Park**  
**William Poole**  
**Real Provencher**  
**Alejo Stark**

### Undergraduate Awards

#### R. Bruce Lindsay Prizes for Excellence in Physics

Laurentiu Rodina  
Sorawis Sangtawesin

#### Mildred Widgoff Prizes for Excellence in Thesis Preparation

Kyle F. Cackett  
Edward T. Parker

#### School of Engineering Award for Outstanding Senior in Engineering and Physics

Sorawis Sangtawesin

### Department Undergraduate Group (DUG)

The Brown Physics DUG is committed to enriching the physics undergraduate experience at Brown. Last semester, **Zack Winoker**, **Karri DiPetrillo** and **Caitlin Carpenter** resurrected the DUG and brought it back in full force. Among the events sponsored by the DUG were faculty presentations and graduate school information sessions. The highlight of the semester was a discussion between Professor **Leon Cooper** and Douglas Kutach, Professor of Philosophy, which attracted nearly 200 attendees. The students plan to do more of the same exciting, accessible and fun events during the spring and look forward to keeping the DUG active.



# Graduate Students

## Graduate Student Awards

### Galkin Foundation Fellowship Award

Helen A. Hanson, 2010-2011

Xi Wang, 2010-2011

Wenzhe Zhang, 2011-2012

### Beyer Award for Excellence in Scholarship and Service

Jeffrey M. Shainline

### Anthony Houghton Award for Excellence in Theoretical Physics

Scott E. Field

Kewang Jin

### Dissertation Fellowship Award

Dafei Jin

### Physics Merit Dissertation Fellowship Award

Congkao Wen, 2010-2011

Vivek Parahar, 2011-1012

### Award of Excellence as a Graduate Teaching Assistant

Michael L. Jokubaitis

Timothy Raben

J. Niclas Svensson

## Grad Student Coffee Hour

The graduate student coffee hour has become a fixture in the department and attracts a consistent group of students each week. Originally conceived as a method to build community among students and share information, the coffee hour has expanded to include well-attended events such as a mentor-mentee meeting and a workshop on applying for outside funding. Graduate students **Richard Cook**, **Andrew Favaloro**, **Shawna Hollen** and **Xu Liu** are responsible for the organization of the weekly gathering.

## Professional Help and Development Society

Physics PHDs (Professional Help and Development Society) is an organization founded and run by graduate students in the Physics Department. The role of Physics PHDs is to provide support for graduate and undergraduate students. The society's mission is to prepare students for roles as leaders and teachers in the future and provide information about life during and after graduate school. The organization shares research and teaching experiences, provides a network of contacts within the department and beyond, and facilitates new friendships. Their activities, which also extend outside of the Physics Department, are an effort to help students be more productive during their PhD years.

This year, 24 senior graduate students were enlisted to welcome the incoming graduates and form mentor-mentee pairs, with the purpose of helping them to acclimate to life and study at Brown. The Physics PHDs also organize a weekly coffee hour, designed as a time for graduate students to come together, socialize, and learn about research of various groups in the department.



L to R: Wessyl R. Kelly, Scott E. Field, Georgios Papathanasiou, Dung V. Nguyen, Cengiz Pehlevan, Dina N. Obeid, Georgios Koutroulakis, Ka Vang Tsang, Duong H. Nguyen, Zhijun Jiang, Kewang Jin  
Not present in photo: Steven E. Horowitz, James M. McFarland, Jeffrey M. Shainline

# Honors and Awards

## Maris Awarded Fritz London Memorial Prize



**Humphrey Maris** was one of three winners of the 2011 Fritz London Memorial Prize, considered the highest award in the field of low-temperature physics. Since the prize was inaugurated in 1957, ten recipients have gone on to win the Nobel Prize. His co-winners are Professor Johan Mooij of Delft and Professor Gerd Schön of Karlsruhe. The Prize was awarded during the opening ceremony of the 26th International Conference on Low Temperature

Physics held in Beijing, China last August. The citation for Humphrey Maris reads: “The Fritz London Memorial Prize is awarded to Humphrey J. Maris in recognition for his original theories and experimental discoveries in liquid helium, concerning phonons, Kapitza resistance, levitation, nucleation, electron bubbles and vortex imaging.”

Professor Maris is a Fellow of the American Physical Society and recipient of many awards, including the Senior Humboldt Award, a United Kingdom Research Council Fellowship, two Japanese Society for the Promotion of Science Fellowships, the Brown University Technology Partnership Award for Technological Innovation, the Prize for Phonon Physics (Klemens award), the Philip J. Bray award for Excellence in Teaching in the Physical Sciences at Brown University, and the American Physical Society India-US Professorship Award.

## Derek Stein Receives Honor



In recognition of his accomplishments as a scholar and teacher, **Derek Stein** has been appointed Manning Assistant Professor of Physics



**Michael Jokubaitis** was awarded the 2011 National Defense Science and Engineering Graduate (NDSEG) Fellowship.



**Shawna Hollen** is the recipient of the Brown/Wheaton Faculty Fellowship and the American Association of University Women (AAUW) American Fellowship.

## 2011-2012 Physics Merit Fellowship Recipient

**Vivek Parihar**'s PhD dissertation focuses on the field of precision measurement of the top quark mass. Under the supervision of Professor Ulrich Heintz, Vivek does research at the D0 experiment housed in the Fermi National Accelerator Laboratory (Fermilab).

The top quark, discovered at Fermilab, is the heaviest known fundamental particle and affords study of the standard model of particle physics through the measurements of its mass, width and couplings. The mass of the top quark is a fundamental parameter in the electroweak fits, which predict the mass of the elusive Higgs boson. These fits have other parameters known to less than one percent precision. It is therefore important to obtain a measurement of the top quark mass at a similar precision. The top quark decays before it can form bound states with other quarks. It thus provides a unique opportunity to study a “bare quark” and probe its properties directly.

Top quarks and their antiquarks are produced in pairs at the Tevatron. While there are many channels in which the top quark can decay, the golden channel for the mass measurement is the one in which the top quark and the antitop decay into two b-quarks and two W bosons, one of which further decays into a lepton (electron or muon) and a neutrino, while the other decays to a pair of quarks. This is also known as the l+jets topology. The quarks of the decay system hadronize into jets which are then seen as collimated energy deposited in the detector. The measurement is challenging and computing-intensive due to the combinatorial ambiguities in the topology of top quark decay products.

Vivek's research addresses the uncertainties in the mass measurement. He and Professor Heintz have adopted a method that uses a kinematic fitter to extract the best possible value of the top quark mass. The measurement is dominated by systematic uncertainties studied using various Monte Carlo simulations of the production and decay process of the top quark.



# Faculty News

## Landsberg Appointment



Professor **Greg Landsberg** began his two-year term as physics coordinator for the Compact Muon Solenoid (CMS), a detector at the Large Hadron Collider in 2011. The physics coordinator is considered one of most important positions in the CMS collaboration, akin to a cabinet-level post in a U.S. presidential administration.

As coordinator, Landsberg defines the goals and types of experiments that researchers will undertake at the CMS as the detector hunts for particles theorized to exist and possibly new ones as well. He is taking a sabbatical to work full time at the European Organization for Nu-

clear Research (CERN), which is in charge of the CMS and other detectors at the Large Hadron Collider, located outside Geneva. Arguably the biggest pursuit by CMS and its competitor detector, called ATLAS, is to establish the existence of the Higgs boson, which some scientists believe gives matter mass. Landsberg expects that during the next two years the Standard Model Higgs will either be found or excluded completely; obviously he hopes for the former. In addition to the hunt for the Higgs, it is possible the detector will find super symmetry, discover new forces, and even reveal extra spatial dimensions.

Professor Landsberg grew up in Moscow and has lived in the United States for nearly 20 years. He joined the Brown faculty in 1998 following a stint as a postdoctoral researcher at the Fermi National Accelerator Laboratory in Illinois. At Brown, he does research in elementary particle physics, specifically experimental investigation of the fundamental particles and fields at the energy frontier accelerators. His main research activity is the search for new physics phenomena, including extra dimensions in space.

This new course, taught by Professor **David Lowe**, introduces theoretical approaches and experimental signatures of a variety of extensions to the Standard Model of Particle Physics. Examples range from already known effects, such as neutrino masses to effects on the verge of discovery, such as candidates for dark matter and the predictions supersymmetry brings. The theoretical approaches are based on “effective quantum field theory” which allows for low energy predictions to be quickly established once one forms a hypothesis for the symmetries present in the high energy theory. By the end of the course, students are able to take a Grand Unified Theory (possibly with supersymmetry) and understand how the generalized Higgs effect breaks the symmetry down to the Standard Model, and produce predictions for new particles to be discovered at accelerator experiments, or through astrophysical observations.

## PHYS 262G: Beyond the Standard Model

**Promotions**

**Marcus Spradlin**, who works on theoretical particle physics, was promoted to Associate Professor in 2011. The main focus of his current research is to explore the mathematical structure of quantum field theories such as quantum chromodynamics and to exploit that structure to make previously difficult or impossible computations relevant to particle physics much simpler, and in some cases even trivial. Marcus has also worked on dualities between quantum field and gravity theories. He received his PhD. from Harvard University in 2001 and joined Brown in 2006 following post-doctoral appointments at Princeton University and the Kavli Institute in Santa Barbara. His research, and that of several of his postdocs and students in the high-energy theory group, has been funded by grants from the National Science Foundation and the Department of Energy, from which he received an Outstanding Junior Investigator Award.

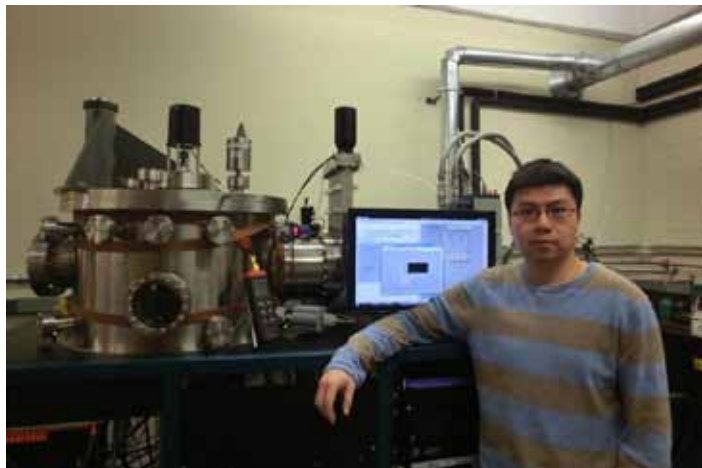


**Anastasia Volovich** is a high energy theorist, working in the area of string theory and related areas in particle physics, general relativity and mathematics. Recently she has been working on scattering amplitudes in gauge and gravity theories. Anastasia received her PhD. in Theoretical Physics from Harvard University in 2002. She came to Brown University as a Richard and Edna Salomon Assistant Professor in 2006 after her post-doctoral research at the Kavli Institute for Theoretical Physics in Santa Barbara and as a William D. Loughlin Member at the Institute for Advanced Study in Princeton. She was promoted to an Associate Professor of Physics with tenure at Brown in 2011. Anastasia is the recipient of many awards and honors, including an NSF CAREER Award, White House PECASE Award, DOE Early Career Research Award, and Sloan Research Fellowship.



# Graduate Student Research Highlight

## Wenzhe Zhang, 2011-2012 Galkin Fellow



Wenzhe with the new magnetron-sputtering system

**Wenzhe Zhang** is completing his PhD dissertation research in the field of Spintronics with emphasis on current noise and spin-dependent transport in Magnetic Tunnel Junctions. For the past five years, Wenzhe has conducted research at the Nanoscale Physics and Devices Lab in Brown University with his advisor Prof. Gang Xiao.

Spintronics is an emerging technology that relies on the electron's spin degree of freedom to manipulate electron motion or to store information. For instance, the resistance in certain magnetic materials can change dramatically with the application of a magnetic field or a highly spin-polarized current, leading to a new way of representing logic "0" and logic "1". The so-called magnetoresistance (MR) effect is most pronounced in CoFeB/MgO/CoFeB magnetic tunnel junctions (MTJs), in which electrons coherently tunnel through the near-epitaxial MgO/CoFeB structure. Over the last decade, MTJ has not only exhibited rich new physics, but also shown great promise for applications in electronics.

Wenzhe began his PhD research working on the anisotropy dispersion in the CoFeB free layer of MTJ arrays. Due to the inherent disorder in local structures, anisotropy dispersion exists in almost all systems consisting of multiple MTJs. Such dispersion can be an adverse effect. Wenzhe first used the so-called "two dimensional sensitivity maps" to extract the dispersion information from MTJ arrays, and then he studied the dependence of magnetic field sensitivity on MR, coercivity, and magnetic anisotropy dispersion. The analysis used in this work allows for better design of MTJ-based devices, and has been published in *Physical Review B*.

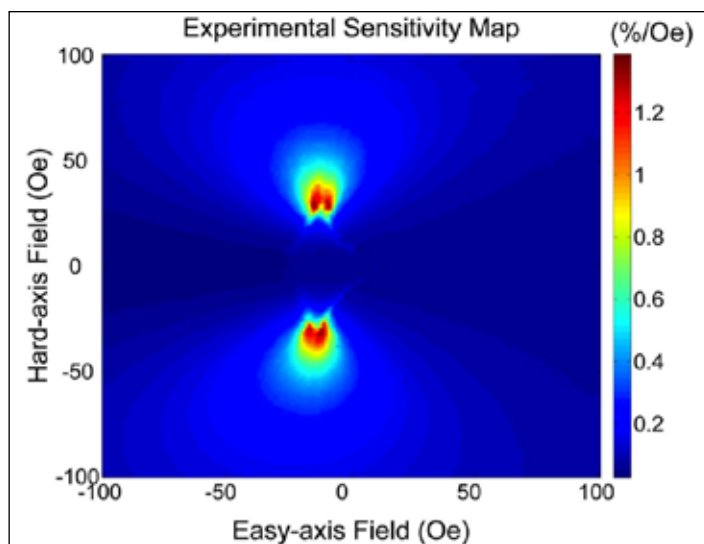
For realizing high speed MTJ devices, Wenzhe moved on to study the ferromagnetic resonance (FMR) and damping properties of CoFeB thin films. In close collaboration with Dr. Xiaoyong Liu from National Institute of Standards and Technology (NIST), Wenzhe discovered a strong thickness dependence of the effective magnetization and observed a large surface perpendicular anisotropy with film thicknesses below 2nm. In such thin films, two-

magnon scattering and inhomogeneous broadening were found to be significant for the magnetization dynamics. This work has been published in *Journal of Applied Physics*.

Simultaneously with his research on damping properties of CoFeB thin films, Wenzhe embarked on a project involving detection of pico tesla magnetic fields using MTJs. The initial emphasis of the project was to improve the signal-to-noise ratios (STN) of MTJ sensors by optimizing an array of junctions connected in series. Wenzhe then discovered that, instead of following  $1/N^{0.5}$  rule, the magnetic field noise exhibited a large correlation component. The enhanced noise was found to be due to the magnetic coupling of neighboring MTJ elements through the transverse magnetization fluctuations. This work was published in *Physical Review B*.

In MTJs, electrons tunnel across the barrier randomly and independently. In such a Poisson process, the squared current fluctuation (shot noise) is equal to two times of the average current. If additional correlation among electron exists, the shot noise is reduced or "sub-Poissonian". Wenzhe systematically investigated spin-dependent transport in MTJs by measuring shot noise as a function of the angle between the two lead magnetization vectors. In the sequential tunneling regime, the electrons of majority spin tunnel in bunches due to the spin-blockade of minority spins, giving rise to a sinusoidal-like variation of shot noise. This work may lead to a better understanding of charge and spin transport in MTJs.

Just recently, Wenzhe designed and built a high-vacuum magnetron-sputtering system with base pressure as low as  $10^{-8}$  Torr. The brand new system is capable of depositing up to eight different materials in a single run with fully-automated routines. The system will be intensively used in the future to fabricate a wide variety of new MTJ-based devices.



The experimental sensitivity map of an MTJ array. The field sensitivity is plotted as a function of the easy- and hard-axis fields

The Galkin Foundation Fellowships are funded through a generous donation by Warren Galkin, Class of '51. The Fellowship recognizes exceptional promise and achievement in physics by a senior graduate student.



# Faculty Research Highlight

## Strongest Limit Set on Dark Matter



In December 2011, **Savvas Koushiappas** and graduate student **Alex Geringer-Sameth** published a paper in *Physical Review Letters* reporting that dark matter must have a mass greater than 40 giga-electron volts in dark-matter collisions involving heavy quarks. Using publicly available data collected from an instrument on NASA's Fermi Gamma-ray Space Telescope and a novel statistical approach, they constrained the mass of dark matter particles by calculating the rate at which

the particles are thought to cancel each other out in galaxies that orbit the Milky Way galaxy. "What we find is if a particle's mass is less than 40 GeV, then it cannot be the dark matter particle," Koushiappas said.

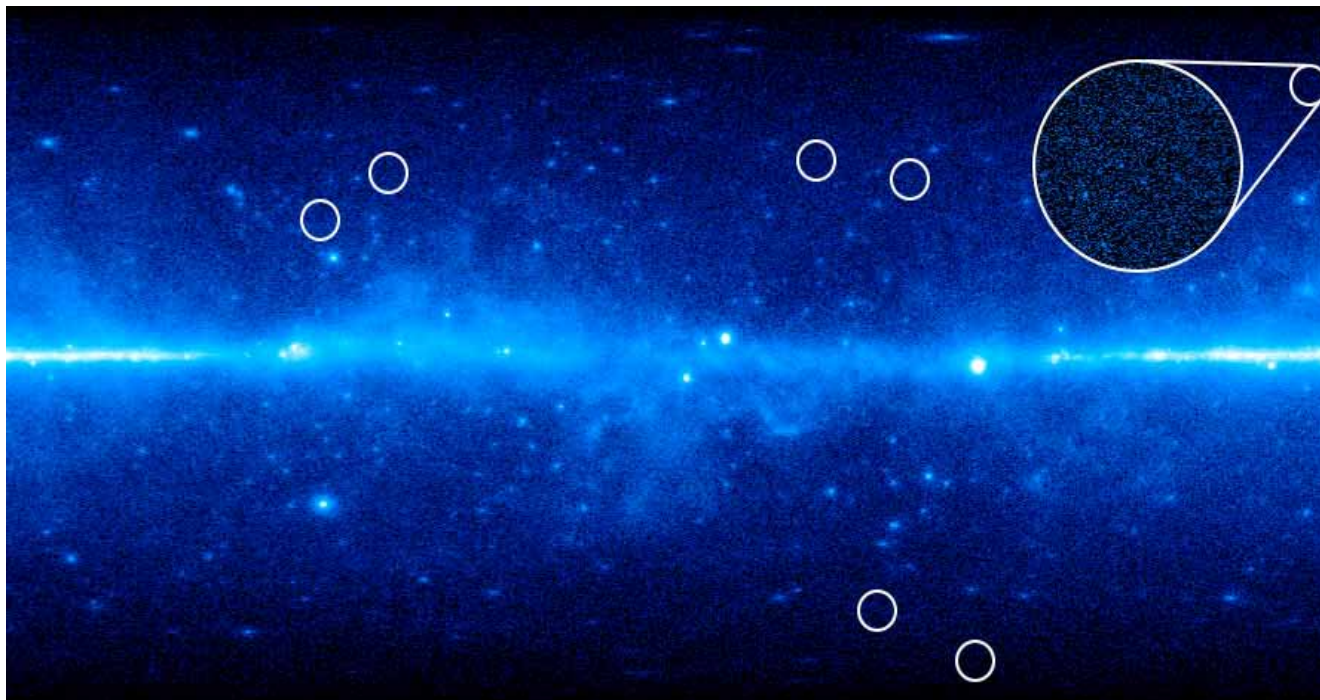
The observational measurements are important because they cast doubt on recent results from dark matter collaborations that have reported detecting the elusive particle in underground experiments. "If, for the sake of argument, a dark matter particle's mass is less than 40 GeV, it means the amount of dark matter in the universe today would be so much that the universe would not be expanding at the accelerated rate we observe," Koushiappas said, referring to the 2011 Nobel prize in physics that was awarded for the discovery that the expansion of the universe is accelerating.

Dark matter and dark energy do not emit electromagnetic radiation like stars and planets; they can be "seen" only through their gravitational effects. Its shadowy profile and its heavy mass

are the main reasons why dark matter is suspected to be a weakly interacting massive particle (WIMP), which makes it very difficult to study. When a WIMP and its anti-particle collide in a process known as annihilation, the debris spewed forth is comprised of heavy quarks and leptons. A jet of particles that includes photons, or light, is produced when a quark and its anti-quark sibling annihilate.

Koushiappas and Geringer-Sameth in essence reversed the annihilation chain reaction. They focused on seven dwarf galaxies that appear full of dark matter because their stars' motion cannot be fully explained by their mass alone. These dwarf galaxies are largely bereft of hydrogen gas and other common matter, meaning they offer a blank canvas to better observe dark matter and its effects.

Gamma-ray data collected over the last three years was analyzed to measure the number of photons in the dwarf galaxies. "This is the first time that we can exclude generic WIMP particles that could account for the abundance of dark matter in the universe," Koushiappas said. Geringer-Sameth developed the statistical framework to analyze the data and then applied it to observations of the dwarf galaxies. "This is a very exciting time in the dark matter search, because many experimental tools are finally catching up to long-standing theories about what dark matter actually is," said Geringer-Sameth. *Courtesy of Richard Lewis, Brown News Service*



View of the universe from NASA's Fermi Gamma-ray Space Telescope. Seven dwarf galaxies, circled in white, were studied. Observations indicate those galaxies are full of dark matter because their stars' motion cannot be explained by their mass alone, making them ideal places to search for dark matter annihilation signals. Credit: NASA/DOE/Fermi-LAT Collaboration/Koushiappas and Geringer-Sameth/Brown University

# Postdocs

**Joseph Bush** received his BS from WPI in chemistry, where he studied organic synthesis and metal organic crystal design. Subsequently, he came to Brown in 2005 and completed his PhD in Physical chemistry under Professor Peter Weber in 2010. His doctoral thesis probed the Rydberg states of multifunctional amine molecules as models for larger biological systems. Joe's postdoctoral research focuses on the liquid to vacuum interface at nanometer scale openings. By applying high fields to electrolytic solutions at such small interfaces, it is possible to draw bare ions into the vacuum chamber of a mass spectrometer without increasing the vacuum pressure or differential pumping. The goal of the project is to use a nanometer liquid-vacuum interface to confine DNA to a linear configuration while extracting the individual bases into our mass spectrometer for analysis. The temporal arrival times of the bases at the detector should then correspond to the DNA sequence.



**Grant Christopher** joined Brown in September 2011 and is working on the CMS experiment, stationed at CERN, under Professor Greg Landsberg. Grant graduated in 2011 from NYU after his thesis on cosmic-ray shadows of the Moon and Sun with Milagro; a water-Cerenkov telescope located in New Mexico. At CMS, Grant is focused on multijet analyses in searches for new physics. As part of his work he also is part of the trigger studies group in CMS.



**Alexey Ferapontov** earned his master's degree with highest distinction from Moscow State University, and was awarded a PhD magna cum laude from Kansas State University. In 2009, he came to Brown as a Postdoctoral Research Associate and joined the CMS Collaboration at the Large Hadron Collider in Geneva, Switzerland. He is an active member of the Exotica group and performs searches for rare processes with jets in the final state. Alexey, Professor Greg Landsberg and graduate student Ka Vang Tsang have developed a method to estimate multi-jet backgrounds directly from data, thus enabling the most extensive search for microscopic black holes and string balls at



the hadron colliders. Alexey currently co-leads a search for exotic processes with a spectacular eight jet final state, and also participates in the High-Level Trigger (HLT) development and integration. Some of his studies have led to substantial improvements in the HLT menu and more efficient data taking. Alexey recently received a one-year fellowship from the LHC Physics Center at Fermilab that will allow him to play a key role in the US CMS physics program.

**Daniel Ferrante's** research focuses on theoretical physics and theoretical neuroscience. He and Professor Gerald Guralnik are using symmetry to further the understanding of quantum moduli spaces and brane quantization. Using non-linear Fredholm theory and novel numerical techniques, they generalize the concept of the partition function and its role in quantization. This approach extends the usual notion of how a theory is quantized, opening previously inaccessible regions in theory space. Applications range from quantum phases and topology change to the new field of PT-symmetric quantum mechanics and novel cosmological models. Professor Guralnik and Daniel also collaborate with Professor Jim Anderson and his group in the Cognitive Science and Linguistics Department, applying techniques from quantum gauge theory and spin glass systems to model neural systems and represent information in novel ways. Complex systems' properties such as scaling, dimensionality, and chaos are key ingredients for brain models, plasticity and learning.



After earning a master's degree in engineering and material Sciences, **Simon Fiorucci** switched to physics and earned his PhD on the French dark matter search experiment Edelweiss (cryogenic germanium crystals) in 2005. Following that, he was hired by Brown University as a post-doc under Professor Richard Gaitskell to participate in the Xenon10 experiment, searching for dark matter with liquid xenon, a new and different technology. He worked full time at the Gran Sasso lab in Italy for two years until the experiment ended in 2007. Simon has since been working as a senior research associate on the LUX project, the next generation of liquid xenon detector. His responsibilities include coordination of the current science program at a surface laboratory in Lead, South Dakota, and planning for the one-mile underground installation, scheduled to begin this spring.





**Alexandra Junkes** joined the Brown high-energy particle physics group in January 2012. She is working on the development of silicon sensors for the CMS experiment at the Large Hadron Collider at CERN in Switzerland. She is also an active member of the CERN RD50 collaboration that aims to develop radiation tolerant detectors. Alexandra earned her PhD in physics from the University of Hamburg in Germany. Previously she worked in the Detector Laboratory of Hamburg University. Alexandra is a native of Hamburg and lived there for 31 years before coming to Brown University.



**Andrei Korotkov**, Senior Research Associate, joined the observational cosmology group in 2003. A graduate of Nizhny Novgorod State University, he received his PhD from the Institute of Applied Physics (Russian Academy of Science) in 1995, and worked at the Institute for Physics of Microstructures RAS, and Georgia Institute of Technology before coming to Brown. The research includes study of early universe by measuring polarization of the cosmic microwave background, and star formation in cold Galactic interstellar clouds by submillimeter polarimetric observations.



**Monica Pangilnan** obtained her PhD from Brown in 2010 under Professor Meenakshi Narain on the discovery of the top quark in the electroweak production channel. She is currently working for Professor Richard Gaitskell on the LUX experiment, a direct detection experiment looking for dark matter. LUX is a 350 kg, two-phase Xenon detector located at Sanford Laboratory that will be deployed 4850 ft underground by the end of this year. Monica is also doing background studies for next generation experiments such as LZD, a 20 ton two-phase Xenon detector.



**Jan-Patrick “JP” Porst** joined Brown as a post-doc in April 2011 from Heidelberg, Germany, where he completed his dissertation work on the development of metallic magnetic calorimeters (MMCs) for applications such as beta spectroscopy. Currently, JP is working with Professor George Seidel, and is located at the NASA Goddard Space Flight Center, where he continues working with low temperature detectors for high resolution X-ray spectroscopy. At Goddard, he joined the microcalorimeter group and is focusing on the development and the readout of different detector technologies, including MMCs, a fairly new and promising low temperature detector technology; MPTs, magnetic penetration thermometers; and transitions edge sensors.



**Alexander Prygarin** received his PhD in Particle Physics from Israel’s Tel Aviv University in 2008 and spent three years at Hamburg University in Germany as a postdoctoral researcher before coming to Brown in September 2011. His research interests are in various theoretical approaches applied to particle scattering at very high center-of-mass energies. In particular, his recent scientific activity is devoted to the study of Maximally Helicity Violating (MHV) amplitudes in supersymmetric theories using apparatus of the high energy limit of Quantum Chromodynamics (QCD).



# Professional Meetings

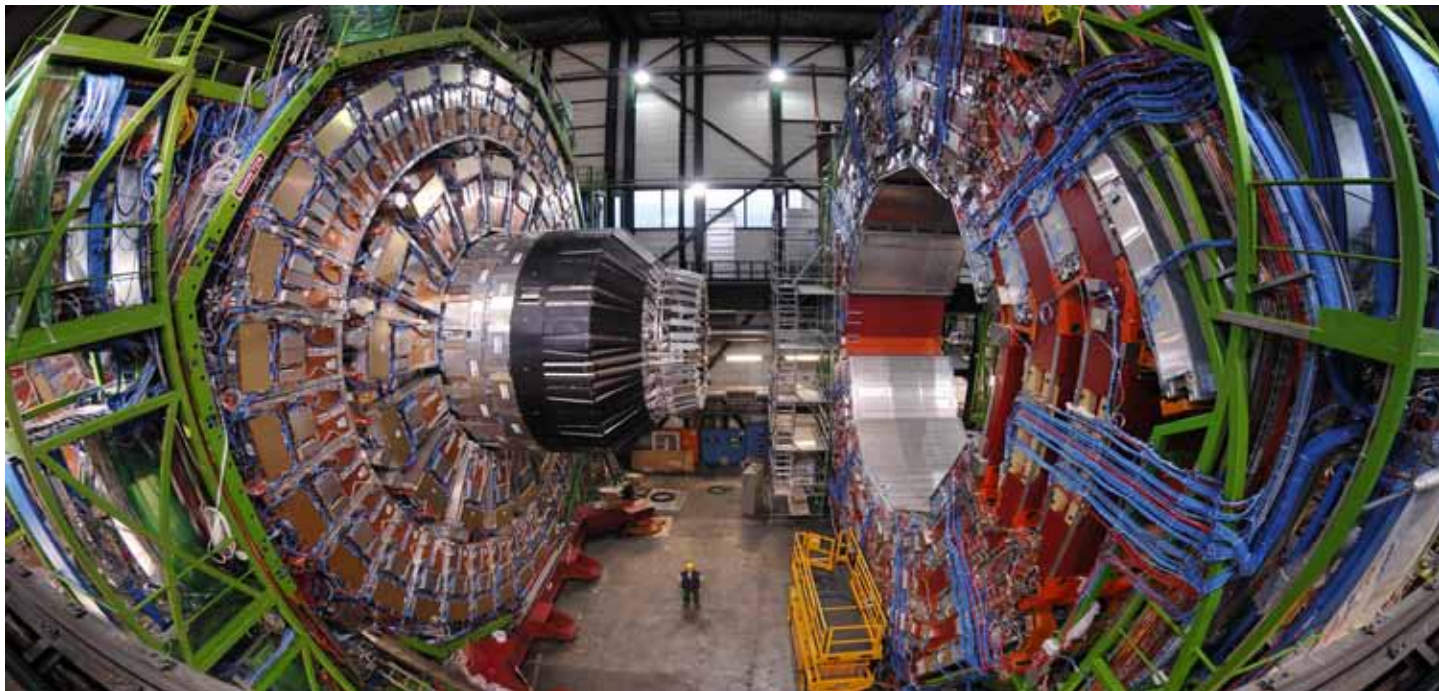
## Division of Particle and Fields Meeting Held at Brown

Brown University hosted the biannual meeting of the Division of Particle and Fields of the American Physical Society last summer. Held August 9-13, nearly 500 particle and astrophysicists from all over the United States and abroad gathered at the Rhode Island Convention Center in downtown Providence. The latest results from the Tevatron, the Large Hadron Collider and other experiments and their theoretical implications were discussed in 25 invited plenary talks and almost 400 parallel sessions. Consideration of how the field should evolve in the future was a key feature of the meeting's agenda, which also included forums regarding support of detector research and development, the physics potential of lepton colliders, project X at Fermilab, and the US role in underground-based physics. Topics related to presentation of physics research in the modern media and women's issues were also discussed.

A well-attended lecture conveyed the excitement of current re-

search to the general public. Among the attendees of the conference were the director of the office of science in the U.S. Department of Energy, the director of Fermilab, the director of accelerators and technology from CERN, and the president of the American Physical Society. The participants enjoyed a reception at the RISD art museum and a clambake on Brown's Main Green. The conference ended with a plenary session on campus, where the mayor of Providence, Angel Taveras, and Brown's Provost Mark Schlissel addressed participants.

The department's particle and astrophysics faculty and staff organized the event. Professors **David Cutts** and **Ulrich Heintz** co-chaired the local organizing committee and Professor **Meenakshi Narain** chaired the program committee. The U.S. Department of Energy, the National Science Foundation, the American Physical Society, Brown's Provost's Office and Physics Department provided financial support for the conference.



## Fifth New England String Meeting

The fifth annual New England String Meeting was held at Barus & Holley on November 18, 2011. About 70 students, post-docs, and faculty gathered for the one-day conference to hear six presentations. Barton Zwiebach from MIT kicked off the program with a talk about recent developments in Double Field Theory. He was followed by Sergei Gukov of Caltech, who discussed 3-D gauge theories labeled by 3-Manifolds. After lunch, Alex Maloney, McGill University, spoke about the Holographic Dual of the Ising Model and then Harvard's Subir Sachdev gave a pre-

sentation about the holography of Compressible Quantum States. Herman Verlinde, Princeton, spoke about gravity from Instantons, and Nima Arkani-Hamed from the Institute for Advanced Study at Princeton concluded the program with a presentation entitled "Scattering Amplitudes and the Positive Grassmannian." The schedule included plenty of time for participants to chat informally about their work, and the day ended with dinner at Café Paragon on Thayer Street.



# International Activities

## Year of China Initiative

As part of Brown's internationalization efforts, **Chung-I Tan** is leading a year-long series of events about China entitled "Opening Doors, Opening Minds." The initiative strives to examine China in the broadest possible terms, including culture, history, people, geography and China's relationship to the world. Professor Tan has made a concerted effort to invite scientists to come to Brown as part of the Year of China, saying that "science transcends national boundaries; it is an area where collaboration can be achieved more easily. China's growing economic strength, like ours, depends not only upon labor skills and natural resources but also increasingly upon our collaboration and competition in pure and applied science. Our pre-eminence in industrial and university R&D is being challenged by China's growth in science and engineering." Several distinguished scientists are on the roster of speakers for the year, including Wang Enge, Provost of Peking University and Zhejiang University's President Wei Yang. On October 24, President Yang delivered a lecture, "Defect Evolution In Nanocrystals and Graphens" to a packed auditorium. Provost Enge, formerly the Dean of Peking University's School of Physics, will visit Brown on March 5 to present a colloquium and a public lecture.

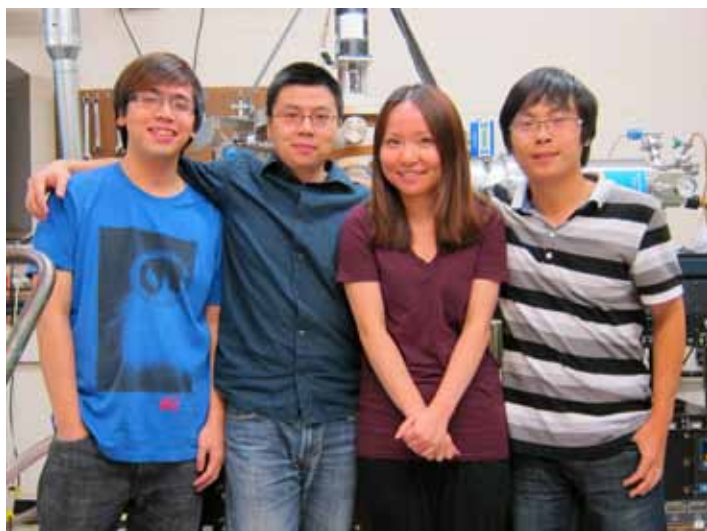


President Wei Yang of Zhejiang University

Last fall, Professor **Jay Tang** participated in a panel discussion, "A Century, and More, of Chinese Students Studying Abroad," that explored the historical antecedents of the large flow of students from China, how this history shaped the trajectory of exchange, and the impact of US-China educational exchange at Brown. In addition to Professor Tang, participants included scholar and author, Edward Rhoads and Leslie T. Chang, former Wall Street Journal reporter and author of the book, *Factory Girls*. Current undergraduate and filmmaker, Yue Shen, the fourth panelist, showed a preview of her film about Chinese students coming to Brown. To see a full recording of the panel discussion, please visit Brown University on YouTube. Read more about the Year of China at [www.Brown.edu/yearofChina](http://www.Brown.edu/yearofChina).

## SURE Program

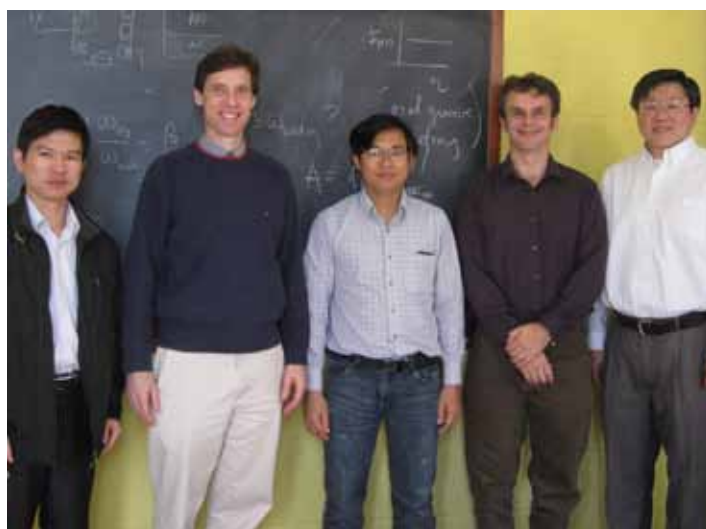
As part of the Department's ongoing relationship with the Chinese University of Hong Kong (CUHK), two students participated in the Summer Undergraduate Research Experience (SURE) program. Professor **See-Chen Ying** coordinates this program with CUHK, and has facilitated the placement of three more students in labs this summer, which will bring the total number of participants in the program at Brown to ten.



L to R: CUHK student Hon Ming Chan with Wenzhe Zhang, Shu Wang, and Qiang Hao

## Hanoi University of Science

Since 2009 the Physics Department has hosted eleven faculty members from the Hanoi University of Science. Each visiting faculty has spent at least two months observing classes and meeting with Brown faculty and staff to learn about various teaching techniques and methods as well as laboratory demonstrations. The most recent visitors chose to observe classes taught by Professors **David Lowe** (Thermodynamics and Statistical Mechanics) and **Gang Xiao** (Techniques in Experimental Physics).



L to R: Nguyen Ngoc Dinh, Jim Valles, Nguyen Anh Tuan, David Lowe, and Gang Xiao

## Ladd Observatory

Ladd Observatory had another exciting year of research and community outreach, and continued to host record crowds on public nights. In addition to informal “fireside” talks in the library downstairs and viewing through the telescopes upstairs, there were more formal events, including Professor **Ian Dell’Antonio**’s presentation, “Supernovae and the Accelerating Universe.” University of Pennsylvania’s Nathan Sivin, the nation’s leading expert on Chinese astronomy, gave a special seminar, “How Astronomy Evolved in China and in the West.”

Now that the restoration of the historic transit room is complete, Ladd is focusing on associated instruments such as transit telescopes and clocks. A generous gift of \$1600 will support the restoration of two of Ladd’s historic clocks. This project is important because time is determined by the rotation of Earth relative to the celestial background. At Ladd and other observatories, telescopes were used to monitor stellar transits and set clocks.

The U.S. Naval Observatory and NIST now determine and broadcast the exact time, but up until recently, Ladd provided the time signal for Rhode Island. Ladd also supplied the correct time for the bell that rings on top of University Hall to mark the class schedule and important events, thus eliminating the “nuisance and inconvenience often caused by the bell being rung too soon.” (*Brown Daily Herald*, September 20, 1895). When our project is completed, visitors will have a unique hands-on opportunity to understand how time was, and continues to be, determined.

A gift from John and Louise MacMillan, P’08, P’09, afforded the purchase of an “all sky camera” to record at moderate resolution, throughout the evening, faint stars as well as more transient events such as passing asteroids, meteors, and comets. At 3:23:30 a.m. on the morning of January 19, 2012, the camera caught an unusually bright meteor, or fireball. Coverage of this discovery by the Providence Journal and area television stations included spectacular footage of the meteor’s trail and interviews with Ladd curator **Michael Umbricht** and Professor **Savvas Koushiappas**.

Plans are in the works to take Ladd’s main telescope, the 12” (15’ focal length) Brashear refractor, out of service for a long-overdue restoration of its intricate clock drive mechanism. It has served



Ladd well for more than 120 years. The overhaul is expensive (\$15,000), and Ladd is seeking funds to cover this highly specialized type of historic instrument restoration.

Staff and faculty are currently preparing for an event of historic significance to science in general and Brown in particular. On June 5, 2012, the planet Venus will transit (or cross) the face of the sun as viewed from the Earth. In 1769, a worldwide effort was mounted to measure, using parallax, the scale of the solar system by observing a Venus transit from different points on Earth. While Captain Cook observed the transit from Tahiti, Benjamin West, Brown’s first professor of mathematics and astronomy, along with a member of the Brown family and others, witnessed the transit from a location that soon became known as Transit Street. Ladd is planning events and a public viewing, including a display of the telescope used by Professor West. Don’t miss this historic occasion! The next transit will not occur until December of 2117.

*Courtesy of Dean David Targan, Director, Ladd Observatory*

**Do you want to receive engaging weekly news stories about events in the night sky over Providence? More than 1100 people have signed up for Ladd’s Listserv, which provides information on events at Ladd and celestial happenings. Sign up at: <http://www.physics.brown.edu/physics/commonpages/ladd/>**



**Jeremiah Horrocks making the first observation of the transit of Venus in 1639**  
Image provided by Astley Hall Museum & Art Gallery



## Activities in Providence Schools

An introductory class in beginning astronomy, taught by Professor **David Cutts** last spring, included an optional community outreach component. Twelve students in the class chose that option. The students formed four groups and collaborated with one another to create teaching materials on topics of their choosing. Each group gave the resulting presentations at least three times to various groups of students at Hope High School in May. Professor Cutts commented that this exercise is an effective method to demonstrate the concept that explaining ideas helps to develop understanding. The Brown students responded enthusiastically to the entire experience.

Catharine Sully, a physics teacher at Hope High School, said the Brown students were able to fit in weeks of curriculum in just days. She praised the quality of their presentations and said, “New people, fresh faces really have an effect on students’ willingness to be engaged. Not only does it have a positive effect on the students but it always serves to reinvigorate me...after every interaction with Brown faculty I walk away feeling lucky and re-energized!” Ms. Sully also reported that her students eagerly anticipated the sessions, and that she developed homework assignments specifically related to slides in each group’s presentation.

Other faculty contributions to learning activities in Providence schools include a particle physics project at Wheeler School developed by Professors **Meenakshi Narain** and **Ulrich Heintz**. Last June, Professors **Ian Dell’Antonio**, **Derek Stein** and **James Valles** participated in a science conference sponsored by the GK-12 project at Vartan Gregorian Elementary School, where they gave talks about various aspects of physics. Professor **Greg Tucker** also gave a talk “Measuring the Universe from Space” at a June conference sponsored by GK-12 at the Martin Luther King Elementary School.

Over the past year, **Ryan Michney** has coordinated multiple efforts funded by the National Science Foundation’s GK-12 program. Ladd Observatory was the conduit for outreach activities in

## Museum Programs

During 2011, graduate student **Ryan Michney**, recipient of a Rhode Island Space Grant Consortium Fellowship, engaged in an array of outreach activities related to museum exhibits. He



**Ryan Michney** assisting **Martin Luther King elementary school students** to view sun spots and solar prominences

local public schools, and Ryan presented solar observing demonstrations with the hydrogen-alpha telescope and lessons about solar activity. Ryan’s other teaching activities included Brown Summer High School and a Summer Studies course called “Exploring the Planets” about the solar system and efforts to explore it. He is also working on a system to deliver data (which would be updated daily) from Ladd’s all-sky camera to teachers in a form they can use to teach students about variable stars.

worked with his advisor, Professor **Ian Dell’Antonio**, and Peter Neivert of the Planetary Science Data Center to create “Alien Worlds: New Discoveries Around Distant Stars,” a special exhibit workshop for grades 5-8 at the Roger Williams Park Museum of Natural History, which ran from September through December. The workshop featured hands-on activities as well as a guided exploration of the exhibit.

**Michael Umbrecht**, curator of Ladd Observatory, worked with Ryan to create another workshop that opened at the Museum in November entitled “Saturn: Beyond the Rings.” This exhibit, also aimed at grades 5-8, includes more than 50 photographs of Saturn taken from the Cassini Spacecraft as well as historic astronomical instruments from Ladd Observatory’s collection. The two of them are collaborating with Professor Dell’Antonio on other outreach activities, including a new program that will open at the Providence Children’s Museum in March called “Stargazers,” an activity using telescopes. NASA’s Rhode Island Space Grant Consortium funded all of the above-mentioned exhibits.

# Department Events

## Brown Degree Day

Twenty alumni returned to campus on April 30 to participate in the third Brown Degree Day program. As always, the event was well-attended and appreciated by undergraduates and graduate students alike. **Xi-Cheng Zhang PhD'86** and **Matt Bowen ScB'00** spoke at length about their experiences, and their presentations were followed by a lively panel discussion. The panelists included **James Battat ScB'01**, **Jasmine Foo ScB'02**, **Harlan Hurwitz AB'69, ScM'70**, **Carl Kramer ScB'69** and **Janine Shertzer PhD'84**. After the panel, the program also featured roundtable discussions and a presentation to alumni by Professor **Meenakshi Narain** entitled "The Large Hadron Collider: Gateway to the Early Universe." Physics will host the fourth annual Brown Degree Day on Saturday, April 28, 2012.



## Arthur O. Williams Lecture

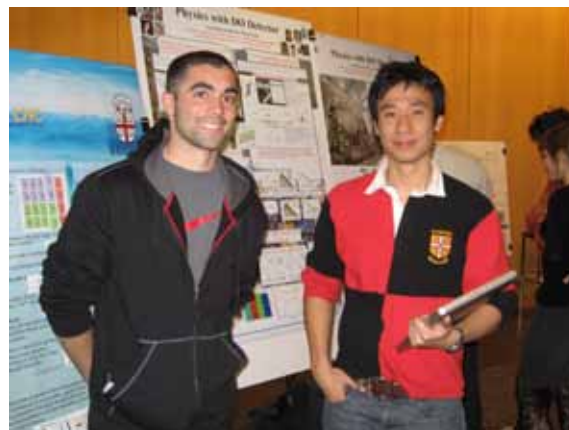
On January 31, 2011, Dr. John Ellis delivered the annual A. O. Williams Lecture, "Perspectives for Discovering New Physics at the CERN Large Hadron Collider," to a packed auditorium. Dr. Ellis is the Clerk Maxwell Professor of Theoretical Physics and Head of the Theoretical Particle Physics and Cosmology Group at King's College. Prior to his appointment at King's, he held a number of major roles at CERN.

His research interests lie in the theoretical physics of elementary particles, ranging from standard model physics to string theory. One of the pioneers of research at the interface between particle physics and cosmology, Dr. Ellis has made fundamental contributions to the advancement of our understanding of the standard model of particle physics and pioneering contributions to the theory and phenomenology of the unifications of forces. Much of his research has also concerned the prospects for future particle physics accelerators, including the present Large Hadron Collider.

In 2004, the SPIRES High-Energy Physics Literature Database ranked Dr. Ellis as the second most-cited theoretical physicist of all time. The recipient of the Maxwell Medal and the Paul Dirac Prize, he is an Elected Fellow of both the Royal Society of London and the Institute of Physics.

## 2011 Poster Session

In November, faculty and students gathered for the annual poster session. The well-attended event showcased 42 posters and attracted nearly 70 students and faculty.



Michael Segala and Michael Luk



James Besson and Adam Frees



Alex Garabedian and Zeynep Demiragli



## Physics Art Show

The second annual art show was held on November 29, 2011 in Barus & Holley's faculty lounge. An array of wonderfully diverse artwork by members and friends of the Physics Department was exhibited to a crowd of more than 50 people. Also featured was a compelling performance of a scene from Michael Frayn's award-winning play, *Copenhagen*, based on a meeting between the physicists Niels Bohr and Werner Heisenberg that occurred in Copenhagen in 1941. Graduate students **Andrew Favaloro** and **Saptaparna Bhattacharya** played the roles of Niels and Margrethe Bohr, and undergraduate **Harry Mickelide** performed the part of Werner Heisenberg.



Physics Fall Picnic



St. Patrick's Day

## Newton's Apple Tree

On October 7, the Physics Department gathered to commemorate the legendary fall of an apple. A dozen years ago, **Humphrey Maris** planted a graft of a descendant of the apple tree believed to have inspired Sir Isaac Newton's universal law of gravitation. The tree, located near the steps of Barus & Holley, is an antique strain called "Flower of Kent." Each fall, Professor Maris harvests the fruit it bears to share with his students.

Legend has it that the bubonic plague played a peripheral role in Newton's seminal moment. Newton was a student at Trinity College in Cambridge when the plague swept across Europe, reaching Cambridge in 1665 and forcing the university to close. He returned to Woolsthorpe Manor, his family's home in Lincolnshire, England, where he observed apples falling in the garden. William Stukeley, a contemporary of Newton, produced a 100-page manuscript entitled "Memoirs of Newton's Life" which The Royal Society recently made available online. The following excerpt describes a visit Stukeley made to Newton on April 15, 1726.

*After dinner, the weather being warm, we went into the garden, & drank tea under the shade of some apple trees, only he, & myself. Amidst other discourse, he told me, he was just in the same situation, as when formerly, the notion of gravitation came into his mind. Why should that apple always descend perpendicularly to the ground, thought he to himself occasion'd by the fall of an apple, as he sat in a contemplative mood. Why should it not go sideways, or upwards? but constantly to the earth's centre?*



*Assuredly, the reason is, that the earth draws it. There must be a drawing power in matter. & the sum of the drawing power in the matter of the earth must be in the earth's center, not in any side of the earth. Therefore does this apple fall perpendicularly, or toward the center. If matter thus draws matter, it must be in proportion of its quantity. Therefore the apple draws the earth, as well as the earth draws the apple.*

This anecdote supports earlier writings by Newton that it was during the time he spent at Woolsthorpe while Cambridge University was closed that he first understood the theory of gravitation. According to scholars, Newton polished this anecdote over the years, although there is no evidence that he ever said an apple fell on his head. Richard S. Westfall, one of Newton's most esteemed biographers, refers to that version of the story as "a vulgar myth." Westfall characterized Newton as somewhat humorless, as evidenced by the experience of Humphrey Newton, Newton's copyist for five years in the 1680's. In all that time, Humphrey saw Newton laugh only once, when he lent an acquaintance a book of Euclid's work and the borrower asked him what use it would be.

The Physics Department is grateful to Professor Maris for bringing this piece of history to Barus & Holley and providing a reminder that the most ordinary objects and events can be inspiring if only you know how to observe them.



## Physics at Brown

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