Physics at Brown

2010 Issue

Message from the Chair

It is my pleasure to welcome you to another edition of the Physics Department newsletter. I began serving as Chair in July 2010, when Chung-I Tan stepped down after six years of outstanding leadership. It has been a busy and exciting year. The Department is actively engaged in efforts to expand research and increase funding while continuing to focus on the value of good teaching and scholarship. I have recently chaired a series of meetings with our faculty to chart the future of the Physics Department, and I look forward to working with them and members of the Brown administration to put our plans into action.

The Physics Department faculty continue to garner well-deserved recognition and funding for their research, and I am delighted to share news that Humphrey Maris was recently selected as a recipient of the 2011 Fritz London Prize. Over the past year, several faculty have designed and offered interesting new courses, and I am pleased to report that the number of undergraduate concentrators in physics continues to show robust growth. Nineteen undergraduate degrees and eighteen doctoral degrees were awarded in 2010, and we are currently in the process of crafting our new class of graduate students. I am especially proud of our graduate students who have worked hard to refine a successful peer-mentoring program that they designed.

Two large gatherings of physicists were hosted at Brown last year. The US Compact Muon Solenoid Collaboration met in May to discuss the most recent results from the LHC, and the New England Sections of the American Physical Society and the American Association of Physics Teachers held their fall meeting at Brown last October. In addition, the Physics Department held a symposium in honor of Gerald Guralnik's receipt of the prestigious Sakurai Prize, and many distinguished physicists have visited over the course of the year to present seminars and colloquia.

The second annual Brown Degree Day, held last April, brought 25 alumni back to campus to talk with our students. Sylvia Smullen '98 and Rob Stoner PhD'92 spoke to students about their career paths since graduation, and their presentations were followed by a panel discussion comprised of five alumni who talked about teaching and research. A second panel focused on entrepreneurial and other careers. The third Brown Degree Day is scheduled for Saturday, April 30, and I look forward to welcoming more alumni back to campus. Our students sincerely appreciate the opportunity to learn from, and connect with, their predecessors.

Lastly, the Department was saddened by the passing of two emeriti, Hendrik Gerristen and Jan Tauc. More about these remarkable individuals is contained in the following pages.

I hope you enjoy reading about the activities and people in the Physics Department, and I encourage you to contact us with news of your own.

Jim

James M. Valles, Jr.

Ladd Observatory

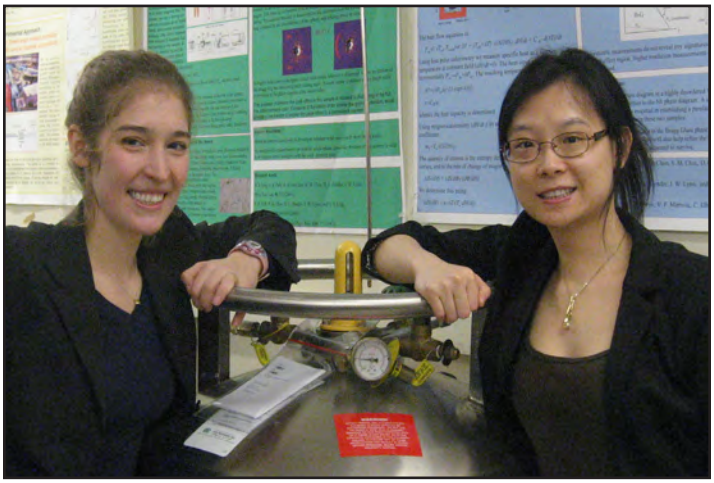
Over the course of the last year, Ladd staff and faculty from the Department of Physics have been very active in their support of Ladd's mission to educate the public about astronomy and astrophysics. During this period we have had a productive program of historical research and restoration, and completed one major restoration project. Professors Savvas Koushiappas and Greg Tucker gave presentations related to their research, and others contributed with talks about light pollution, astronomy in colonial Mexico and Peru, and historical aspects of astronomy and timekeeping in the late 19th and early 20th centuries. Francine Jackson's weekly emails to our growing listserv (now more than 900 members) keep the public informed of events they can see in the night sky. The newsletter draws a constant stream of positive comments by people who go outside and observe these phenomena directly. Our all-sky camera is operational and allows us to view either recordings or real-time observations of the night sky.

On October 19, 2010, a ribbon-cutting ceremony for the Transit Room was held an hour before the regular Tuesday open house, so that the Historic Commission, architects, contractors, and members of the department could partake in the celebration. Now regular visitors can see the Transit Room and, skies permitting, view transiting stars through the refurbished hatches.

Michael Umbricht, a Ladd staff member, sits in the recently restored Transit Room gazing through a portable telescope, which once was used to make accurate time measurements through observations of the stars

Ladd continued on page 8. . .

Helen Hanson and Xi Wang, 2011 Galkin Fellows



Helen Hanson and Xi Wang

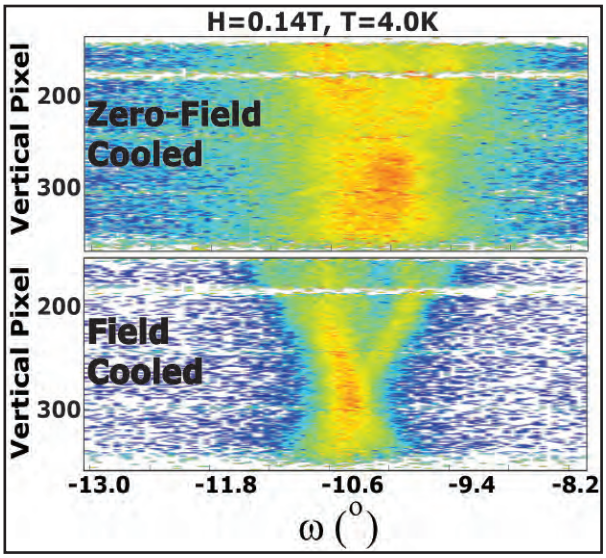
Helen Hanson and Xi Wang, the joint 2010-2011 Galkin Foundation Fellows, are completing their Ph.D. dissertation research on determining the ground state structure of the vortex matter in type-II superconductors with novel neutron scattering techniques. For the past four years, Hanson and Wang, with their advisor Prof. Sean Ling and collaborators, have conducted research at Brown University and at the NIST Center for Neutron Research (NCNR).

Vortex matter in type-II superconductors is a useful model system for studying the effects of quenched disorder on elastic systems with long-range order associated with broken continuous symmetry. The goal of the experiments by Hanson and Wang is to determine the nature of the long-range order in the ground state of a vortex lattice in the classic bulk type-II superconductor Nb.

Early theoretical models predicted that any finite quenched disorder will destroy the long-range order of an elastic system. However, early neutron scattering experiments on the vortex lattices in Nb measured resolution-limited Bragg peaks, implying the existence of long-range order and contradicting the models. In the 1990's, theorists predicted that the subtle interplay between the elastic interaction and the random pinning may produce a new phase of matter, a topologically order Bragg glass, which has a power-law shaped structure factor, analogous to a two-dimensional solid at finite temperatures with no random pinning. Many experiments have been carried out in search of this new phase, but no conclusive evidence has been found.

In the Hanson-Wang experiments, it was quickly discovered that the vortex matter formed by standard zero-field-cooling and field-cooling procedures is spatially inhomogeneous. This explains why previous standard measurements using small angle neutron scattering (SANS) often reported contradictory results. By using the Advanced Neutron Diffractometer/Reflectometer (AND/R) at NCNR, Hanson and Wang systematically studied the formation of the vortex matter by different growth procedures. The AND/R system provides the ability to isolate different parts of the sample and measure the orientational Bragg peak structure along and perpendicular to the length of the flux lines. Positional dependence of the structure in the sample has been observed. A broader Bragg peak at the edge of the sample supported the edge contamination effect model (an inhomogeneous surface barrier results in a disordered state around the sample edge). This may explain a longstanding issue in vortex physics – why some samples show the existence of the peak effect, which has been accepted as a footprint of a first-order transition in the vortex matter, while others do not. The group has also observed variations of orientational order along the length of the flux lines. The Bragg peak splits into two distinct peaks near the top of the sample and exhibits a "Y-shaped" Bragg peak. This fascinating result sheds new light on the interaction between the vortex matter and the underlying atomic crystal. The splitting of the Bragg peak at different fields and temperatures supports the model of strong interaction between the flux line lattice and the atomic crystal even in a sample with supposedly weak pinning.

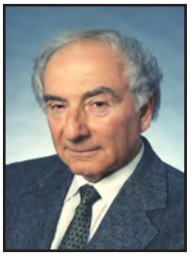
This research has important impact for the theoretical models governing vortex physics and the applications of type II superconductors. All high temperature superconductors are type II and the most accessible portion of the phase diagram is where the vortex matter forms. Forming a universal phase diagram for vortex matter is important to understanding the impact of quench disorder on this system.



Comparison of neutron scattering intensities from vortex matter with different growth histories in the same niobium single crystal. The horizontal axis, ω, is the rocking angle which reflects the orientation of the vortex lattice planes. The vertical axis, corresponds to the spatial location (along the length of the flux lines) where the scattering occurs.

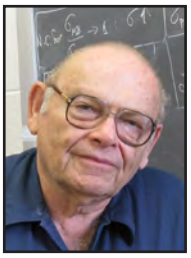
The Galkin Foundation Fellowships are funded through a generous donation by Warren Galkin, Class of '51. The Fellowship recognizes exceptional promise and achievement in physics by a senior graduate student.

Faculty Honors and Research Highlights



Leon Cooper's research group identified a new aging-associated gene through computational and experimental analysis with Drosophila melanogaster, which they published in the journal Aging. The group invented a new method for comparing gene expression experiments, and has begun to apply it to stress and aging-related datasets. Also, as part of the project Genetic Tests of the Linear No Threshold Theory of Radiation Damage, they generated the first known gene expression dataset for organisms in radiation levels below background.

David Cutts is working with graduate student Juliette Alimena to update their search for charged massive long-lived particles. Being massive, these objects would move more slowly than v=c particles and would have a distinct signature of long time-of-flight and high ionization energy loss, as they pass through the D0 Detector. Cutts and Alimena are in the process of preparing a paper describing their results.



During the past year, **Herb Fried** and his ex-grad student, Ming Sheu, along with two French colleagues (M. Gattobigio and T. Grandou), extended their work on a new, gauge-invariant formulation of QCD, whose exact sum over all possible exchanged gluons can be expressed by a simple set of local integrals for any process, which has enabled them to construct, from first principles, quark-binding and hadron scattering potentials. In addition, Fried has found a new, QED symmetry-breaking solution which with one parameter reproduces the four parameters previously estimated of values of the necessary density for "dark energy" at the times when inflation is believed to have begun and finished.

Gerald Guralnik Gerald Guralnik was named to an endowed chair, the Chancellor's Professor of Physics. Gerry's current research is focused on quantum field theory, general relativity, and related computational methods. In addition, he applies his expertise in large-scale computations to Brown's Ersatz Brain Project, which has the ultimate goal of designing a computer that simulates various processes of the brain. He was one of six recipients of the prestigious Sakurai Prize in 2010 for work that contributed to an essential part of the theory of fundamental particles.

Greg Landsberg co-leads the Exotics Physics group of the CMS Collaboration, which authored about ten publications already, with many more in the works. Over the past year, achievements from the Compact Muon Solenoid (CMS) experiment at the Large Hadron Collider (LHC) included an impressive set of physics results obtained with early data collected at center of mass energies up to the new record energy of 7 TeV, many of which have been already published. The Brown group is involved in several aspects of the experiment, including hadron calorimeter, silicon tracker, and trigger. The current focus of his interest is a test of models with extra spatial dimensions, in particular a possibility of producing mini-black holes at the LHC, which he predicted theoretically in 2001 and has recently probed with the LHC data with his student Ka Vang Tsang and postdoc Alexey Ferapontov.

Humphrey Maris received a fellowship from the American Physical Society to give five lectures in India during January 2011. These include a special lecture in Bangalore in memory of K.S. Krishnan, co-discoverer of the Raman light scattering effect.

Brad Marston was selected to speak at the Fall 2010 meeting of the American Geophysical Union in San Francisco. He discussed his recent work on the direct statistical simulation of atmospheric circulations. In addition, during 2010 the American Physical Society named Brad an Outstanding Referee. This highly selective award program was initiated to recognize scientists who have been exceptionally helpful in assessing manuscripts for publication in the APS journals. The basis of selection for this lifetime award was the quality, number and timeliness of their reports, without regard for membership in the APS, country of origin, or field of research.

Vesna Mitrovic and collaborators from Brown University and the Laboratoire National des Champs Magnétiques Intenses in Grenoble, France, reported in Physical Review Letters a detailed low-temperature NMR investigation of the phase diagram of CeCoIn5. They found that the magnetic order induced at high fields is an incommensurate spin-density wave, which likely coexists with a so-called Fulde-Ferrell-Larkin-Ovchinnikov phase—a superconducting state with a spatially modulated order parameter. They also discovered a new phase lying between the incommensurate spin-density wave state and the low-field ordinary superconductivity; they conjecture that it is a different kind of Fulde-Ferrell-Larkin-Ovchinnikov phase. Vesna is the recipient of a 2010 ADVANCE Career Development award.

Greg Tucker's group helped lead the rebuilding of BLAST and adding polarization capability, after the Balloon-borne Large Aperture Submillimeter Telescope (BLAST) had a rough landing in 2006. The goal of BLAST-pol is to measure magnetic fields in star formation regions. BLAST was launched from the Antarctic on December 26, 2010 and had a successful ten-day flight before landing back on the Ross ice shelf. Analysis of the data is underway.

Research and honors continued on page 9 . . .

2010 PhD Recipients

Cuong H. Dang "CdSe-Based Colloidal Semiconductor Nanocrystal Quantum Dots: From Single Photon Emitters to Lasers" Advisor: Professor Arto Nurmikko

Luis A. deViveiros "Optimization of Signal versus Background in Liquid Xe Detectors Used for Dark Matter Direct Detection Experiments" Advisor: Professor Richard Gaitskell

Rongwei Hu "Investigation of a d-Electron Kondo Insulator $FeSb_2$" Advisor: Professor Vesna Mitrovic

Hyeran Kang "Kinetic and Kinematic Properties of Actin Network Assembly and Nonlinearity of Cross-Linked Fibrin Gels" Advisor: Professor Jay Tang

Hyunjin Kim "Interface Studies on Organic-Inorganic Hybrid Heterojunctions and Device Applications of Nanowire Materials" Advisor: Professor Arto Nurmikko

Tongsik Lee "Monte Carlo Simulations of Structural Phase Transitions in Metals and Alloys" Advisor: Professor James Doll

Feifei Li "Transport in Low Dimensional Strongly Correlated Electronic System" Advisor: Professor Dmitri Feldman

Jing Ma "Localized Modes and the Vibrations of Nanostructures" Advisor: Professor Humphrey Maris

Hung Q. Nguyen "Experiments on a Cooper Pair Insulator" Advisor: Professor James Valles

Monica O. Pangilinan "Top Quark Produced Through the Electroweak Force: Discovery Using the Matrix Element Analysis and Search for Heavy Gauge Bosons Using Boosted Decision Trees" Advisor: Professor Meenakshi Narain

Shubho R. Roy "Holographic Description of Black Holes and Cosmic Inflation in Asymptotically Anti de Sitter Backgrounds" Advisor: Professor David Lowe

Leslie J. Shelton "Liquid Crystal and Polymeric Coupling, and Stressed Liquid Crystal Technology for Fourier Transform Spectroscopy" Advisor: Professor Gregory Crawford

Phong A. Tran "Nanostructured Selenium for Biomedical Applications: From Theory to Practice" Advisor: Professor Thomas Webster

Yury Vinokurov "EBEX, a Balloon-Borne Telescope for Observing the Polarization of the Cosmic Microwave Background" Advisor: Professor Gregory Tucker

Heng Xu "Optical Recording and Photo Modulation in the Study of Dynamics in Neural Circuits" Advisor: Professor Arto Nurmikko

Fan Yang "Study of Gigahertz Ultrasound Propagation in Water Using Picosecond Ultrasonics" Advisor: Professor Humphrey Maris

Jiayi Zhang "Optical Stimulation and Spatiotemporal Electrical Recording in Genetically Targeted Brain Tissue" Advisor: Professor Arto Nurmikko

Xiaojing Zou "Magnetic Domain Configurations and Huge Wall Resistivity in Half-Metallic Chromium Dioxide (CrO_2) Nanostructures" Advisor: Professor Gang Xiao

Graduate Awards 2009-2010

Galkin Foundation Fellowship Award
Kewang Jin

Dissertation Fellowship Award and Beyer Award for Excellence in Scholarship and Service
Phong A. Tran

Forrest Award for Excellent Work Related to Experimental Apparatus
Wanchun Wei

Dissertation Fellowship Award
Georgios Papathanasiou

Master of Science Recipients

Juliette Alimena
Jeremy J. Chapman
Scott E. Field
Chao Li
Pengyu Liu
Michael M. Luk
Ryan J. Michney
Duong H. Nguyen
Michaeld A. Segala
Tutanon Sinthuprasith
James R. Verbus
Chenjie Wang
Wenzhe Zhang
Mengdi Zheng

2010 Undergraduate Degree Recipients

Kenneth L. Aronson, *Bachelor of Arts, Physics; Bachelor of Arts, Linguistics, Magna Cum Laude, Phi Beta Kappa*

Katherine E. Dagon, *Bachelor of Science, Mathematics-Physics, with honors*

Alexandre A. de Chaumont Quitry, *Bachelor of Science, Engineering-Physics*

Alice F. Goldfarb, *Bachelor of Science, Mathematics-Physics*

Jeremy L. Goodman, *Bachelor of Arts, Physics; Master of Arts, Philosophy, with honors; Bachelor of Science, Cognitive Neuroscience, Magna Cum Laude, Phi Beta Kappa*

Nicholas W. Hagerty, *Bachelor of Science, Physics, with honors; Bachelor of Arts, Economics, Magna Cum Laude*

James C. Hinton, *Bachelor of Arts, Physics*

Nicholas R. Kennedy, *Bachelor of Arts, Physics*

Ariella Kirsch, *Bachelor of Science, Mathematics-Physics, with honors, Magna Cum Laude*

Matthew R. Kretschmer, *Bachelor of Science, Physics, with honors*

Noah I. Langowitz, *Bachelor of Science, Chemical Physics, with honors, Magna Cum Laude, Phi Bets Kappa*

Michael G. Levy, *Bachelor of Science, Physics, with honors*

Laura M. Mocanu, *Bachelor of Science, Physics, with honors*

Benjamin J. Mossbarger, *Bachelor of Science, Physics, with honors*

Eric L. Rudisaile, *Bachelor of Science, Engineering-Physics*

Barbara K. Stekas, *Bachelor of Science, Physics, with honors*

William E. Strecker-Kellogg, *Bachelor of Science, Physics, with honors*

Nicholas R. Werle, *Bachelor of Arts, Physics; Bachelor of Arts, Independent Concentration, Magna Cum Laude*

Charles R. Wood, *Bachelor of Arts, Physics*

Undergraduate Awards 2009-2010

R. Bruce Lindsay Prizes for Excellence in Physics
Laura M. Mocanu

Mildred Widgoff Prizes for Excellence in Thesis Preparation
Nicholas W. Hagerty

Joseph J. Loferski Award for Exceptional Promise for a Career in Solar Electricity, awarded by the Division of Engineering
Katherine E. Dagon

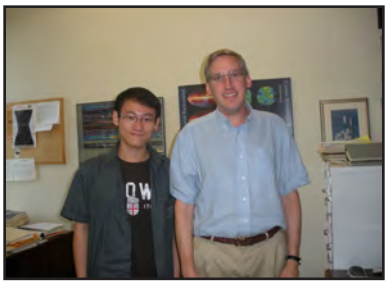
2010 UTRA Students

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.

Stephen Albright "Electrokinetic energy harvesting in nanofluidic channels"
Jonathan Beller "Electrokinetic Energy Harvesting in Silica Nanochannels with Hydrodynamic Slip"
James Bensson "Examining the Near Surface Swimming Behavior of Bacterium C. crescentus"
Octavia Crompton "Liquid Crystal Modeling"
Allison Deshler "Simulations of Bolometric Interferometry"
William Hicks "Implementing New Algorithms for Particle Physics Computations"
Thomas Iadecola "Statistics of the Atmospheric General Circulation from the Hopf-Flow Approach"
Jacob Isbell "Educational Labs and the D0 Experiment"
Yosuke Kurokawa "Self-immobilization of Genetically Engineered Caulobacter Crescentus and Its Application in the Removal of Heavy Metal Ions from Water"
Daniel Munger "Gravitational Lensing in the Medium-Weak Limit-Extra Information from the galactic Structure
Jared Lafer "Improvements to the CMS trigger systemâ€™s detection of top quark production"
Edward Parker "Exploring the Leading Singularity Conjecture"
Real Provencher "Comparative Investigation of the Swimming of Paramecia of Two Different Sizes"
Laurentiu Rodina "Twistors, Grassmannians and Gravity"
Sorawis Sangtawesin "Research in String Theory and Quantum Field Theory: Scattering Amplitudes"
Elijah Shelton "An Investigation of Reaction Rate Theory via Thermally Activated DNA Transport in a Nano-scale Topography"
Erik Stayton "An Analysis of Mass Distribution in Galaxy Clusters Through the Application of Strong and Weak Gravitational Lensing"

SURE Program

The Summer Undergraduate Research Experience (SURE) program at the Chinese University of Hong Kong (CUHK) selected Robert Liu to participate in a research project at Brown University last summer. Robert worked under the guidance of Prof. Greg Tucker to characterize the optical response of the Millimeter-wave Bolometric Interferometer (MBI), an prototype experiment designed to measure the polarization of the cosmic microwave background (CMB). A detection of CMB polarization would tellus about the physics of inflation 10−35 s after the Big Bang.



Robert Liu and Greg Tucker

Robert successfully developed a motion control system for scanning a room temperature detector across the focal plane and acquiring data from the detector. He is the fifth student from CUHK since 2008 to participate in a research project in the Physics Department.

Fourth New England String Meeting

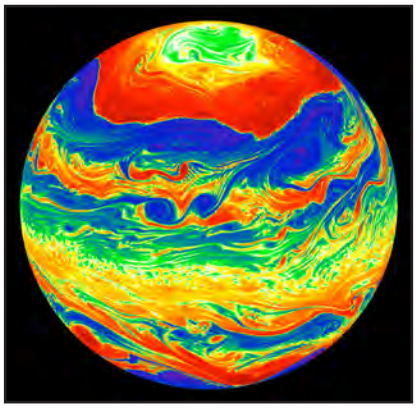
Professors David Lowe, Marcus Spradlin and Anastasia Volovich organized the Fourth New England String Meeting held at Brown last April. The one-day conference included six presentations, and attracted about 70 faculty, students and post-docs. Kavli Institute's Shamit Kachru opened the meeting with a presentation about Abelian gauge theory and new quantum Hall transitions. Niam Arkani-Hamed and Juan Maldacena, both of the Institute for Advanced Study, spoke about N=4 SYM scattering amplitudes and Wilson Loops. Xi Yin (Harvard) discussed holographic twistors, and John McGreevy (MIT) gave a talk about non-fermi liquids from holography. The final presentation was by Petr Horava from Berkeley, who discussed quantum gravity with anisotropic scaling.

Brown Degree Day

The second annual Brown Degree Day at the Physics Department was held on April 10, 2010. Twenty-five alumni participated in the program, which included roundtable discussions over lunch, two keynote speakers, Sylvia Smullin '98 and Robert Stoner, PhD'92, and two panels. The first panel discussion focused on teaching and research, and the second cadre of panelists shared their experiences regarding entrepreneurial and other careers. Both undergraduate and graduate students participated in the event as well as many faculty members. The conclusion of the program was a presentation to a standing-room only audience by Professor Brad Marston about the quantum mechanics of global warming. Following the presentation, the Physics Department hosted a dinner at the Faculty Club for all of the participating alumni. One of the returning alumni wrote, "It was a thoroughly enjoyable day from start to finish and a pleasure to see the range of the vibrant Brown physics community from emeritus faculty to undergraduates. And, of course, it was great to catch up with former fellow grad students as well."

The Physics Department's third Degree Day is scheduled for Saturday, April 30, 2011.

Climate Modeling Seminar



Flows in a simplified model of planetary atmospheres show jets and eddies much like those actually observed

A new seminar on climate modeling, co-sponsored by the Departments of Physics and Geological Sciences, the Division of Applied Mathematics, and Brown's Environmental Change Initiative, hosted four speakers during the fall of 2010. The talks, which attracted large audiences, focused on various aspects of simulating the Earth's climate. University of Toronto Professor Paul Kushner began the series with an overview of climate modeling and the sensitivity of global temperature to increasing levels of greenhouse gases in the atmosphere. Frank Giraldo of the Naval Postgraduate School in Monterey, California discussed the development of a next generation of models that can be used for both weather prediction and climate simulation. The physics of storm tracks and how these may change as the climate changes was the subject of a talk by Paul O'Gorman from MIT. Finally, Bette Otto-Bleisner, a senior scientist at the National Center for Atmospheric Research in Boulder, Colorado, spoke about modeling climate since the peak of the last ice age 21,000 years ago.

Financial support for the talks has been provided by The Colver Lectureship. Funds permitting, the co-sponsors hope to continue the seminar.

Sakurai Symposium

The Sakurai Symposium on May 5, 2010 celebrated the award of the illustrious Sakurai Prize to Gerald Guralnik and also served to kick off the annual meeting of the US-CMS collaboration. Gerry was one of six recipients around the world of the 2010 J.J. Sakurai Prize, awarded by the American Physical Society (APS) for outstanding achievement in particle theory. The citation from APS praises the six researchers for "elucidation of the properties of spontaneous symmetry breaking in four-dimensional relativistic gauge theory and of the mechanism for the consistent generation of vector boson masses."

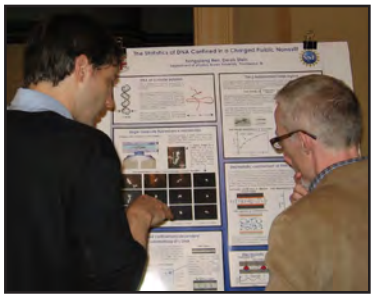
A series of well-attended talks by distinguished physicists, headlined by a presentation by Gerry Guralnik, took place in the afternoon at Barus & Holley. The talks were followed by a cocktail reception at the Faculty Club where President Ruth Simmons and Dean of the Faculty Rajiv Vohra were on hand to congratulate Gerry and welcome the CMS meeting attendees.

Faculty Promotion

Meenakshi Narain

Meenakshi Narain, promoted to full professor in July 2010, was instrumental in the discovery of the top quark, the most massive fundamental particle known. Her research focuses on experiments with high-energy collisions, including studies of the properties of the top quarks, searches for new heavy particles indicative of new physics at the TeV scale, and extra dimensions of space. She is a member of the DZero and CMS experiments operating at the energy-frontier facilities of the Fermilab Tevatron collider in Batavia, Illinois and the Large Hadron Collider in Geneva, Switzerland. She co-leads a group to uncover a signal for a neutral heavy gauge boson, and was recently selected to convene the bquark identification group of the international CMS collaboration. She also sits on the management board of the Fermilab's LHC Physics Center. Meenakshi earned her PhD in physics from the State University of New York at Stony Brook, and taught at Boston University before joining the Brown faculty in 2007. She was a 2006 Jeanne Rosselet Fellow at Harvard's Radcliffe Institute, and in 2008, she was elected as a Fellow of the American Physical Society. She has also received a CAREER Award from the National Science Foundation (2000-2004), the Department of Energy's Outstanding Junior Investigator Award (2000-2004), and two NSF Major Research Infrastructure awards (2002-2005 and 1999-2001). She is the recipient of a Career Development Award from the ADVANCE program at Brown, and a co-PI of the DoE grant for Brown High Energy Physics. Meenakshi enjoys helping students and continually explores new ways of teaching physics to both undergraduate and graduate students.

NES APS/AAPT



Derek Stein (left) with participant

Professor Derek Stein organized the 2010 Joint Fall Meeting of the New England Sections of the American Physical Society and the American Association of Physics Teachers (NES APS/AAPT) hosted by the Physics Department on October 29-30. The theme of the conference was "Nanobiophysics", and the plenary sessions highlighted leading research in the manipulation, imaging, and study of biological systems at the nanoscale. Recent insights into the teaching of physics, as well as teaching workshops, were also showcased. Excellent plenary talks were given by Patrick Doyle (MIT), Mark Reed (Yale), Rohit Karnik (MIT), Naomi Halas (Rice), Peter Nordlander (Rice), and David Pritchard (MIT). Nobel Laureate, Prof. Leon Cooper, delivered a captivating banquet speech on the meaning of quantum mechanics entitled, "Does the moon exist only when you look at it?" Over 100 physicists attended the meeting, contributing oral and poster presentations. Many participants also took part in an evening of astronomical observation at the Ladd Observatory which had a timely Halloween theme.

2010 USCMS Conference

On May 6-8, 2010, approximately 150 members from American universities collaborating on the CMS experiment at the Large Hadron Collider (LHC) met at Brown University for their annual collaboration meeting. Brown was fortunate to host this significant meeting, as it was the first gathering to discuss the results from the initial data delivered by the LHC at an energy of 7 TeV, an energy regime that had never been previously probed.

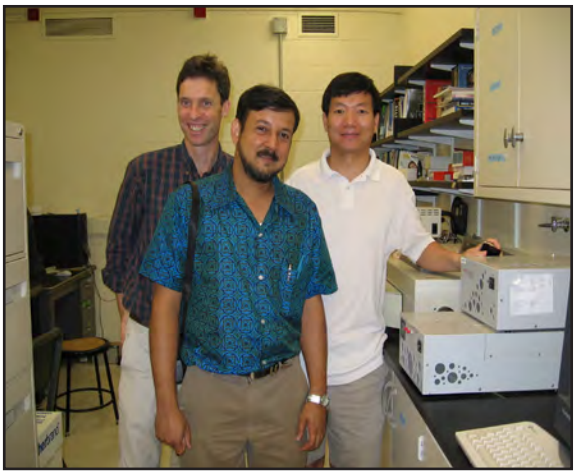
Due to the large amount of public interest in the LHC, an open lecture on "Physics at LHC", was held on Friday, May 7 in conjunction with the conference. The speaker, Professor Jim Virdee of Imperial College, London, shared the excitement of potential discoveries at LHC with a standing-room only audience. The lecture was generously sponsored by the Office of the President.

The meeting also included a media training event for scientists which was attended by 25 people, many of them students and post-docs at Brown. The training focused on effective communication with the general public and with colleagues, and how to prepare for interviews with print, television, or radio journalists. Brown's ADVANCE program sponsored the training and also provided travel funds for young scientists to attend the meeting.

Brown-Tougaloo Collaboration

Santanu Banerjee, Professor of Physics and Chair of the Physics Department at Tougaloo College, spent the summer of 2010 at Brown teaching a survey course of mechanics, electricity, magnetism, optics, and modern physics designed for concentrators in sciences other than physics. Dr. Banerjee was pleased to be the first faculty from Tougaloo College in more than a decade to teach a credit-bearing course at Brown, and he characterized his teaching experience here as "truly enjoyable." Dr. Banerjee was most appreciative of the resources and instructional support for the course that was provided by the Department and Jim Valles.

Brown University's relationship with Tougaloo College spans more than forty years, and Chung-I Tan initiated a collaboration with Tougaloo's Physics Department three years ago. Dr. Banerjee is particularly grateful to Jay Tang for working on this collaboration effort to make a lasting positive effect in terms of curriculum and research, and believes their joint efforts will lead to a sustainable impact in the relationship between Tougaloo College and Brown University.



Jim Valles, Santanu Banerjee and Jay Tang

Student Activities

Physics Women in Science and Engineering (WiSE)

Physics WiSE hosted two Pre-Registration Teas in 2010; the first took place in April and the second was in October. The intent of these events was to provide a forum through which students could share experiences, pose questions about physics concentration requirements and learn more about the Physics Department and course offerings. All people interested in physics were invited to the teas, regardless of age or gender. The events were sans faculty so students could speak freely about classes. There was a good turnout at both events, and the October tea featured a lively discussion about physics-related activities on campus. Physics WiSE also collaborated with the students running the Physics Faculty Seminar Series last fall to advertise the seminars.

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.

Peer Mentoring

On October 15th, 2010 graduate students Helen Hanson and Richard Cook gave a presentation to the New England International Teaching Assistant Network (NEITAN) on The Development of a Teaching Assistant Orientation for the Department of Physics. They discussed their roles as graduate students in developing a support network for incoming students as well as developing and sustaining a peer-led teaching orientation for new teaching assistants. The presentation was part of a workshop, where Helen and Richard shared and received advice on running peer support and professional development exercises for graduate students with the knowledgeable and experienced members of the NEITAN group.

Richard Cook and Helen Hanson

Richard and Helen also gave a talk to the APS AAPT (American Physical Society - American Association of Physics Teachers) during the New England meeting at Brown in November. This gave them both an opportunity to share their experiences with running peer-oriented teacher training to a wider audience of physicists from across the northeast.

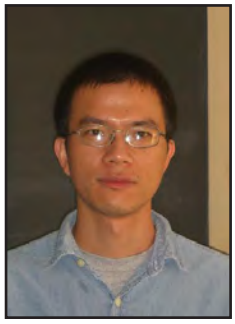
Ladd *continued from page 1*

The $100,000 Transit Room restoration was made possible by a grant from the Rhode Island Historical Preservation Commission (RIHPC), the Department of Physics, and an anonymous donor. Robert Horton and Michael Umbricht worked closely with the architects and project managers to ensure that every detail of the restoration was in accord with the original design of the room. The most important work was the restoration of the hatches and windows, allowing them to open for the first time in at least a half century. The hatches and windows now allow an unimpeded view of a stripe of of the sky running from the North, overhead, and to the South, so that observations of stars as they transit the meridian can be made. While we have an antique transit instrument that can be temporarily used for such observations, we are still working on the historic primary transit instrument, clocks, and the electrical system that transmits a signal from the observer's telegraph key to the clock, as a star transits the meridian in the telescope's cross-hair. (Incidentally, in keeping with historical precedent, the crosshair is made of a fine spider web spun by Ladd's resident spider!) We are once again, after many decades, able to observe transits and show members of the public how time is determined, based upon the rotation of the Earth and resulting transits of stars as they appear to move from East to West. After a thorough review of the work done at other observatories, we learned that Ladd may be the only observatory that allows such direct "hands-on" observation by the public of transiting stars and time-setting. A link to a video about the Transit Room can be found at http://brown.edu/Departments/Physics/Ladd/history/transit.html

We were sorry to lose a dear friend of Ladd Observatory, Professor of Physics Emeritus Hendrik Gerritsen, on November 10, 2010. While he was Director for only three years, from 1986 through 1989, his involvement with Ladd began in the early 1970s, and continued through 2010. He gave engaging talks about a wide range of topics, from Polynesian astronomy to optics. Henk's forceful enthusiasm for astronomy inspired the current staff and countless others who continue their pursuit of astronomy as amateurs or professionals. His love of physics and astronomy, his compassion and mentorship of those of he touched, and his unconventional approach to astronomical observation and theory, are permanent legacies at Ladd.

Do you want to receive engaging weekly news stories about events in the night sky over Providence? More than 900 people have signed up for Ladd's Listserv, which provides information on events at Ladd and celestial happenings overhead.
Sign up at: http://www.physics.brown.edu/physics/commonpages/ladd/

Congkao Wen, Physics Merit Fellowship Winner



Congkao Wen

Congkao Wen's research interests focus on the dualities between quantum field theory and string theory. One dual formulation of gauge theory, particularly N = 4 super Yang-Mills theory, was first constructed by Witten a few years ago. On the other hand, recently Arkani-Hamed, Cachazo, Chueng, and Kaplan wrote a remarkable contour integral over a Grassmannian, which computes all-loop leading singularities of N = 4 SYM, in addition to tree-level amplitudes. Studying the connected prescription formulation of Witten's twistor string theory using "link" variables, enabled us to make the connection between these two dual beautiful formulations for the S-Matrix of N=4 SYM. This also allows understanding of the origin of all tree-level contours of the Grassmannian formulation from twistor string theory in details.

Another fascinating duality between the gauge theory and string theory is the so-called AdS/CFT correspondence. Its applications currently range from nuclear physics to hydrodynamics to tabletop condensed matter systems. Recently the simplest geometries with the Schrodinger group isometry were constructed, leading to the so-called non-relativistic AdS/CFT. A very interesting system with such symmetries is fermions at unitarity which can be realized experimentally in certain cold atom systems. In this context, Congkao and Professor Anastasia Volovich calculated higher-point correlation functions and demonstrated that the standard holographic prescription for computing correlation functions can also be applied to non-relativistic AdS/CFT. They found that the calculation of tree-level *n*-point correlation functions of scalar fields can be reduced to the computation in the ordinary AdS space via a particular Fourier transformation. It also allowed them to work out for the first time the general structures of *n*-point functions for a non-relativistic CFT.

The experimental particle physics group was selected by the Department of Energy to receive ARRA (recovery and reinvestment) funds in order to upgrade our laboratory infrastructure. The group is participating in R&D associated with planning and designing new detector elements for CMS. As the LHC luminosity increases, some components need to be upgraded, particularly as related to tracking and trigger, even in advance of the planned SuperLHC. The new infrastructure consists of state-of-the art electronics design and measuring instruments, which will provide a boost to our in-house capabilities.

Faculty Research *continued from page 3*

Anastasia Volovich's research during 2010 focused on scattering amplitudes in gauge theories, specifically the relation between twistor string theory and Grassmannian formulation for N=4 Yang-Mills proposed earlier this year. Together with Alexander Goncharov, Marcus Spradlin and Cristian Vergu, she pioneered the application of a branch of mathematics known as Theory of Motives to the computations in quantum gauge theories. The result was published in *Physical Review Letters*.

Meenakshi Narain is co-leading the group conducting searches for new massive Z' bosons. Her postdoc, Gena Kukartsev, is also contributing to this effort. Narain and **Ulrich Heintz** are studying top quark production at the LHC together with graduate student Aram Avetisyan and research assistant professor Thomas Speer. The group contributed to the first LHC publication on top quark physics, which was accepted by Physics Letters in November. They are now working on the first measurement of the top quark mass at the LHC. Graduate student Saptaparna Bhattacharya won the URA fellowship to pursue her interests in particle physics phenomenology with Narain and Dr. Dobrescu at Fermilab. Graduate student Michael Segala and Gena Kukartsev contributed to the studies of detector performance using the early data from the LHC. On the D0 experiment, a prime focus of the group is top quark physics. Heintz, who is a URA visiting scholar at Fermilab this academic year, and postdoc Dookee Cho completed a search for massive 4th generation quarks that decay like top quarks but are much more massive. The results were presented at the ICHEP 2010 conference in Paris. Postdoc Shabnam Jabeen is co-leading the top quark physics group at D0. Narain, together with graduate student Monica Pangilinan and Tutanon Sinthuprasith, completed a search for massive W' bosons that decay to top and bottom quarks. This result has just been submitted for publication. Postdoc Lidija Zivkovic has been searching for massive Higgs bosons that decay to W boson pairs and this result was also presented at the ICHEP 2010 conference.

See-Chen Ying was awarded the C. N. Yang Visiting Professorship by the Department of Physics at the Chinese University of Hong Kong (CUHK). The award entitled Prof. Ying to spend a month at CUHK, giving talks and sharing his research experience with faculty members.

Faculty Seminar Series

The Physics Department's Faculty Seminar Series continues into its second year with great success. The series consists of Brown faculty presenting their research in a colloquium-style talk to fellow faculty members, graduate students, and undergraduates. This past fall, Professors Bob Pelcovits, Antal Jevicki, Brad Marston, and Leon Cooper covered topics involving the self-assembly of structures from viruses, how gravity emerges from M-theory, the statistical mechanics of planetary climates, and the road to and from the BCS theory. So far this semester, we have learned from Professor Rick Gaitskell about searching for particle dark matter using a noble liquid detector. We are looking forward to presentations from Professors Sean Ling and Savaas Koushiappas in April.

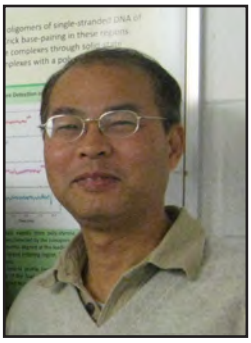
Hanoi University of Science

Under the reciprocal arrangement with Brown University, the Hanoi University of Science (HUS) sent three faculty to Brown in the fall of 2010. This group represented the third cohort of HUS faculty to travel to Brown's Physics Department to learn about teaching methods and curriculum materials. Ha Thuy Long, Le Thi Hai Yen, and Nguyen Viet Thuyen arrived on campus in early September and spent two months observing classes, meeting with faculty and studying the physics curriculum. They focused primarily on three courses: Quantum Mechanics A, Physics of Matter and Introduction to Astronomy.

In November, Prof. Chung-I Tan traveled to Hanoi to present a seminar to HUS faculty about physics training and research at the undergraduate and graduate levels at Brown. He met individually with members of the HUS Physics Department to discuss various aspects of teaching, and gave a lecture to students about the importance of active participation. He also discussed Brown's unique standing in American higher education.

Jim Valles with visiting HUS faculty

Professor Jing Shi



Jing Shi

During the academic year of 2009-2010, **Professor Jing Shi** took a leave of absence from his permanent position at Wuhan University, China, for the second time and participated in the neutron scattering research in the Ling Research Group at Brown. In 1998-2000, Dr. Shi was a visiting associate professor working with Prof. Sean Ling on the discovery of the giant peak effect in high-Tc superconductor YBa2Cu3O7 which was since known as the signature of a Bragg glass melting or disordering phase transition in the presence of random pinning. With the ongoing construction of a neutron scattering facility in Guangdong, China, it is natural for condensed matter physicists in China to find out how the US researchers use neutron scattering technique to solve materials physics problems. Prof. Jing Shi's broad knowledge in solid-state physics was beneficial to Helen Hanson and Xi Wang. During his visit at Brown, Jing joined Helen and Xi in the neutron scattering experiments at NIST and is a coauthor of the group's paper which has been submitted for publication.

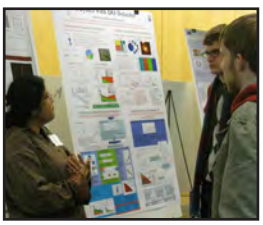
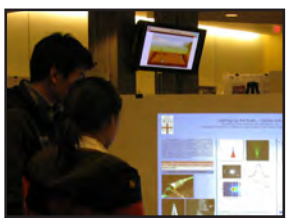
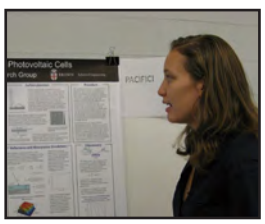
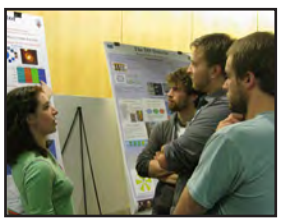
BCS: 50 Years

Professors Leon Cooper and Dmitri Feldman co-edited a book, BCS: 50 Years, published last June. The famous BCS theory of superconductivity developed by Bardeen, Cooper and Schrieffer in 1957 has been remarkably successful in explaining the properties of superconductors. The book celebrates and reviews BCS theory and experiment, and aims to introduce students and researchers to the origins, impact and current state of the BCS theory. Concepts from BCS have been incorporated into diverse fields of physics, from nuclear physics and dense quark matter to the current standard model. Practical applications include SQUIDs, magnetic resonance imaging, superconducting electronics and the transmission of electricity. This excellent book is both a historical account and a discussion of contemporary BCS theory and experiment. All chapters are by outstanding physicists, including many Nobel Prize winners.

2010 Poster Session

The 2010 poster session was on the first Wednesday evening in November. This annual event provides an opportunity for graduate and undergraduate students, along with the rest of the community, to learn about the exciting research occurring within the Department of Physics. Faculty, post-docs, graduate students and some undergraduate members of research groups spent two hours talking about their research projects and findings with session attendees. An exceptionally large number of exhibitors (51) necessitated an expansion of the exhibit space in the main lobby of Barus & Holley to include the south corridor and east lobby.

The crowd enjoyed light refreshments while viewing and discussing the many posters. The event is designed to be informal, and it encourages conversation with faculty and graduate students attached to research groups. It is a valuable opportunity for first-year graduate students to learn more about potential advisors and their research, and it also affords an opportunity for undergraduates to familiarize themselves with departmental research and establish connections with faculty that may lead to a senior research thesis or participation in a summer research project.

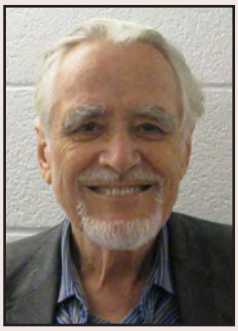






In Memoriam - Hendrik Gerritsen

Hendrik Gerritsen spent a happy childhood in The Hague before enduring five years of Nazi occupation during his adolescence. The deprivations were severe, and at times, food was so scarce that his diet consisted primarily of tulip bulbs. In 1944, he and his fellow students were forced at gunpoint by the Nazis to dig trenches at the Battle of Arnhem, a fierce but failed Allied attempt to break through German lines. He was able to escape and returned home where he remained hidden indoors until the Netherlands were liberated by the Allies. Although his experience at Arnhem, where he was confronted daily by the wounded and dead, was horrific, it showed him the human side of the opposition and the helplessness of many who were caught up in the war. According to an interview Henk gave to the Brown Alumni Monthly in 1987, one of the older German soldiers assigned to dig trenches took a liking to him because he reminded him of his grandson. He counseled Henk to hide when he heard the airplanes coming telling him, "Watch out that you don't get killed; we all have to get through this." Henk's first-hand experience of war made him a passionate and life-long pacifist who acted upon his ideals.

In 1949, Henk was awarded an A.B. in Physics and Chemistry, and went on to earn his Ph.D. in Physics Summa Cum Laude in 1955 at Amsterdam's University of Leiden. He started his professional career at RCA Research Labs in Zurich, Switzerland and in Princeton, New Jersey where he performed research and wrote patents related to lasers, masers, holographic storage and electrostatic photography. Most notably during that time, he wrote a patent describing the embossing of holograms, now a ubiquitous feature of credit cards.

Henk joined the faculty at Brown University in 1967 as a tenured Professor of Physics. While at Brown, he performed research in optics, laser physics, and semi-conductor physics, authoring nearly 100 papers and mentoring many graduate and undergraduate students in research. He generously shared his life-long interest in astronomy with the general public at Brown's Ladd Observatory. In addition to his teaching and research, he served as a consultant for numerous companies such as Hasbro, Polaroid, Honeywell, the Gas Research Institute and Exxon and authored many more patents, including one on a novel type of star and constellation viewer. Henk also endeavored to link technology and art in his teaching, and he delighted in offering courses on the aesthetics of materials, the physics of music and a very popular holography course that was supported jointly by Brown and the Rhode Island School of Design.



Hendrik Gerritsen

Over the thirteen years following his retirement, he continued teaching and his research. He was a member of many societies including the American Optical Society, Sigma Xi, the Federation of American Scientists, and the Union of Concerned Scientists. Henk addressed many humanitarian issues, including arms control and civil rights, as he believed that as a scientist he had a special responsibility to society. A significant feature of his research over the years was the peaceful use of technology. In the 1980's, Henk circulated a petition and garnered more than fifty signatures from Brown faculty who agreed not to accept money to perform research for the Strategic Defense Initiative. He founded the local chapter of Amnesty International, and was a long-standing member of the American Civil Liberties Union.

Henk's courtly Old World manners belied the ferocity of his beliefs, and he lived by a credo summed up by the line from Dante's Divine Comedy: "The hottest places in hell are reserved for those who in time of great moral crisis maintain their neutrality."

2010 New Course Offerings

PHYS0100: Flat Earth to Quantum Uncertainty: On the Nature and Meaning of Scientific Explanation

Physics has had a dramatic impact on our conception of the universe, our ideas concerning the nature of knowledge, and how we view ourselves. Philosophy, sometimes inspired by developments in physics, considers the impact of such developments on our lives. In this seminar, Professor Leon Cooper explores how classical and modern physical theory have affected our view of the cosmos and ourselves as well as our view of the relation of mathematical or physical structures to 'truth' or 'reality.' Through a study of physics and selected philosophical readings, it is examined how we know anything, from seemingly simple facts to whether a machine is conscious.

PHYS0111: Are There Extra Dimensions Under Your Bed?

This course examines some of the most exciting questions confronting contemporary physical science in a fashion suitable for both humanists and scientists. What are particles, antiparticles, superstrings, and black holes? How are space and time related? How are mass and gravity related to space and time? Do we live in a three-dimensional world, or are there extra dimensions? Professor Meenakshi Narain addresses such questions with conceptual explanations based upon current research on campus, and highlights the current experiments at the energy frontier, carried out by the world's largest scientific instrument to-date, the Large Hadron Collider, located in Geneva, Switzerland.

PHYS1250: Stellar Structure and the Interstellar Medium

An introduction to the physics of stars and their environment, this course covers the fundamental physics that set the physical properties of stars, such as their luminosity, size, and spectral properties and how these quantities evolve with time. In addition, Professor Koushiappas includes a study of the physics that takes place in the gaseous environment surrounding stars, the Interstellar Medium (ISM). The ISM is very important because it contains a wealth of information about the evolutionary history of galaxies, their composition, formation and future.

PHYS1970C: String Theory for Undergraduates

Professor Antal Jevicki and Dr. Ari Pakman created this special course on String Theory. The course is presented at an introductory/intermediate level with a review of some background topics in Theoretical physics , including dynamical systems, Symmetries and Noether's Theorem; nonrelativistic strings; relativistic systems (particles and strings); quantization, gauge fixing, Feynman's sum over paths; electrostatic analogy; strings in curved spacetime; and Supersymmetry. The course also gives an outline of more advanced recent topics, i.e., D-Branes and M-Theory.

In Memoriam - Jan Tauc

Jan Tauc, a pioneer in semiconductor physics, passed away on Tuesday, December 28, 2010. He was born in Pardubice, Bohemia (now the Czech Republic). During his teen years, Jan's schooling was disrupted by a forced move as the Nazis took over the town where he lived with his family. Jan vividly recalled how his family was given a few hours to leave. During the war, Jan was pressed into factory work. As the war ended, universities reopened with an overwhelming number of students and a shortage of professors (many died in the war or in concentration camps). Jan earned his E.E. degree in two years, and was awarded a PhD in technical sciences at Prague's Charles University in 1949.

Having heard of the discovery of the transistor, Jan began research in the field, managing to build the first point-contact transistor in the country. In 1952, the Communists founded the Czechoslovak Academy of Sciences (CSAV) for the purpose of centralizing scientific research. CSAV offered its members a certain degree of political laxity, and Jan, although not a party member, was asked to head the Semiconductors Department of its Institute of Technical Physics. He held the position until 1969 while retaining his position of Professor at Charles University. His department soon achieved recognition on both sides of the Iron Curtain and Jan was allowed to attend the 4th International Conference on the Physics of Semiconductors (ICPS) in Rochester, NY, where he persuaded the committee to select Prague as the venue for the next ICPS. The 5th ICPS took place there in 1960, with Jan as chair of the program committee. It was the first such event held in the Communist world.

Jan was interested in photovoltaic, thermoelectric and optical properties of crystalline semiconductors, and collaborated with Antoncik and Abraham to unravel the role of the spin-orbit splitting in the dielectric function. In the mid-1960's, he became interested in amorphous semiconductors due to their ease of preparation and photovoltaic applications. His paper with the Rumanian Grigorovici and Vancu on the electronic properties of amorphous germanium became the basis of semiempirical studies of amorphous structures and led to the often-used eponym "Tauc gap".

Shortly after the invasion of Czechoslovakia by the Russians in 1969, Jan was able to leave the country and travel with his family to Bell for a year-long stay. While at Bell, he received a letter from the CSAV revoking his leave and demanding immediate return under threat of prosecution. Fortunately, Brown was in a position to hire Jan with funds from a major gift to increase the University's standing in solid state physics and engineering. Jan stayed at Brown until his retirement 22 years later. In Prague he was sentenced in absentia to five years in jail.

It is remarkable that Jan was able to produce such influential papers under the precarious economic and political conditions in Prague. In December of 1987, he and his Brown colleagues, Humphrey Maris and Christian Thomsen, were issued a patent for a method to investigate properties of thin films using picosecond spectroscopy. This patent, and the follow-on patents by Humphrey Maris and co-workers, have become the most valuable basket of patents that Brown has ever owned. Jan authored or edited several books and was editor of three important professional journals. Jan received numerous honors including membership in the NAS, the prestigious Isakson Prize and the Adler award of the APS, and De Scientia et Humanitate Optime Meritis Medal from the Czech Academy.

Jan was a caring person who was cherished by his family and colleagues. His gentle nature and dry wit were evidenced by his oft-repeated reference to his native country's Nazi and Russian occupiers as "our guests."

Bob Horton and Meenakshi Narain with 2010 entering grad students

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