BROWN | PHYSICS

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SUMMER 2014

What's Inside

Greetings from the Chair

The 2013-2014 academic year was, as always, busy and productive but there were some unusually high peaks and low valleys. On October 8, the Nobel Prize in physics was awarded "for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider." Brown faculty played pivotal roles in both the prediction and discovery of the Higgs boson. Professors David Cutts, Ulrich Heintz, Greg Landsberg and Meenakshi Narain contributed significantly to the search to discover the elusive particle.

Professor Gerald Guralnik was one of the six physicists who predicted the existence of the Higgs boson in 1964. The department was deeply saddened by his sudden death this past April. We are grateful, though, that he was able to witness the fruition of his prediction and celebrate his contribution.

The continuing quest to find dark matter made front-page news in the New York Times, and quoted Professor Rick Gaitskell, elected spokesperson of the LUX experiment. He announced results that ruled out certain low-mass signal hints thus allowing researchers to focus on fewer leads.

I commend the ongoing efforts of the physics faculty to secure research dollars in this challenging funding environment. The department's faculty represent an extraordinary breadth of research interests and continue to forge new connections and collaborations. There is much exciting research occurring. For example, Professor Brad Marston recently received a grant to develop predictive models necessary to ensure the safe, long-term disposal of spent nuclear-fuel rods. Solving this issue could advance the use of nuclear power, which some climate scientists regard as a way to provide energy while reducing carbon emissions.

Two distinguished professors, Leon Cooper and Humphrey Maris, retired from their teaching duties this June, although both continue to maintain active research programs. Two new faculty searches will be opened in the coming year, and it is likely an additional search will take place the following year.

In other department news, we are looking forward to welcoming 16 new PhD candidates this fall along with 14 students who will enter our rapidly expanding master's program. Our undergraduate and graduate students are thriving and continuing to excel in many different areas. We are proud of their achievements, some of which you will read about in the following pages. They are a vibrant group and it is a pleasure to be part of their evolution as the next generation of scientists.

Plans are in the works for a series of lectures in honor of the late Professor Tony Houghton. Up to 14 speakers will participate over the two-day event in May 2015, and alumni are most welcome to attend. We will keep you informed.

I look forward to the coming academic year with great anticipation. As always, we are pleased to hear about your news and wish you the best in all of your endeavors.

Jim

James M. Valles, Jr.

2014 Undergraduate Degree Recipients

2013 UTRA Students

Eliza Brine
Ryan Brown
Montana Feiger
Soumya Ghosh
Ellen Goldberg
Nathan Johnson
Alexander Moskowitz
Richard Nally
Sean Pike
John Ribbans
Adam Scherlis
Scott Underriner
Samuels Zeif

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.

Undergraduate Awards

R. BRUCE LINDSAY PRIZE (EXCELLENCE IN PHYSICS)

Jaeyoon Lee
Jason Wei Jie Poh

MILDRED WIDGOFF PRIZE (EXCELLENCE IN THESIS PREPARATION)

Bradley Barry
Robert Rozansky

Astronaut Scholarship Foundation's Scholarship 2014-2015 Academic Year

Abigail Plummer

Department Undergraduate Group (DUG)

This year, the Physics DUG hosted events focused on encouraging discussion among undergraduates in the department. Last spring, the Physics DUG held a declaration event, in which sophomores declaring their concentrations in physics asked upperclassman concentrators about their experiences with classes and research. The DUG also hosted a pre-poster Session with Professor Derek Stein, in which undergraduates learned about the nature of research in the field of physics and picked up advice on how to engage in research themselves. Most recently, the DUG hosted a discussion on the state of diversity in physics academia, contemplating causes of and solutions to the lack of diversity seen in physics, along with other STEM fields. Throughout the year, the DUG has held informal lunch talks with faculty, in which students were able to discuss developments in the field in small group settings with various professors in the department. In the coming year, the Physics DUG expects to continue fostering a sense of community among physics undergraduates by increasing the number and variety of hosted events.

Graduate Student Awards

GALKIN FOUNDATION FELLOWSHIP AWARD
Ata Karakci

BEYER AWARD FOR EXCELLENCE IN SCHOLARSHIP AND SERVICE
Xu Liu

ANTHONY HOUGHTON AWARD FOR EXCELLENCE IN THEORETICAL PHYSICS
Guang Yang

AWARD OF EXCELLENCE AS A GRADUATE TEACHING ASSISTANT
Thomas Harrington
Joseph Skitka
Rizki Syarif
Michael Zlotnikov

SIGMA XI AWARD FOR EXCELLENCE IN RESEARCH IN PHYSICS
Mirna Mihovilovic

PHYSICS MERIT FELLOWSHIP
Alex Loosley

Master of Science, Master's Program

Xue Zhang (left) and David Tersegno

Doctor of Philosophy

Left to Right: Xu Liu, Guang Yang, Hui He, Antun Skanata, Qian Miao, Jeremy Chapman, Son Le, Carlos Hernandez Faham, Mirna Mihovilovic, David Malling

Rosenberger Medal

Leon N Cooper, Nobel laureate and professor of physics at Brown University for more than five decades, accepted the Susan Colver Rosenberger Medal at the University's 245th Commencement ceremony last Spring. The medal, which has been awarded 29 times since its establishment in 1919, is the highest honor bestowed by the Brown faculty.

The citation read, in part, "Brown faculty, students, and staff of ensuing generations have been the beneficiary of your wisdom, your wit, your joy, and, above all, your great love of the discovery and communication of knowledge. Your gentle presence and keen intellect loom large on this historic campus, and Brown without Professor Cooper is quite impossible to imagine."

"I'm extremely flattered, especially because it's an award given by the faculty, my colleagues," Cooper said in an interview. "That makes it specially meaningful. I'm very grateful to Brown for providing me with a place where I could be productive."

"Leon Cooper is a giant in the world of physics, yet he wears his mantle of accomplishments lightly," said James Valles, professor and chair of the Department of Physics. "It is extraordinary how engaged in Brown and accessible Leon has remained since winning the Nobel Prize in 1972. He has served as an effective mentor and adviser to countless students and junior faculty over the years. He has burnished our reputation by his scientific prowess and through the many students he has reached over his 55-year career at Brown."

"It is extraordinary how engaged in Brown and accessible Leon has remained since winning the Nobel Prize in 1972."

Cooper came to Brown in 1958, having just published a paper the year before titled simply "Theory of Superconductivity," with colleagues John Bardeen and Robert Schrieffer. Their theory, known as BCS, was the first credible explanation of the property of some metals to conduct electricity without resistance. The trio accepted the Nobel Prize in Physics for BCS theory in 1972, and their work continues to fuel new experiments and discoveries in superconductivity.

However, Cooper's research and teaching at Brown was hardly limited to superconductivity, or even physics. His work spans disciplines from physics to neuroscience to philosophy. "Basically, I'm a problem solver," Cooper said. "I'm intrigued by problems, and I'm not fastened to any particular technique. The only real technique I have, I think, is to see through very complex problems and to reduce them to a hardcore minimum, and focus on that."

It's the hardest of problems that seem to intrigue him most. In 1955 when Cooper began working on superconductivity, there were those who had doubts that the problem could be solved at all. Indeed,

Cooper and his colleagues succeeded in solving superconductivity where some of the greatest minds in physics — Einstein, Heisenberg, and Bohr, to name a few — had previously failed.

He turned his attention to another difficult problem: understanding how learning and memory take place in the brain. His interest in the topic grew partly out of a conversation with a graduate student. "We thought, how is that we understand neurons quite well, but no one has a clue how or where memory is stored," he said.

With the help of several colleagues, Cooper began investigating ways to model the workings of the brain's visual cortex. The model was based on the idea that synapses, the structures that carry chemical signals between neurons, were crucial in memory. Along with Elie Bienenstock (now a professor of applied mathematics at Brown) and Paul Munro, Cooper published a theory in 1982 that would become known as BCM theory, one of the first mathematical models showing how synaptic modification could lead to some forms of learning and memory. The paper describing the theory has been cited more than 1,000 times.

Cooper's work on BCM and his other activities in brain research laid crucial groundwork for Brown's thriving programs in neuroscience and brain science. It also led to new lines of research for Cooper in artificial neural networks, machine learning, and pattern recognition.

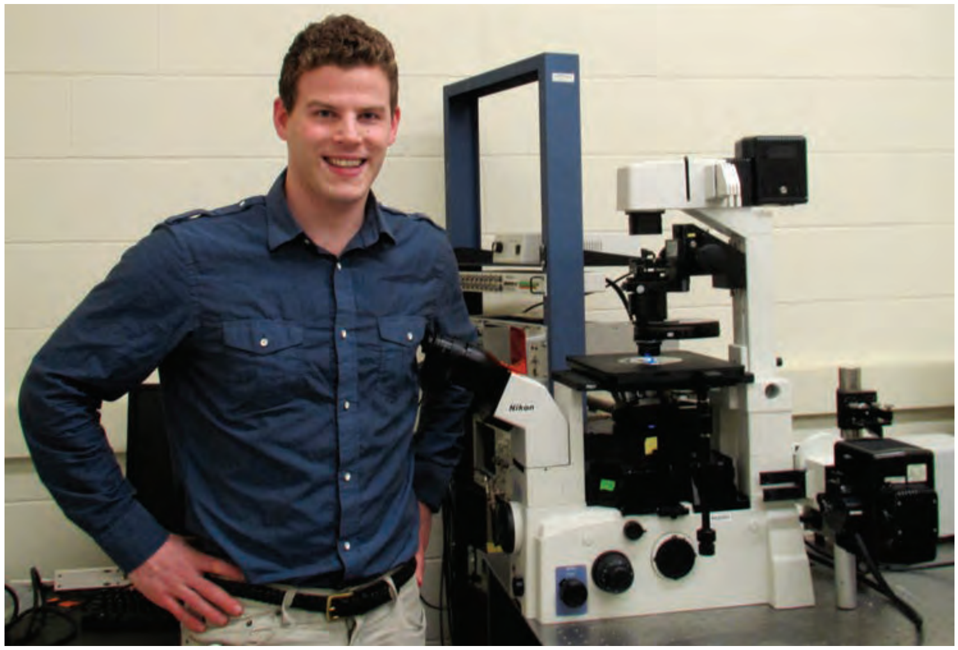
More recently, Cooper has pushed into yet another new area of research, looking at the way radiation affects genes and cells. "We're getting some very exciting amazing results," he said. The freedom to explore new problems and go where the questions lead is something for which Cooper is grateful. "That's one of the things that has always made me very happy at Brown," he said. "I can do what I want to and for me that's everything."

Cooper continues to teach classes and work with colleagues to solve new problems. It's the search for new solutions that drives him, not the pursuit of prizes. "People ask me: What did you do after your Nobel Prize?" Cooper said. "Did you go to work everyday trying to win another one? Absolutely not. You just go to work."

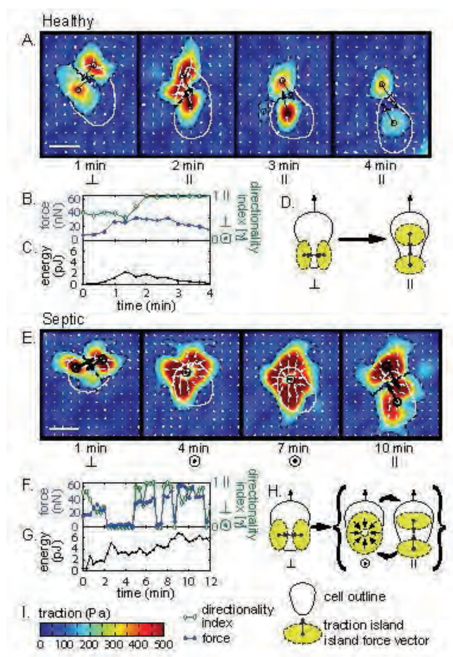
Excerpted from article by Kevin Stacey, Brown News Service

2013–2014 Physics Merit Fellowship Recipient: Alex Loosley

This year's Physics Merit Fellowship recipient, Alex Loosley, applies concepts from physics to study the movement of cells. Alex's project is part of an interdisciplinary project, led by Professor Jay Tang of the Department of Physics in collaboration with Professor Jonathan Reichner in the Department of Surgery. To determine which biochemical and biomechanical factors mediate directed cell migration (i.e. white blood cells migrating to sites of infection or injury), and by how much, they have developed a new quantitative metric called directionality time, a measure of how long a cell takes to hone towards an external cue. Directionality time is, in theory, applicable to anything with a directionally biased trajectory, from lightning bolts trajectories to the migration paths of birds. They are applying the directionality time metric to determine how neutrophils, the most prevalent of human white blood cells, integrate information about the stiffness of their environment. This behavior is essential to their physiological function, as they migrate from blood vessels through tissue to sites of infection or injury. During this migration, neutrophils encounter a variety of tissues characterized by order of magnitude differences in rigidity. They have shown previously that migration trajectories are sensitive to these rigidities and in our latest work, directionality time analysis was used to identify a specific receptor on the neutrophil surface that mediates rigidity dependent honing. Blocking this receptor may form the basis of a tissue specific anti-inflammatory treatment.



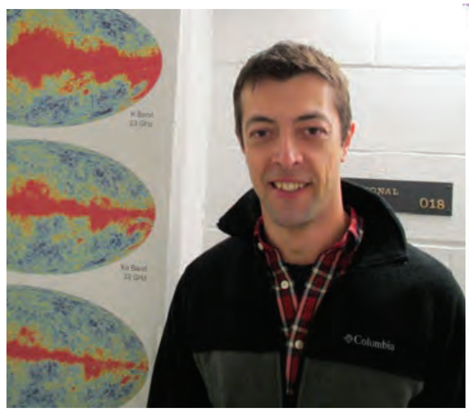
Using similar techniques, we are also studying the effects of sepsis on neutrophil chemotaxis (migration along a chemical gradient). Sepsis is an often fatal condition that occurs when the body undergoes a systemic inflammatory response to severe infection. It has been shown that neutrophil chemotaxis is impaired in sepsis patients, and the extent of this impairment correlates with mortality rate. Once sepsis has resolved, the chemotaxis defect disappears. To study the cause of this defect, they used traction force microscopy to measure and compare the traction stresses of healthy and septic migrating neutrophils. Their observations show significant differences in the way septic neutrophils apply traction stresses during migration, with implications about the mechanism of the chemotaxis defect and therapeutics that can be used to treat sepsis.

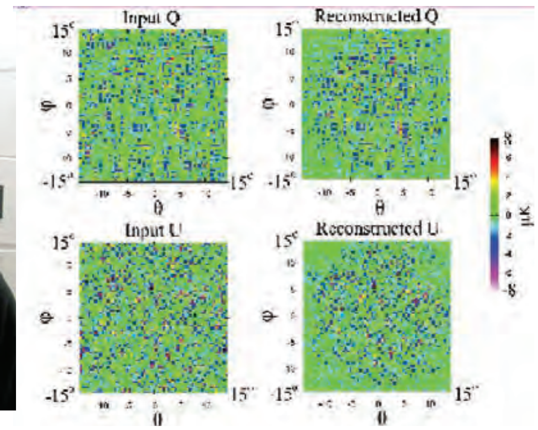


2013-2014 Galkin Fellow: Ata Karakci

BAYESIAN ANALYSIS OF SYSTEMATIC EFFECTS IN INTERFEROMETRIC OBSERVATIONS OF THE COSMIC MICROWAVE BACKGROUND POLARIZATION

The homogeneity and isotropy of the observable universe is explained by an almost exponentially expanding epoch of the early universe known as inflation. The gravitational waves created during the inflation produce a certain polarization pattern, called the primordial B-modes, on the CMB sky. The B-modes are orders of magnitude smaller than the temperature signal and detection of such weak signals requires excellent control of systematic effects. Interferometers may have certain advantages over imaging experiments in the control of systematic effects. Since the observed CMB signal can be interpreted as a single realization of a random process, CMB data is most suitably analyzed in a Bayesian, rather than frequentist, approach. We developed a Bayesian method for simultaneous inference of polarized CMB signal and power spectra, called the Gibbs sampling, and applied it to simulations of interferometric observations of the CMB polarization to understand the effects of systematic errors. We also showed that the method of Gibbs sampling naturally extends to include a Bayesian foreground separation technique.





Input signal maps (left) and final mean reconstructed maps obtained by Gibbs sampling (right) match within the primary beam. The top and the bottom rows show the Stokes Q and the Stokes U maps of the CMB polarization signal, respectively.

Image Credit: Ata Karakci and Greg Tucker/Brown University

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.

Last August, Professors Greg Landsberg (left) and Chung-I Tan accepted Vietnam's Medal for the Cause of Science and Technology.

Professors Brad Marston (left) and James Valles were elected as APS Fellows.

First Dark Matter Search Results from LUX (Large Underground Xenon) detector

A new high-accuracy calibration of the LUX (Large Underground Xenon) dark matter detector demonstrates the experiment's sensitivity to ultra-low energy events. The new analysis strongly confirms the result that low-mass dark matter particles were a no-show during the detector's initial run, which concluded last summer.

The first dark matter search results from LUX detector were announced last October. The detector proved to be exquisitely sensitive, but found no evidence of the dark matter particles during its first 90-day run, ruling out a wide range of possible models for dark matter particles. "The new calibration improved our calibration accuracy by about a factor of 10," said Rick Gaitskell (shown in photo), professor of physics at Brown and co-spokesperson for LUX. "It demonstrates that our first dark matter search result, which showed no sign of low-mass particles, is absolutely robust." Results of the new analysis were presented by James Verbus, a graduate student at Brown who led the new calibration work, on February 19, 2014 at the Lake Louise Winter Institute in Alberta, Canada.

Dark matter is thought to account for about 80 percent of the mass of the universe. Though it has not yet been detected directly, its existence is a near certainty among physicists. Without the gravitational influence of dark matter, galaxies and galaxy clusters would simply fly apart into the vastness of space. It's not clear exactly what dark matter is, but the leading idea is that it consists of subatomic particles called WIMPs, short for weakly interacting massive particles. WIMPs are thought to be practically ubiquitous in the universe, but because they interact so rarely with other forms of matter, they generally pass right through the earth and everything on it without anyone knowing it.

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The LUX is designed to detect those rare occasions when a WIMP does interact with other forms of matter. The detector consists of a third of a ton of supercooled xenon in a tank festooned with light sensors, each capable of detecting a single photon at a time. As WIMPs pass through the tank, they should, on very rare occasions, bump into the nucleus of a xenon atom. Those bumps cause the nucleus to recoil, creating a tiny flash of light and an ion charge, both of which are picked up by LUX sensors. The detector is more than a mile underground at the Sanford Underground Research Facility in South Dakota, where it is shielded from cosmic rays and radiation that might interfere with a potential dark matter signal.

This latest work was an entirely new way of calibrating the detector to recognize a WIMP signal. "One of the important things we need to do is to calibrate the detector for what a WIMP-like recoil would look like," Verbus said. "You want to be able to measure your detector response for WIMP-like events." To do that, the scientists use neutrons as a stand-in for WIMPs. The recoil created when a neutron hits the nucleus of a xenon atom is thought to be very similar to the recoil that would be created by a WIMP. To calibrate the LUX for low-mass WIMPS, the LUX team fired low-mass neutrons directly into the detector and used the detector's instruments precisely measure the characteristics of the neutron recoil. Once the researchers established exactly what a low-mass neutron recoil looks like, they went back to their data from the dark matter search to see if similar events occurred.

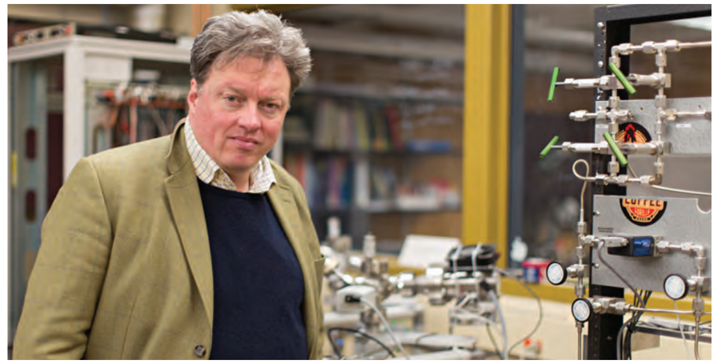


Photo by David Braun/BDH

What makes this calibration method unique is that it was done directly inside the LUX detector. In previous xenon experiments, the neutron calibrations were done in separate test chambers instead of in the detector itself. "Because our detector is so big and detects recoil positions so well," Verbus said, "we can just fire neutrons directly into LUX and get an absolute measurement of energy."

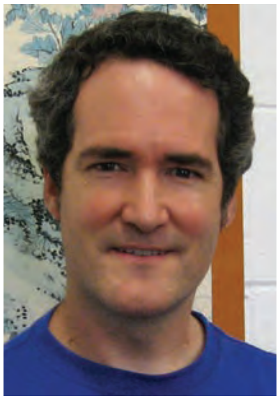
The LUX team used this new calibration to double-check the data from the detector's first run. Those initial results were confirmed: There were no low-mass WIMP events in the first run. Along with the low-mass wimps, the first 90-day run of LUX ruled out a wide swath of possibilities for what dark matter could be made of.

"There are literally thousands of models of particle physics lying bloodied in the gutter," Gaitskell said of the detector's first results.

LUX will expand its search later this year when it begins a second, year-long run searching for new dark matter models at an even greater sensitivity.

Excerpted from article by Kevin Stacey, Brown News Service

Statistical Approach to Jet Streams Simulations

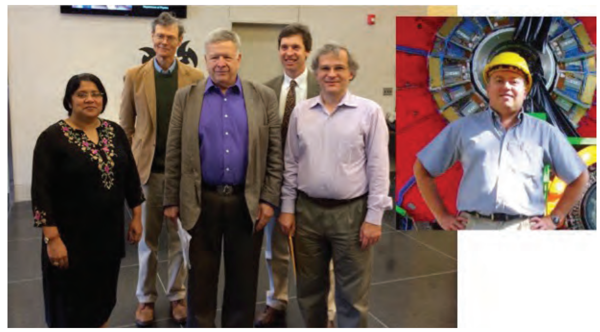


Professor Brad Marston (shown in photo) and S. M. Tobias of the University of Leeds co-authored a paper, "Direct Statistical Simulation of Out-of-Equilibrium Jets" published in Physical Review Letters in March.

The paper shows that jet streams in planetary atmospheres, such as those the make up the belts of Jupiter, can be understood using ideas borrowed from statistical physics. There are both practical, and conceptual advantages, to taking the statistical approach: Computer simulations run faster and deeper insights are attained into the mechanisms behind the formation and maintenance of jets. The approach is illustrated by the Mac OS X app, GCM, which is available from the Apple Mac App Store at URL <https://itunes.apple.com/us/app/gcm/id592404494?mt=12>. The app, which is free, has been installed on over 1,200 computers during the first year since it was made available.

CMS Collaboration

The CMS Collaboration published two significant papers in 2013. "Observation of a new boson with mass near 125 GeV in pp collisions at $\sqrt{s}$ = 7 and 8 TeV", is the detailed paper documenting the discovery of the Higgs boson. It appeared in the Journal of High Energy Physics.



Left to Right: Meenakshi Narain, Dave Cutts, Gerry Guralnik, Jim Valles, Ulrich Heintz, Greg Landsberg during the Higgs Boson Nobel Prize celebration (October 8, 2013)

The second paper, "Measurement of the B_(s) to mu+ mu- branching fraction and search for Bo to mu+ mu- with the CMS Experiment", was published in Physical Review Letters. This paper is the first observation of the Bs(mu mu) decay, which is an apex of a 25-year-long quest to find it and has significant impact on supersymmetry and other new physics models. CMS Collaboration members at Brown University include Professors David Cutts, Ulrich Heintz, Greg Landsberg and Meenakshi Narain.

Promotions

Ian Dell'Antonio was promoted to Full Professor effective July 1, 2014. A recipient of a National Science Foundation Career award and a Presidential Early Career Award from the White House Office of Science, Prof. Dell'Antonio joined the Brown faculty in 1999. Prior to his arrival at Brown, he worked at Bell Laboratories and the National Optical Astronomy Observatories. His research centers on observational cosmology, the experimental measurement of the fundamental properties of the Universe. He is a member of the LSST collaboration's weak lensing working group, and heads the galaxy clusters working group of the LSST Dark Energy Science Collaboration. Prof. Dell'Antonio received his undergraduate degree from Haverford College and his PhD from Harvard.

David Lowe, promoted to Full Professor effective July 1, 2014, earned his MA from Corpus Christi College, Cambridge, and his PhD from Princeton University. Prof. Lowe works on a broad range of topics ranging from "nonperturbative" formulations of string theory, to applications of powerful string theory techniques to problems in black hole physics and cosmology. This work is leading to a consistent quantum description of black holes via string theory that matches well with Stephen Hawking's early work. As string theory develops, it is becoming possible to address cosmological questions from a top- down approach. Prior to his arrival at Brown in 2003, Prof. Lowe was a Senior Research Fellow at the California Institute of Technology and a postdoctoral researcher at UC-Santa Barbara.

Ladd Observatory

Although frequent cloudy weather prevented Ladd Observatory from opening every Tuesday night over the past year, an average of 150 patrons came in on each clear evening to enjoy the beauty of the night sky. In addition to the 12-inch refractor open for viewing, portable telescopes were set up on the deck to handle the larger crowds. Constellations were introduced to those waiting in lines, and any passages of the International Space Station or flares from Iridium satellites were looked upon with awe.

Brown astronomy students often joined the regular members of the Ladd team as part of their lab experience for Physics classes 270 and 220. For many, it was their first exposure to working with the public and participating in the informal education process. The general consensus was that being a part of the Ladd open nights was a thrill.

Recently, NASA's Johnson Space Center transferred equipment formerly used by Space Shuttle astronauts to Ladd. The equipment included a general purpose computer, a programmable pocket calculator, and a camera lens. Ladd Observatory curator Michael Umbricht created an exhibit of the equipment and added a calculator used by former Ladd Observatory Director Charles Smiley to determine the orbit of the early Sputnik satellites. The exhibit was especially remarkable for younger people, many of whom had never seen early 20th century mathematical devices.

After opening its doors in 1891, Ladd observatory served as the time keeping center for the Providence area for many decades. One of the companies that utilized this service was the Rhode Island Electric Protective Company. A donation of $5,000 from a Brown alumnus allowed the acquisition of that company's Master Clock, which represents an important part of Ladd's historic past.

In collaboration with artists from the Rhode Island School of Design and the local community, Ladd was a featured stop on the Providence Gallery Night tour. The exhibits highlighted at Ladd were on display from June 20th to 22nd and drew over 750 visitors.

On April 11, the Department of Physics, the Department of Egyptology and Western Asian Studies, and the Office of the 250th Anniversary co-sponsored a talk at Ladd by Clemency Montelle, PhD '05 of the University of Canterbury, New Zealand, entitled "All Stars: Reflections on the Study of the History of Astronomy at Brown."

Ladd received two memorable gifts this past year. The first was a Moon globe, donated by Shirley Brooke. Her parents, Earl William and Evelyn Devens Perreault had their first date at Ladd Observatory, and subsequently enjoyed 66 years of happily married life together. It was their wish that the globe come to Ladd, and their memory is honored with a brass plaque. A plaque was also made for the other significant gift, a telescope built by Bernard J. Lovely. After cleaning and aligning it, the telescope's optics were seen to be of such high quality that it is now a part of the regular Tuesday night observing sessions.

Photo by Robert Horton

The weekly email, which discusses sky conditions, mentions relevant objects to observe during the week, and highlights any historical events of the time, is now sent by request to over 1,400 persons every Tuesday afternoon. Please consider subscribing!

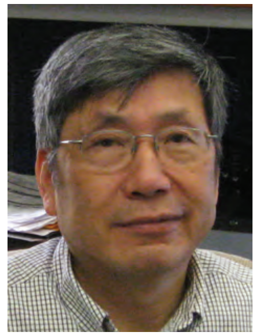
www.brown.edu/ladd

Technology has enabled international collaborations to dramatically increase and flourish in recent years. The research in Brown's Physics Department has a remarkably broad global scope. The following are some activities that exemplify the geographical breadth of the department's research collaborations.

The largest and most publicized collaboration relates to the Large Hadron Collider. Professors Dave Cutts, Ulrich Heintz, Greg Landsberg and Meenakshi Narain along with their students and postdocs have multiple roles within CMS (Compact Muon Solenoid, an experiment at the LHC at CERN). These roles include participation in multi-national groups and interactions with colleagues in the 2,500-physicist collaboration with whom they work closely.

Leon Cooper conducts ongoing research about gene expression and synaptic modification with colleagues from Italy's University of Bologna. The Bologna Group consists of Gastone Castellani, Armando Bazzani, Giorgio Aicardi, Giorgio Turchetti, Daniel Remondini, Claudio Franceschi, and others. Prof. Cooper also collaborates with Nathan Intrator, University of Tel-Aviv, in the investigation of synaptic plasticity.

The study of modulated superconducting states is the subject of Professor Vesna Mitrovic's collaboration with the NMR group at The Grenoble National High Magnetic Field Laboratory in Grenoble, France and J. Flouquet at CEA (the French Alternative Energies and Atomic Energy Commission) in Grenoble. Over the past year, Prof. Mitrovic and her colleagues obtained very significant results that established the hallmark of the modulating superconducting state. Prof. Mitrovic also collaborates with colleagues from the Laboratoire National des Champs Magnétiques Intenses, the University of Tokyo and the Jozef Stefan Institute in Slovenia. In addition, she has been advising a group at ETH-Zurich on how to set-up NMR experiments in dilution refrigerator.



For many years, Professor See-Chen Ying (shown in photo) has collaborated with Professor Tapio Ala-Nissila of Aalto University in Helsinki, Finland. The most recent focus has been on Statics and Dynamics of Strained epitaxial systems. This year, Prof. Ying received support to investigate Transport Studies of DNA and Filamenous Viruses with Solid State Nanopores and Carbon Nanotubes with Dr. Enzo Granato and Dr. Evaldo Corat at INPPE, Brazil, Prof. Anderson Lobo at UNIVAP, Brazil. Professors Jay Tang and Derek Stein are also collaborating with this group.

Humphrey Maris's international collaborative efforts are focused in Europe and India. He has co-authored papers with Sebastien Balibar of Ecole Normale in Paris ("Study of Solid Helium at Low Temperatures"), and Manuel Barranco from Spain's University of Barcelona ("Computer Studies of Superfluid Helium"). Ambarish Ghosh of the Indian Institute of Science in Bangalore and Prof. Maris recently collaborated to produce a paper, "Investigation of Multi-Electron Bubbles in Liquid Helium."

Ian Dell'Antonio's collaborations span several continents. His collaborators include Satoshi Miyazaki (National Observatory of Japan), Yousuke Utsumi (Hiroshima University) and Antonaldo Diaferio (Universita di Torino). In addition, Prof. Dell'Antonio's role in the LSST Dark Energy Science Collaborations involves a large number of collaborators spread around the world. And, as a member of the Thirty Meter Telescope Science Advisory Committee, Prof. Dell'Antonio works with colleagues from Canada, China, Japan and India.

Direct statistical simulation of climate is the subject of collaborative research by Professor Brad Marston and Tapio Schneider at ETH (Switzerland). Prof. Marston also works with Steve Tobias on non-equilibrium statistical physics of geophysical and astrophysical Flows. Dr. Tobias is from the University of Leeds in England.

Master's Program News

With the institution of the official Master of Science program in Physics this past year, students are now entering into a free-standing physics Master's program at Brown. It is offered for those seeking professional development or preparing for further graduate study at the doctoral level. The program aims to select and train those with strong intellectual capacity and undergraduate education into well-rounded ScM graduates with comprehensive physics knowledge, considerable research experience, and strong communication skills. It will serve as a stepping stone for students to launch into competitive doctoral programs, become fully competent teachers at the college level, or seek employment or promotion in technical fields requiring advanced knowledge in physics or general quantitative problem-solving skills.

Our new program has been well-received and quite successful in its short tenure. Our first student enrolled part-time in Spring 2013 and the first cohort of four full-time students joined him in Fall 2013. Another student began in Spring 2014. Two of these six students were awarded their degrees this May and four will be continuing in the program next year. Fourteen new students have enrolled in the cohort that will begin in the fall, and we are awaiting enrollment confirmation from three additional students. The Master's program enables us to broaden the reach of our educational programs to meet the demands of a changing global environment. We look forward to sharing the success stories of the program and its alumni in the future!

Professor Gang Xiao, Director of Physics Master's Program

New Courses

PHYS 0114 – The Science and Technology of Energy

Energy plays fundamental roles in society. Its use underlies improvements in the living standard; the consequences of its use are having a significant impact on the Earth's climate; its scarcity in certain forms is a source of insecurity and political conflict. Professor Derek Stein developed this course, which introduced the fundamental laws that govern energy and its use. The physical concepts covered include mechanical energy, thermodynamics, the Carnot cycle, electricity and magnetism, quantum mechanics, and nuclear physics. The technological applications include wind, hydro, and geothermal energy, engines and fuels, electrical energy transmission and storage, solar energy and photovoltaics, nuclear reactors, and biomass.

PHYS 1970B – Topics in Optics

Professor Rudolf Oldenbourg taught this new course, an introduction to optical principles and techniques. Professor Oldenbourg has a joint appointment with the Marine Biological Laboratory at Woods Hole and Brown University. The course was offered to students who have a foundation in physics and are especially interested in optics. Topics covered included the interaction of light with matter, geometric and wave optics, polarization, fluorescence, and optical instruments (e.g. interferometer, spectrometer, microscope and telescope).

Outreach Activities

Professor Meenakshi Narain presented a talk about her research to elementary school students at the Vartan Gregorian Science Conference last summer. Her presentation, “Seeing the Cosmic Rain,” explained how she uses cosmic ray detectors to see the particles from the sky, which hit us every moment. The conference, funded by the National Science Foundation’s GK12 program, was aimed at 3rd, 4th and 5th graders. The program opened with a keynote address in the school auditorium and then students were able to select the talks they wanted to hear and rotated from room to room to listen to the various presentations. It was a fun and hands-on way for students to learn about science.

Professor Ian Dell’Antonio and graduate student Ryan Michney (shown in photo) jointly curated (with Professor Peter Schultz of Geological Sciences) an exhibit for the Roger Williams Park Natural History Museum entitled “Comet Tales: Wondrous Wanderers.” This exhibit, on display at the museum from November 2013 until the end of 2014, looks at the history of comet observations and the role they play in our understanding of the astrophysics of planetary system formation. To date, the exhibit has been visited by thousands of visitors and middle school groups.

Professor Ian Dell’Antonio (shown in photo) and graduate student Ryan Michney taught a class at Martin Luther King Jr. Elementary school. Students enjoyed solar viewing using a hydrogen-alpha telescope and filtered glasses.

Professor Sean Ling served as a judge for the 2013 Rhode Island Science and Engineering Fair (RISEF).

In February, Professor Dell’Antonio participated in a “Science Underground” event. These events bring researchers to public spaces (typically bars and cafés) to interact with the public in an informal setting. He presented and organized a discussion “How do we know the Universe is accelerating, and what does it mean?” The very successful event was held at the English Cellar Alehouse on Angell Street and drew more than 70 students, staff and community members to a discussion of cosmology.

Equinox!

Ladd observatory curator Michael Umbricht and Professor Ian Dell’Antonio organized several public astronomy viewing events at the Providence Children’s Museum. They brought telescopes and demonstrations to the museum to observe the Sun, Moon, and Jupiter and demonstrate how telescopes work and explain how the appearance of the Sun and Moon relate to the orbital motions in the solar system.

Professor James Valles and graduate students John Golden, Jimmy Joy, and Tim Raben taught in fourth grade classrooms at the Vartan Gregorian School on a rotating basis, with either a graduate student or professor going once every two weeks. In addition to teaching kids about basic scientific concepts, such as work and energy, they led them through activities to illustrate how these concepts are more broadly applicable. One of the instructional activities performed was dropping rocks and objects of various shapes into pans of flour, then measuring how the size and shape of the crater made changed depending upon the height from which the object was dropped.

Brown-RISD-Erfurt contribution to Solar Decathlon

Students at Brown, RISD, and Germany's University of Applied Sciences Erfurt tackled a great challenge this year. Their charge was to build a house that uses 90 percent less energy than a typical house, make it liveable, flexible, durable, and lightweight enough to be shipped from Providence to France — and design it better than 19 other top teams from around the world. That's the Solar Decathlon. The Brown-RISD-Erfurt team calls its entry the "Techstyle Haus."

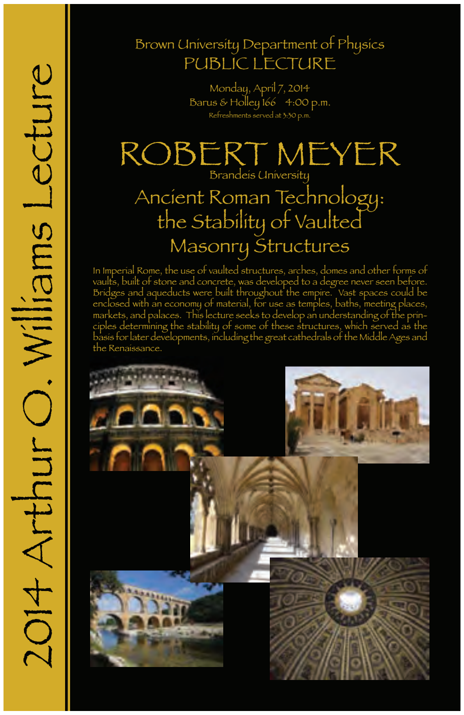
Techstyle Haus is the brainchild of students from Brown, RISD, and the University of Applied Sciences Erfurt in Germany and will be one of only two entries by a U.S.-based team in the 2014 Solar Decathlon Europe. The international competition pits 20 teams against each other in 10 challenges to see who can build the most energy-efficient, innovative, and livable solar house.

Professor Derek Stein, one of the faculty mentors on the project, is impressed with the way the students have managed this project. "The contest states very clearly that this is a student-run project," he said. "There are faculty advisers, but every team role is filled by a student. And our students have been handling those responsibilities wonderfully."

"NOT BAD for a tent!"

For two weeks in July, the grounds of France's Palace of Versailles were transformed into a solar-powered village, showcasing sustainable homes built by college students from around the world. Among them was a house like no other, with a roof and walls made not of wood or metal, but almost entirely of durable, highly insulated textiles. The Techstyle Haus won 3rd place in Comfort Conditions, 6th place in Communications & Social Awareness and House Functioning, and 10th place in Energy Efficiency. "Not bad for a tent!" said the team during acceptance of the Comfort Conditions award. And we can't agree more!

Arthur O. Williams Lecture



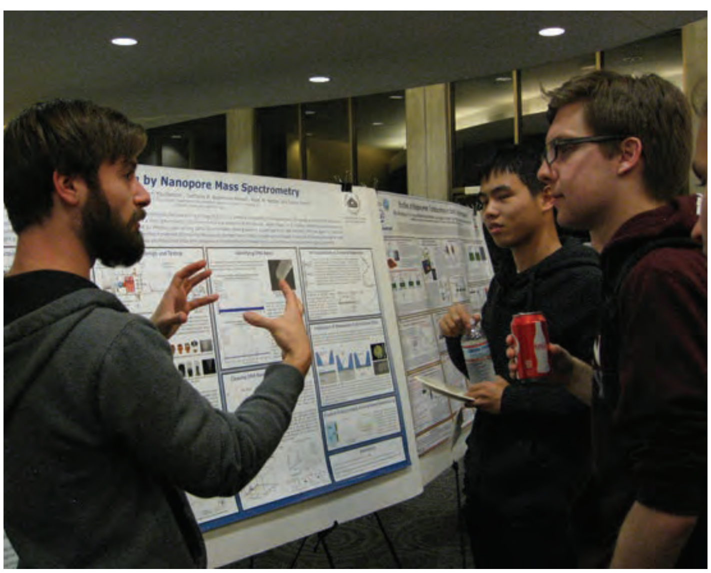
Workshop on Non-Perturbative Quantum Chromodynamics

Professsor **Chung-I Tan** (right) **Konstantinos Orginos**, PhD '98 at L'Institute d'Astrophysique de Paris during the 2013 Workshop on Non-Perturbative Quantum Chromodynamics

Brown Degree Day

James Joy, PhD candidate, chats with **Robert Mohr**, ScB'66.

Annual Physics Department Poster Session



Will Maulbetsch, PhD candidate, explaining his research.

Spring Picnic

Guang Yang, PhD candidate and **Wanchun Wei**, PhD '12 (right).

Physics Art Show

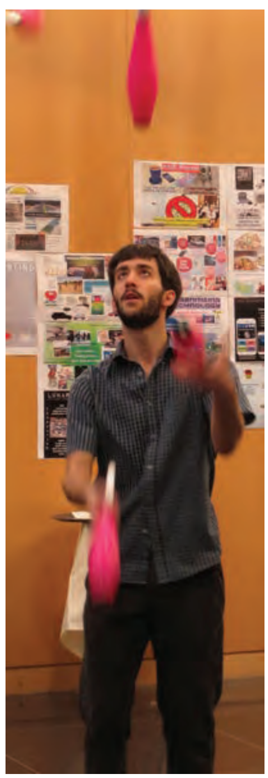
Although physics and art may seem like an unusual juxtaposition, they share common ground. As Leonard Shlain wrote in his book, *Art & Physics: Parallel Visions in Space, Time and Light*, “Revolutionary art and visionary physics are both investigations into the nature of reality. While their methods differ radically, artists and physicists share the desire to investigate the ways the interlocking pieces of reality fit together.”

“Revolutionary art and visionary physics are both investigations into the NATURE OF REALITY.”

The fourth annual Physics Art Show, held last November in the Barus & Holley lobby, showcased fifteen entries from faculty, staff and students. The wide range of exhibits included photographs, drawings, painting, and a steampunk lamp. Two entries were videos; one was a YouTube production by Andrew Favaloro MS’12 entitled “Epic Rap Battle of Science History: Bohr vs. Heisenberg” and the other, filmed by graduate student Peter Tsang, was a walk through a snowstorm in Forest Hills, New York.

Each year the event highlights some form of performance art. The 2013 show featured Michael Zlotnikov playing the guitar and singing, and Adam Lanman treated the attendees to a juggling demonstration. Both Michael and Adam are PhD candidates.

Alex Moskowitz



Adam Lanman

Jim Valles

Valerie Marchenko
Sakharov
pen and ink drawing

Gerald Guralnik

Gerald S. Guralnik, a revered member of the Brown faculty for 47 years whose theoretical work helped complete the Standard Model of particle physics, died Saturday, April 26, 2014. He was 77. Guralnik, the Chancellor's Professor of Physics at Brown, was a leading theorist in the field of elementary particle theory and made enduring contributions to the understanding of mass in the universe.

"Gerry forged his own path and yet always focused on fundamental issues in physics," said Chung-I Tan, professor of physics at Brown and a longtime colleague of Guralnik's. "He was an early advocate and important contributor to the numerical approach to quantum field theories and also in exploring the structure of strong coupling expansion – paving the way for two of the most important current research areas in theoretical particle physics."

In 1964, Guralnik and colleagues C.R. Hagen and Tom Kibble published what would become a landmark paper in particle physics. The paper described a field pervading space that breaks the symmetry between the electromagnetic and weak nuclear forces, explaining why the elementary particles that make up matter have mass, while photons (particles of light) are massless. The paper came just months after two other papers — one by Peter Higgs and another by Francois Englert and Robert Brout — which described a similar mechanism.

The physical manifestation of that mechanism, which would become known as the Higgs boson, was discovered by scientists in 2012 at the Large Hadron Collider in Switzerland. The boson was considered to be the final missing piece of the Standard Model of particle physics."It is a wonderful feeling of great satisfaction and amazement," Guralnik said shortly after the discovery that proved his theory. "We started out to solve an interesting and challenging abstract problem; we were surprised by the answer that turned up."

Guralnik, born in Cedar Falls, Iowa, joined the faculty at Brown as an assistant professor in 1967 following postdoctoral research at the University of Rochester. He received his Ph.D. from Harvard in 1964 and conducted research at Imperial College, London, on a National Science Foundation postdoctoral fellowship. He was a fellow of the American Physical Society and was an Alfred P. Sloan Research Foundation fellow.

Though Guralnik's 1964 paper would become vastly influential, it took years for his ideas to become mainstream, as he described in an essay for the Huffington Post.

"Werner Heisenberg (Nobel Prize in physics, 1932), one of the most important physicists of the 20th century, made it clear to me in the summer of 1965, at a conference in his honor, that he thought these ideas were junk," Guralnik wrote. "Another great 20th century physicist, Robert Marshak, told me that if I wished to survive in physics I must stop thinking about this sort of problem and move on. I wisely obeyed, but I was thrilled a few years later when Steve Weinberg and then Abdus Salam used our mechanism and a generalization of our simple example to build the unified model of weak and electromagnetic interactions and later, with Sheldon Glashow, received Nobel Prizes."

Brown faculty members remember Guralnik as a committed educator, who always offered guidance to students and junior colleagues. "Gerry was above all a kind and generous man, as well as a beloved colleague," said James Valles, chair of the Department of Physics at Brown. "In addition to his unique and lasting contributions in theoretical physics, he was a passionate teacher who mentored countless undergraduates, graduate students and junior faculty members. We will miss him deeply." "He had compassion for others," Tan said, "and quietly performed acts of kindness without any expectation of reciprocity."

Guralnik remained humbly pleased with the lasting power of his theory of symmetry-breaking and mass. As he told the Wall Street Journal, "We are amazed and delighted that our mathematical exercise turned out to play a huge part in describing how nature works."

Excerpted from article by Kevin Stacey, Brown News Service

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