BROWN PHYSICS

2017 NEWSLETTER

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BROWN
Department of Physics

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Greetings from the Chair

I am very happy to write to you after the conclusion of our 2016-17 academic year. One year ago, I became the department chair. Jim Valles, our previous chair, and Sara Tortora, our department manager, were gracious enough to facilitate a smooth transition and help me throughout the process. Jim continued his research, and Sara retired after many years of great service to Brown and to the department. Soon after, Douglas Wilkie became our new department manager, having served as the manager of research and finance in the School of Engineering at Brown. It has been an exciting and eventful year for everyone in Brown Physics.

We had a large graduating class of 2017. I would like to once again congratulate our 28 physics concentrators, 31 masters, and 11 PhDs. Our faculty and I are immensely proud of these students who have worked so hard and completed the rigorous curriculum of our program. Presenting them with their diplomas during the commencement celebration was the highpoint of my chairmanship. Good luck in all your future endeavors, and be sure to visit!

As you all know by now, Michael Kosterlitz won the 2016 Nobel Prize in Physics, along with David Thouless and Duncan Haldane. This award is the long-expected recognition of the distinguished career that Mike has had in physics and at Brown and the importance of his theories on topological phase transitions and topological phases of matter. We're very proud that the Nobel Committee—and recently the National Academy of Sciences—have recognized Michael's groundbreaking work. It is quite an honor to be the chair of this renowned department, with two Physics Nobel laureates, three members of the National Academy of Sciences, and numerous recipients of other prestigious awards and honors.

The department recruited two new faculty members, Sylvester James Gates Jr., the Ford Foundation Professor of Physics, and Kemp Plumb, assistant professor of physics. Gates, a theoretical particle physicist from the University of Maryland, is a recipient of the National Medal of Science and a member of the National Academy of Sciences. He was a member of the President's Council of Advisors on Science and Technology during the entire length of the Obama administration. Plumb, a postdoc at Johns Hopkins University, is an experimental condensed matter physicist. His research is in the area of strongly correlated electron solids using the techniques of neutron diffraction and single crystal synthesis. Their arrivals strengthen our faculty in both research and teaching.

Our faculty continues to make strong progress and produce significant results in their research. In the following pages, you will learn some of the exciting developments in their work. The faculty is strongly engaged in educating our students, caring deeply for them and their professional development. I'm very pleased with the performance of our entire administrative and teaching staff. Their dedication and service are critical to the smooth operation of the department. All of us are working hard to make our department more welcoming and inclusive to all members of our physics community.

I'm glad to announce that the department has established two prestigious fellowships: The J. Michael Kosterlitz Postdoctoral Fellowship and the Leon N. Cooper Postdoctoral Fellowship. These valuable fellowships will allow the department to recruit and support the most promising young physicists at the beginning of their careers.

The department is facing challenges in supporting our students in their research training and education, as well as in continuously raising department stature nationally in research. More than ever, we need the generous support and gifts from our alumni in establishing an endowment fund for the department. I'm very grateful to our alumni and members of our community for their contributions, and I will do everything I can to continuously improve our department with help from the entire faculty.

I look to the new academic year with great enthusiasm and energy. Please keep in touch with us—we love to hear from you on your achievements and hope to see you on campus when you visit.

Gang Xiao,
Department Chair

2017 Undergraduate Degree Recipients

Class of 2017

Shmuel C. Barkan
Sarah C. Blunt
Nicholas Bower
Kaley V. Brauer
Amy L. Butcher
Nicholas T. Chuan
Daniel P. Erdosy
Ian C. Everbach
Soumya S. Ghosh
Elena O. Glen
Oliver P. Hare
Evan W. Harris
Chloe C. Hequet
Nomin Khishigsuren
Changhae A. Kim
Jacob S. Kirschenbaum
Connor F. Lynch
Philip E. Mathieu
Anna Movsheva
Jovan J. Nelson
Richard A. Oliver
Laurent J. Remillard
Raz Q. Rivlis
Carl E. Romines
Eliott N. Rosenberg
Devon C. Seymour
Jessica D. Tennis
Alvaro Zamora

2016 UTRA Students

Harry Chalfin *(Dell'Antonio)*
Evan Coleman *(Jevicki)*
Nathaniel Dick *(Fan)*
Ciaran Godfrey *(Landsberg)*
Kara Hartig *(Marston)*
Steven Hines *(Dubielecka-Szczerba)*
Oliver Isik *(Stein)*
Michelle Miller *(Pober)*

Undergraduate Awards

R. BRUCE LINDSAY PRIZE *FOR EXCELLENCE IN PHYSICS*

Kaley Brauer
Eliott Rosenberg
Richard Oliver

MILDRED WIDGOFF PRIZE *FOR EXCELLENCE IN THESIS PRESENTATION*

Sarah Blunt
Jovan Nelson

CHAIR'S AWARD *FOR EXCELLENCE IN SCHOLARSHIP AND SERVICE TO THE PHYSICS DEPARTMENT*

Amy Butcher

National Science Foundation & Goldwater Fellowships

Five Brown University undergraduate Physics concentrators were awarded highly competitive NSF Fellowships for graduate studies. In 2017, the NSF chose to fund only 2,000 applicants out of a pool of 13,000. Additionally, another undergraduate Physics concentrator has been awarded the prestigious Barry Goldwater Fellowship.

NSF Fellowships:

Sarah Blunt ('17) plans to modify an exoplanet orbit-fitting algorithm she developed in collaboration with the Gemini Planet Imager Team, and then use the modified code to fit the orbits of all known brown dwarfs that have been directly imaged. The resulting orbit information will help us to understand planetary formation.

Amy Butcher ('17) devised a project to desalinate water using the plasmonic response of aluminum nanoparticles. She proposes to assemble core-shell nanoparticles into a porous aluminum structure that floats on water and makes the nanoparticles' photothermal response to sunlight more efficient.

Jovan Nelson ('17) plans to use neural networks to classify Standard Model particles. As certain accelerated particles interact with detector material they form "jets" that at high energies become difficult to measure. Using signal-processing techniques from visual processing and neural networks he proposes to improve our ability to better distinguish signal from background noise.

Daniel Parker ('15) will study entanglement, a uniquely quantum property of matter. He plans to measure the amount of entanglement in 2D theories to diagnose their essential quantum properties by the computing a quantity called the "entanglement entropy." Currently, the process of computing entanglement entropy is well-understood in one dimension, and Daniel's project will begin to make it possible to quickly diagnose and understand many experimentally realizable 2D quantum systems.

Jack Wilson ('16) is working with a group to build an experiment that traps large arrays of laser-cooled Ytterbium atoms in vacuum and engineer strong interactions between individual atoms. Making these large arrays of cold atoms while maintaining control over each one of them could open doors for new quantum computing architectures and new studies of quantum matter, built one atom at a time.

Goldwater Fellowship:

Evan Coleman ('18) won the Goldwater for his work in particle physics. His research is in the physics of top quarks and jet substructure under the guidance of Professor Meenakshi Narain. Last September, he helped produce CERN's first measurement of the lifetime of the top quark. He also focuses on using physically-motivated statistical techniques, like machine learning, to improve particle identification in the recently-upgraded LHC and to study future particle detectors. This summer, he will be starting theoretical research in Quantum Chromodynamics (QCD) and some popular models of Quantum Gravity, while continuing his experimental work.

Master of Science

William Blaine
Robert Bretz
Weijie Chen
Zhizhong Chen
Alexander Chinchilli
Shenming Fu
Dante Gordon
Jiayuan Hu
Shubham Kanodia
Ekapob Kulchoakrungsun
Adrian Lam
Shayan Lame
Jangbae Lee
Mingbin Leng
Shuyi Li
Wenhao Li
Han Liang
Shu Liu
Juan David Lizarazo Ferro
Kwok Wai Ma
Lidong Ma
Qiang Miao
Rui Pu
Lijuan Qian
Saloni Saxena
Timo Yannick Simnacher
Stefan Stanojevic
Tianxudong Tang
Chenwei Wang
Tsung-Han Yang
Jinjing Yi

ScM Student Awards

OUTSTANDING ACADEMIC ACCOMPLISHMENT

Qian Mao
Timo Yannick Simnacher
Rui Pu

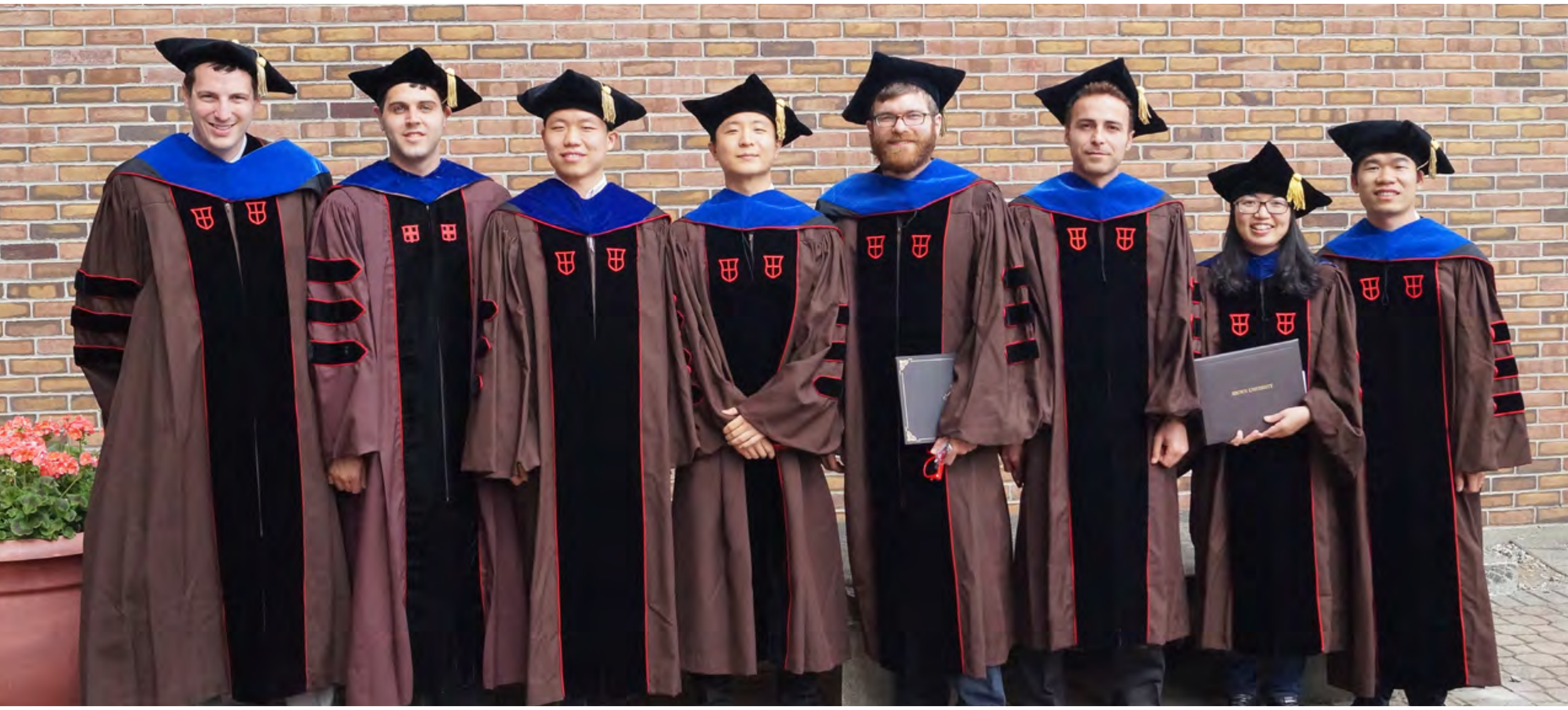
MASTER'S RESEARCH EXCELLENCE

Shayan Lame
Han Liang
Timo Yannick Simnacher

ENGAGED CITIZENSHIP AND COMMUNITY SERVICE TO THE PHYSICS DEPARTMENT

Shayan Lame

Doctor of Philosophy



2017 PhD Recipients

Ankun Dong *(Ling)*
Thomas Harrington *(Spradlin)*
James Joy *(Valles)*
Daniel Sung-Doe Kim *(Stein)*

Jonathan Kurvits *(Zia)*
Zaixing Mao *(Heintz)*
Peter Nagler *(Tucker)*
Sinan Sagir *(Narain)*

Mai Thi Tran *(Oldenbourg)*
Peng Zhang *(Zaslavsky)*
Philip Zucker *(Feldman)*

PhD Student Awards

GALKIN FOUNDATION FELLOWSHIP AWARD

Peter Nagler

ROBERT T. BEYER AWARD FOR EXCELLENCE IN SCHOLARSHIP AND SERVICE

Jacqueline McCleary

ANTHONY HOUGHTON AWARD FOR EXCELLENCE IN THEORETICAL PHYSICS

Philip Zucker

SIGMA XI AWARD FOR EXCELLENCE IN RESEARCH IN PHYSICS

Yang Song

PHYSICS MERIT DISSERTATION FELLOWSHIP AWARD

Yang Song

DISSERTATION FELLOWSHIP AWARD

Wenzhe Chen
Zaixing Mao

FORREST AWARD FOR EXCELLENCE IN WORK RELATED TO EXPERIMENTAL APPARATUS

Shu Wang

AWARD OF EXCELLENCE AS A GRADUATE TEACHING ASSISTANT

Erick Garcia
Mary Hadley
Mingbin Leng

Kwok Wai Ma
Anders Schreiber
Kyriakos Vattis

2016 – 2017 Galkin Fellowship Recipient: Peter Nagler

Peter Nagler, the 2016-2017 Galkin Foundation Fellow, works on developing instrumentation for the next generation of space telescopes for cosmic microwave background (CMB) studies. Working with his advisor, Professor Greg Tucker, and colleagues at NASA's Goddard Space Flight Center, Peter's research focuses on the proposed Primordial Inflation Explorer (PIXIE) instrument. PIXIE is designed to measure the polarization and absolute intensity of the CMB. It will search for evidence of inflation by measuring the B-mode polarization signal of the CMB and will map the energy release history of the early universe by searching for distortions to the CMB Planck spectrum. While most other instruments designed for these measurements are imagers, PIXIE is a Fourier transform spectrometer (FTS). Peter's research focuses directly on the FTS nature of PIXIE, including the modeling and mitigation of instrumental systematic effects and the development of PIXIE's multimode bolometers.

In the context of a CMB experiment, instrumental systematic effects are important to study because the target cosmological signals are so much fainter than the background (a few nK versus 2.725 K, respectively). Thus it is critical to understand whether measured signals are astrophysical or instrumental in origin. As part of his dissertation work, Peter performed a comprehensive analytic study of PIXIE's instrumental systematic errors, including those related to emission and absorption of radiation by the optics, those caused by imperfections in the FTS's moving mirror assembly, and those related to long-term instrumental drifts. Published in The Astrophysical Journal Supplement Series, Peter's analysis includes solutions for the magnitude and spectral content of systematic error terms, and demonstrates how each systematic error signal can be efficiently separated from astrophysical signals.

"It is critical to understand whether measured signals are astrophysical or instrumental in origin."

Peter's research also focuses on the thermal detectors, known as bolometers, that comprise PIXIE's focal plane. Multimode bolometers designed for a FTS like PIXIE require a different optimization from bolometers developed for imagers. In particular, they must handle a large optical bias, orders of magnitude higher than other bolometers, but still operate with sensitivity near the thermodynamic limit across the relevant bandwidth. They also must have a large and mechanically robust absorbing area (30 times larger than the spider web bolometers on Planck) that is sensitive to all optical frequencies of interest, but at the same time is relatively insensitive to cosmic ray hits. For his dissertation, Peter worked on all elements of the PIXIE detector development effort, including circuit design, thermal modeling, microfabrication, packaging, low-temperature (sub-Kelvin) characterization, and environmental testing in anticipation of the space mission.

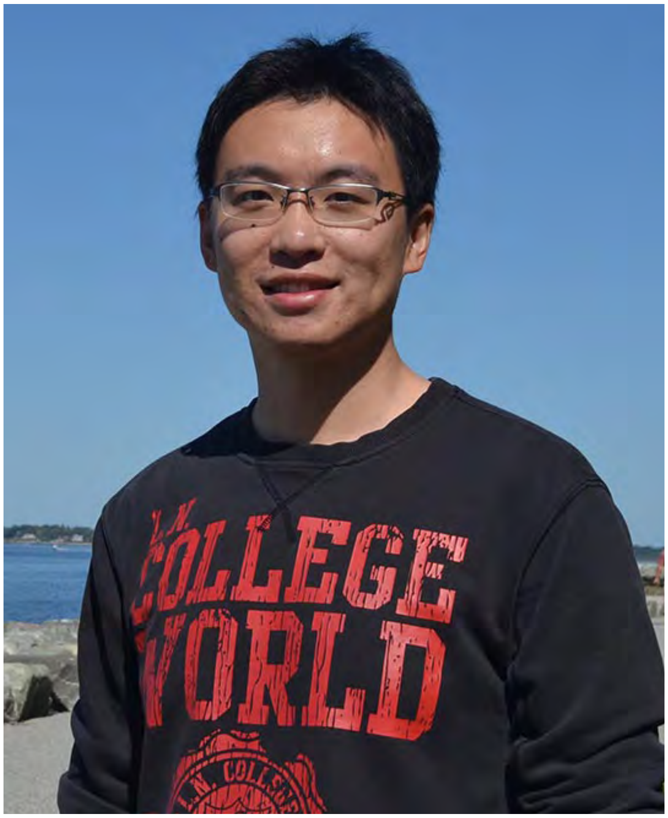
Nagler standing with the adiabatic demagnetization refrigerator used for sub-Kelvin PIXIE detector characterization

The results of Peter's work help demonstrate the feasibility of an instrument like PIXIE. In late-2016, the PIXIE team proposed to fly the experiment in response to the 2016 NASA Medium Explorer Announcement of Opportunity. If the proposal is successful, the PIXIE experiment will launch in the early-2020s.

2016 – 2017 Physics Merit Fellowship Recipient: Yang Song

This year's Physics Merit Fellowship recipient, Yang Song, studied the amorphous oxide semiconductor (AOS) materials, particularly amorphous indium-zinc-oxide (IZO). The first demonstration of the promise of amorphous metal oxide was reported a decade ago in 2004, by Nomura et al., who showed the high performance of thin film transistors (TFTs) based on indium-gallium-zinc-oxide (IGZO). Since then, AOS has shown superior characteristics compared to the old a-Si technology: it is transparent due to the large band gap; it has a field effect mobility that is at least one order of magnitude higher than a-Si; it can be deposited at room temperature on almost any substrate. AOS soon became a star in the arena of high performance TFT and gained considerable interest in both academic and industry world. Driven by the vast needs from the display industry, one of the AOS materials—IGZO—has been successfully commercialized, and now exists in almost every high-performance display panel of cell phone or desktop monitor. It is quite fascinating to see how fast and deep the scientific research can change everyone's life.

Despite the successful commercialization of AOS materials, understandings in some fundamental areas—such as transport mechanisms, efficient doping mechanisms and material stability—are still limited. Yang's project, led by Professor Alexander Zaslavsky and Professor David Paine, focused on amorphous IZO, which has even higher field effect mobility than the commercialized IGZO material. In this project, several fundamental areas of IZO are studied, such as oxide growth kinetics, vacancies/carrier properties, stability mechanisms and interface structure of metal-to- metal oxide/IZO by in-situ self-limiting formation. Different structured top-gated IZO TFTs and Van der Pauw devices were fabricated and characterized, showing high performance of IZO-based devices. For instance, their published IZO TFTs characteristics showed state-of- the-art high field effect mobility estimated at ~95 cm 2 /V·s, great on/off ratio of 10 7 , near zero threshold voltage V T = –0.02 V and exceptionally good subthreshold slope of 62 mV/decade—which is near the room-temperature theoretical limit of 2.3k B T/q = 60 mV/decade. Their study showed the self-limiting in-situ reaction between reactive metal with underlying IZO channel material can yield high performance IZO devices. This work helps to elucidate the fundamental physics in the AOS materials and provides a possible material for future high-current- driven high-frequency RF devices.



"It is quite fascinating to see how fast and deep the scientific research can change everyone's life."

Physics WiSE

New discoveries in STEM fields rely on the experience, collaboration, and mentorship of a thriving community of scientists. When bias is allowed to persist in such communities, be it based on race, gender, sexual orientation, religion, socioeconomic status, or any other factor unrelated to an individual's intellectual merit, those communities lose out on new perspectives, discoveries, and knowledge while the excluded individuals are prevented from applying their skills or pursuing their passion. Over the course of the last 16 years, only 20% of undergraduates awarded a degree in physics at Brown were female, with no appreciable increase between the class of 2000 and of 2016. In the past 10 years, only 4% of Brown physics degrees went to students from underrepresented racial minorities.

The physics subgroup of Women in Science and Engineering (WiSE) at Brown is run by students dedicated to building community and facilitating dialogue in physics around issues of diversity and inclusion. Over the past year, after becoming formally incorporated into the campus WiSE organization, Physics WiSE pioneered new programs in pursuit of this goal. In fall of 2016, the Intersectionality in Physics panel brought together four panelists from across the country to speak about their experiences as members of multiple groups that are traditionally underrepresented in physics and to give suggestions to the Brown Physics Department as it begins to implement its Diversity and Inclusion Action Plan. In the spring, Physics WiSE hosted Scialogue, a showcase of undergraduate research at Brown. At the event, three physics students presented the results of their research on neural networks in particle physics, asteroids and neutron stars, and algorithms for characterizing galaxy evolution to an audience of fellow undergraduates and science enthusiasts.

The year ahead promises more opportunities to foster community and diversity in the physics department. Another panel on diversity and inclusion in physics is in the planning stage for the coming academic year. Following the popularity of last spring's Scialogue, two more are scheduled for the coming fall and spring to give undergraduates the opportunity to practice formal presentation style, share their research, and meet other students passionate about physics. In addition to the headliners, Physics WiSE is planning to hold more informal lunch talks with professors, co-host coffee hours with GWiSE, the graduate student WiSE group, and organize movie nights for undergraduates to unwind and get to know the rest of the department. Through these events, Physics WiSE hopes to foster a more supportive community within the physics department and to create space for those invested in the future of physics, from students to professors to administrators, to acknowledge the shortcomings and plan for the improvement of the field.

Kara Hartig '18

Department Undergraduate Group (DUG)

The 2016-2017 academic year was one of extensive growth and exploration for the Brown University Physics DUG. First and foremost, we had a mission to foster a strong sense of companionship and friendship amongst physics concentrators and those with an interest in the faculty. Furthermore, we sought to break down many of the formal barriers that have historically separated physics undergraduates and the professorship. Lastly, we spearheaded efforts to increase the number of physics concentrators in the department, and to improve the support infrastructure amongst them.

In an effort to solidify a sense of community among our students we organized various activities, including the annual Halloween pumpkin-carving event and an advising day specifically designed for sophomores. Moreover, we increased the number of our regular DUG Discussions that brought together students to discuss and debate on various topics ranging from the philosophical implications of physical theories to the strange and fantastical intertwining of physics and jazz. Moving forward, the DUG seeks to stimulate discourse on socio-economic issues through - but not limited to - a scientific perspective.

The DUG held its first "Concentration Declaration Day" in the Spring semester to induct freshly declared concentrators to the department through a series of speeches, informal discussion rounds and Kabab & Curry. A vast number of professors, including Nobel Prize winners, turned up to welcome the new host of Brown undergraduate physicists to the department. The event exemplified the openness of our faculty, and was a big success in warming our sophomores to an intimidating yet exciting community.

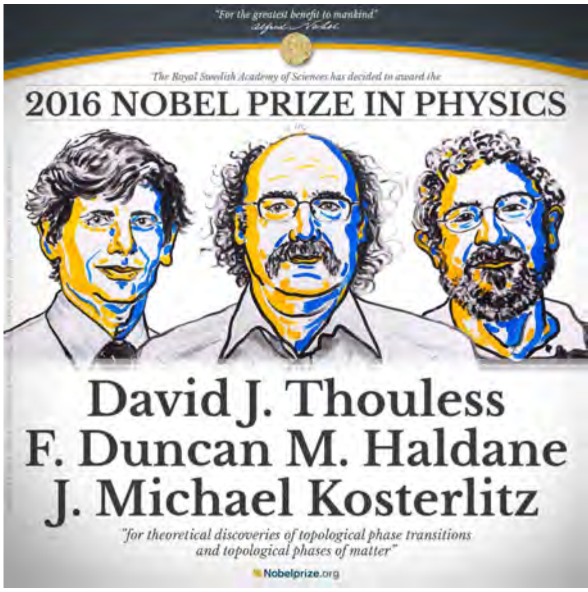
Additionally, to increase the number of concentrators in the department, we represented the Physics faculty at concentration fairs, welcomed interested freshmen for pizza and question-rounds, and hosted an event to present the physics department at Brown's *A Day on College Hill* (ADOCH).

Constantine Wedekind '18

"For the greatest benefit to mankind"

Alfred Nobel

nobelprize.org



On October 4, 2016, the Royal Swedish Academy of Sciences awarded Brown University Professor J. Michael Kosterlitz the Nobel Prize in Physics "for theoretical discoveries of topological phase transitions and topological phases of matter."

Kosterlitz is the Harrison E. Farnsworth Professor of Physics at Brown, where he joined the faculty in 1982. He shares one half of the Nobel Prize with F. Duncan M. Haldane of Princeton University, with the other half of the Nobel going to David J. Thouless of the University of Washington in Seattle.

"This year's Laureates opened the door on an unknown world where matter can assume strange states," the Royal Swedish Academy of Sciences stated in its news release. "They have used advanced mathematical methods to study unusual phases, or states, of matter, such as superconductors, superfluids or thin magnetic films. Thanks to their pioneering work, the hunt is now on for new and exotic phases of matter. Many people are hopeful of future applications in both materials science and electronics."

Kosterlitz earned his Ph.D. from Oxford University in 1969. After an appointment as a postdoctoral researcher at Torino University in Italy, he became a research fellow at Birmingham University in 1970 before coming to Brown in 1982. He is a fellow of the American Physical Society and received the Maxwell Medal from the U.K. Institute of Physics in 1980. In 2000 he was awarded the Lars Onsager Prize by the American Physical Society. He was inducted into the American Academy of Arts and Sciences as a fellow in 2007.

Brown President Christina Paxson congratulated Kosterlitz for being recognized with the world's highest prize for physics. "This is such a well deserved honor, and everyone at Brown is thrilled and delighted by this recognition of Professor Kosterlitz and his important body of research and scholarship," Paxson said.

Kosterlitz becomes the second Nobel laureate currently on the Brown physics faculty. He joins Leon Cooper, who won the prize in 1972 for developing a theory of superconductivity, the ability of some materials to conduct electricity with zero resistance.

Nobel Laureates Leon Cooper and Mike Kosterlitz
Credit: Nick Dentamaro / Brown University

"It is highly appropriate that the Royal Swedish Academy of Sciences chose to honor Michael Kosterlitz with the 2016 Nobel Prize in Physics," Cooper said. "Kosterlitz has made major contributions to the development of theoretical physics. The theory of topological phase transitions he developed in the 1970s with David Thouless laid the foundation of the entire field and has since been cited over 6,600 times in scientific literature. This recognition is richly deserved for an outstanding physicist and extraordinary mind."

Kosterlitz was born in Aberdeen, Scotland, in 1943. His father, Hans Kosterlitz, who was Jewish, fled Germany in 1934 during the rise of the Nazis. The elder Kosterlitz had dreamed of becoming a theoretical physicist, but his father refused to pay for his studies if he went into physics. So Hans Kosterlitz went into medicine. After traveling to the U.K., he established himself as a prominent researcher in brain physiology. He's credited as one of the discoverers of endorphins and enkephalins, brain chemicals that modulate the body's response to pain.

"I got very interested in science because of him," Michael Kosterlitz said, "but I decided that it's not a good idea to go into medicine. I could see people saying something like: 'Young Kosterlitz is quite good, but he's not a patch on his old man.' I thought I'd better not go into competition with my father."

So the younger Kosterlitz chose physics instead, fulfilling his father's own dream.
After earning his Ph.D. from Oxford University in 1969, Michael Kosterlitz took a job as a postdoctoral research at Torino University in Italy.

It was during his time at Torino that a bit of a blunder put Kosterlitz on a path that would eventually lead to the Nobel Prize. He had been studying high-energy physics, a branch dealing with elementary particles and forces that govern their behavior. The top destination in Europe for a young high-energy physicist was CERN — the European Organization for Nuclear Research — and that's where he wanted to be. But Kosterlitz, who admits to being a bit disorganized at times, flubbed the opportunity. "As is my wont, I failed to get my paperwork in on time," he said. "So I couldn't go." The mistake left him scrambling for a job, which he eventually found at the University of Birmingham in the U.K. He was deeply disappointed to have missed his shot at CERN, "but you could say the rest is history because that's where I met David Thouless," Kosterlitz said. That meeting came at a time when Kosterlitz was increasingly frustrated with his high-energy work.

On October 4, 2016, Kosterlitz was announced as one of the three recipients of the 2016 Nobel Prize in Physics.

Before the Nobel festivities began, Kosterlitz was feted by the Swedish Embassy in Washington, D.C., and met with then-President Barack Obama in the Oval Office.

Brown University held a press conference that same day, where Kosterlitz joined from Finland.

On December 8, he gave the 2016 Nobel Lecture in Physics at the Nobel Symposium in Stockholm, Sweden.

On Saturday, December 10, Mike Kosterlitz received an honor he had never envisioned when he embarked on this research more than 40 years ago. With his wife, two daughters and son in a crowd of luminaries from all over the world, Kosterlitz stood on the stage at the Stockholm Concert Hall as King Carl XVI Gustaf of Sweden handed him his diploma and gold medal as winner of the 2016 Nobel Prize in Physics.

"Not only have this year's Laureates made important special discoveries, but in addition — and perhaps most importantly — they have set the stage for a new way of describing matter," said Thors Hans Hansson, member of the Nobel Committee for physics, in his introduction of Kosterlitz, Thouless and Haldane. Their theory, he added, "combines truth with beauty. This is theoretical physics at its best."

Michael Kosterlitz accepts his Nobel diploma and gold medal from the King of Sweden
Pi Frisk / © Nobel Media AB

© Nobel Media AB

“I still have the odd problem I'd like to look at,” he said. “There's no way I can do anything like that now — not until all this hype and excitement is over. I need time to sit and think again.”

Lately, he's thinking about problems in nonequilibrium physics. “If you drive a system out of equilibrium and you keep the driving force absolutely fixed, many systems are known to go into some stationary state,” Kosterlitz said. He's trying to develop a theory of how those dynamics work. “I've been working on that… for a few years,” he said. “To tell the truth, I'm beginning to think that my hypothesis is wrong. Maybe it is and maybe it's not. I'm not sure.”

That uncertainty is inherent in exploring the unknown. Four decades ago, when Kosterlitz started investigating the idea of phase changes, he had no idea where it might lead. As it turns out, it led to Stockholm, and the highest honor in physics.

Nobel Prize pieces excerpted from articles by Kevin Stacey, Brown News Service

Faculty Awards and Promotions

National Academy of Sciences

Professor and Nobel Laureate, Mike Kosterlitz, was elected to the 2017 class of National Academy of Sciences members. Kosterlitz is one of 84 new members and 21 foreign associates elected in this year's class. Members and associates are chosen for what is regarded as one of the highest honors a scientist can receive based on their "distinguished and continuing achievements in original research."

APS Fellow

Professor Jay Tang was elected as a Fellow of the American Physical Society for applying polyelectrolyte theories to lateral association and aggregation of protein filaments and filamentous viruses, and for his research in bacterial motility, adhesion, and statistical properties of flagella motor switches.

2017 James Smith Prize of IPPA

Research Professor, Humphrey Maris, has been awarded the 2017 James Smith Prize of the IPPA. Professor Maris received this award for pioneering picosecond laser ultrasonics, experimental techniques based on the application of femtosecond lasers to both generation and to detection of coherent hypersound, which has become a key tool for opto-acousto-optic studies of nanomaterials and nanostructures in microelectronics and in fundamental research.

Simons Fellowship Award

Professor Marcus Spradlin was awarded a prestigious 2017 Simons Fellowship Award in Theoretical Physics. With this award, Professor Spradlin plans to further pursue his studies in Cluster Algebras and Scattering Amplitudes, a subject of great interest to mathematicians but that can, with physical input, be exploited to carry out calculations of previously intractable amplitudes in physics.

Promotion

Marcus Spradlin was promoted to Full Professor effective July 1. Professor Spradlin graduated from Princeton University in 1996 with highest honors in Physics, and received his Ph.D. in theoretical physics from Harvard University in 2001. He came to Brown as Manning Assistant professor in 2006 after post-doctoral positions at Princeton University and the Kavli Institute for Theoretical Physics in Santa Barbara. Professor Spradlin is a recipient of the Outstanding Junior Investigator Award from the United States Department of Energy, and has recently been named a Simons Fellow in Theoretical Physics for 2017-18.

New Faculty

After 124 applications were received for the tenure-track position for Assistant Professor in Experimental Condensed Matter physics, the committee compiled a list of ten candidates that were invited for interviews. The candidates were chosen based on the quality of their prior work and their potential synergy with current faculty in condensed matter physics.

The committee unanimously voted for Kemp Plumb. Professor Plumb is an expert in neutron and X-ray scattering techniques that he proposes to use to study quantum magnetism of low dimensional systems. In addition, he will establish quantum materials synthesis program. The sample making component of his research program is particularly important to assure success in this field and also to foster collaborations within the department. Furthermore, the scattering techniques are complementary tools for study of quantum magnetism to magnetic resonance techniques that already exist in our department.

Vesna Mitrovic, Chair of the search committee

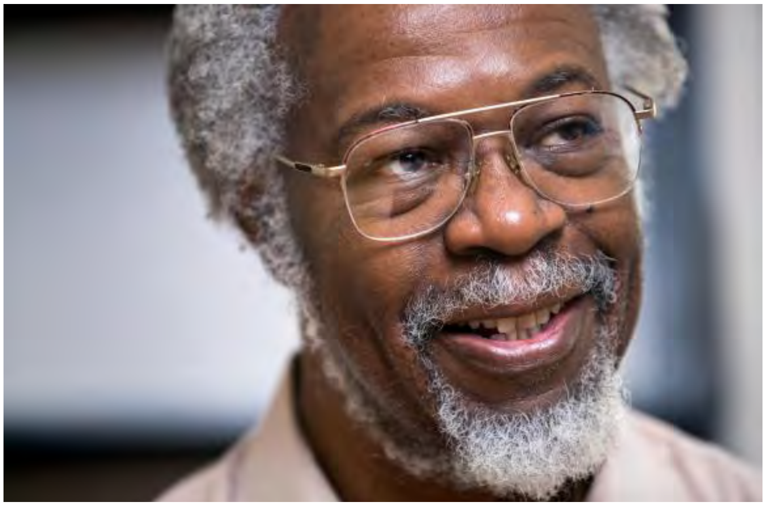
Sylvester James Gates

Walk down the street with Jim Gates, Brown University's newly appointed Ford Foundation Professor of Physics, and you immediately know you are in the presence of a person of consequence. You can see it in the faces of students and other pedestrians as they walk by -- the instant spark of recognition followed by the slow dawning realization of why his face looks familiar. "A lot of people mistake me for Morgan Freeman," Gates says modestly, "which I have trouble understanding, because I don't have any freckles." What Gates does share with Freeman is a deep, resonant voice that conveys gravitas, although it is coupled with an occasional slightly bemused tremor, as if he is stifling a secret chuckle that holds the keys to the secrets of the universe.

Gates' voice will soon enthrall Brown undergraduates when he begins teaching PHYS0100 "Flat Earth to Quantum Uncertainty: on the Nature and Meaning of Scientific Explanation" in the Fall of 2018. The course, previously taught by Nobel Laureate Leon N Cooper, probes the deep issues of physics in a way that is accessible to non-science concentrators while still being of interest to those already well versed in the discipline of physics. Gates, whose face and voice are familiar from television's NOVA, and numerous other public appearances already has years of experience making the most difficult ideas in physics accessible to the public.

Gates, a 2013 recipient of the National Medal of Science, comes to Brown from the University of Maryland, where he was a Distinguished University Professor, University System of Maryland Regents Professor, John S. Toll Professor of Physics, and Director of the Center for String and Particle Theory. He also recently completed a residency at the MIT Center for Theoretical Physics, the institution from which he previously earned his BS and PhD degrees. Gates is well known for his pioneering work in supersymmetry and supergravity, and his 1977 doctoral dissertation on supersymmetry earned him a prominent place in the early development of the field, as did the 1984 book he co-authored, *Superspace, or One thousand and one lessons in supersymmetry*, which is widely considered the first comprehensive book on the subject.

His study of string theory and supersymmetry has recently led Gates to develop an interest in what are called adinkras. Adinkra symbols are graphical representations of supersymmetric algebras named after symbols created by the Asante people. Adinkras may help us understand the structure of the universe, although Gates cautions, "most of the time when we make up ideas, they're wrong. However, when we get it right, it's amazing."



Credit: Nick Dentamaro / Brown University

"At age sixty-six, I find I am still chasing dreams and new adventures."

Gates is also a pioneer in another respect, having been the first African American to hold an endowed chair in physics at a major U.S. research university. He comes to Brown with a mission to increase the participation of historically underrepresented groups in the sciences, but has no plans to leave his research behind, "I am currently working on three more scientific research papers, at least. I may be doing the best research of my life as I enter this fall and winter of my career. Physics is still great fun for me." As Ford Foundation Professor of Physics, Gates says he plans to interact with researchers across a number of disciplines at the University including, "physics, mathematics, public policy, and maybe computer science/information theory, along with some sort of genetics or evolutionary biology."

A former scientific advisor to President Barack Obama, Gates is also a member of the National Academy of Sciences, as well as the board of trustees of Society for Science & the Public, and one of the USA Science and Engineering Festival's "Nifty Fifty." Gates is typically modest when asked why he made the move to Brown: "At age sixty-six, I find I am still chasing dreams and new adventures. This seems so odd. When I was young, every adult I knew retired when they were sixty-five. When the possibility of this change first appeared, I kept asking close friends, why would Brown be interested in an 'old car' like me. Finally, one of them explained, 'Jim, you are not an old car, but an antique car and those are valuable.'"

Article by Pete Bilderback, Department of Physics

Researchers observe heat exchange in an exotic material

In an article published today in the journal Nature, physicists report the first ever observation of heat conductance in a material containing anyons, quantum quasiparticles that exist in two-dimensional systems.

The work confirms theoretical predictions about how anyons behave. That confirmation is important because scientists hope to one day harness the behavior of anyons to create self-correcting quantum computers, which could perform calculations far more complex than digital computers can.

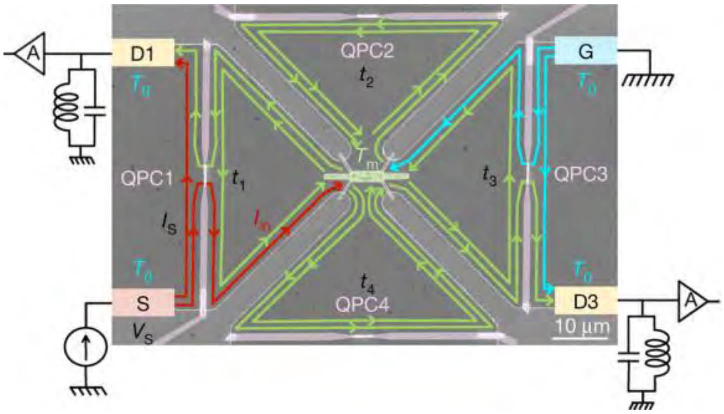
Dima Feldman, associate professor of physics at Brown, is a coauthor of the research with researchers at the Weizmann Institute of Science in Israel. He spoke about the research in an interview.

Could you summarize what you and your colleagues discovered?
In technical language, we observed the quantization of heat conductance in a strongly interacting system. So what does that mean? Everyone knows about conductance. It's simply the transfer of heat from a hot object to a cold object. In science, you can learn a lot about the nature of a material by understanding how fast it conducts heat. So here, we observed how this works at a quantum level among anyons, which are essentially fractional states of electrons in two-dimensional topological materials. Quantization of heat conductance had been observed before in systems where particle interaction is unimportant, but this is the first time it's been observed in a system dominated by electric interaction.

Why is the finding important?
It's important for two reasons. The first is more philosophical. We've arrived at a universal number for the quantization of anyonic heat flow, and physicists love universal numbers. When you arrive at a universal number, you've found order and harmony in nature. That's really what physics is all about.

More concretely, we performed our experiment in a topological material, and there's an idea for using topological materials in quantum computing. Quantum states are easily disrupted, which in a quantum computer means that it makes lots of errors. Correcting those errors is a big challenge. But there's this idea of using topological materials to harness quantum states of anyons, which we think will be much less fragile and can therefore do error-free calculations.

Understanding how heat flows gives us new information about anyons. There had been theoretical predictions about heat transport, and we were able to demonstrate them experimentally. So this is a big step toward understanding how anyons work.



Researchers developed a device to measure heat flow at the quantum level in an exotic form of matter.
Mitali Banerjee

> "In science, you can learn a lot about the nature of a material by understanding how fast it conducts heat."

What was your role in the work?
I was a theorist on the project, and theorists have several roles on something like this. I helped the group to understand what we want to measure, and I worked to help devise the experiment. But I think mainly where I helped was to understand the data we got from the experiment. Some of our results were surprising, so it was my job to help make sense of that.

What's next for this line of research?
The next step would be taking this to the second Landau level, meaning a higher energy electron state. Anyons are interesting at the first Landau level where our work was done, but they get even more interesting at the second level. So what people want to understand is what anyons are, because those are the potential keys to self-correcting quantum computer. But our research was a critical step in the process.

Article by Kevin Stacey, Brown News Service

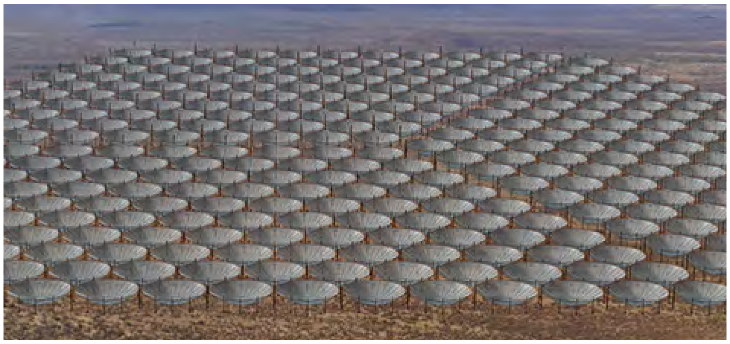
Experiment looks back to when the universe's lights came on

An experiment that will peer deep into the past to a time when stars and galaxies first illuminated the universe is getting a nearly $10 million boost from the National Science Foundation. The experiment, an international collaboration called the Hydrogen Epoch of Reionization Array, or HERA, currently has 19 radio dishes, each 14 meters wide, aimed at the southern sky near Carnarvon, South Africa. The $9.5 million in new funding will expand that array to 240 dishes by 2018.

HERA will look across the universe and more than 13.5 billion years back in time, to the period when the first stars began producing light, creating bubbles of ionized hydrogen gas around them. Those bubbles expanded outward, slowly filling all interstellar space with the ionized hydrogen we see today. By searching for the faint signal of that hydrogen ionization process, HERA scientists hope to learn more about the period when the universe first became bathed in light and what those first stars and galaxies were like.

The effort is led by the University of California, Berkeley, with partner institutions including Brown, University of Washington, UCLA, Arizona State University, the National Radio Astronomical Observatory, the University of Pennsylvania, the Massachusetts Institute of Technology, Brown University, the University of Cambridge in the UK, the Square Kilometer Array in South Africa and the Scuola Normale Superiore in Pisa, Italy.

Jonathan Pober, assistant professor of physics at Brown, is a member of the HERA science team. He talked about the experiment in an interview.



Can you explain more about the period in the universe's history that HERA is investigating?
We're looking at this period of reionization, which happened about 500 million years after the Big Bang. Thinking back to just minutes after the Big Bang when the first hydrogen atoms formed, they were all ionized — there was so much energy around that protons and electrons were stripped from each other. As the universe cooled and expanded, protons and neutrons started to recombine, which slowly filled the universe with neutral hydrogen. But around 500 million years after the Big Bang, all of the hydrogen in the universe outside of galaxies — in what we call the intergalactic medium — got reionized. It's still that way today.

Our best model for what caused this reionization is that when luminous matter — stars and black holes and galaxies — starting forming, they put energy back into the universe that reionized the surrounding hydrogen gas. The picture we have is like blowing bubbles. Light from these first stars and galaxies made bubbles of ionized hydrogen, which grew outward. Eventually they all overlap and we get the completely ionized intergalactic medium we see today. We want to know more about this reionization period, which is ultimately tied to questions about what the first stars and galaxies were like. Were they putting out more ultraviolet photons, more x-ray photons or what? How were the first stars formed? Did they live a long time or were they blips in the night? These first stars and galaxies are the building blocks of everything we see today, so we'd like to understand what they were like.

What signal from the reionization epoch is the experiment looking for?
These galaxies are too faint to see the light from them directly. So HERA is a radio telescope that looks for a signal from neutral hydrogen. We're looking back to the time when ionization was still happening. Neutral hydrogen emits radiation at a wavelength of 21 centimeters, and that's the signal we're tracking. As reionization happens, and these bubbles of ionized hydrogen start growing, the 21-centimeter signal of neutral hydrogen decreases. So we're effectively looking for the disappearance of this signal.

What does the telescope look like?
It's an array of radio antennas — dishes about 14 meters across each. We have 19 of these right now, and this new grant will get us to 240. So when it's done it will be about three football fields across. We're in the Karoo Desert in South Africa, probably the most desolate place I've ever been. But that keeps us away from a lot of radio interference.

I like to describe this as a software telescope. Each of those antennas feeds back to a supercomputer, which correlates every antenna to every other antenna. Each pair of antennas is sensitive to a particular scale in the sky. You use those cross correlation to reconstruct information about the sky. The hardware is pretty simple. If you're looking at the optical wavelength, you polish your mirror to nanometers. But we're looking wavelengths on the order of meters, so we can build our antennas out of PVC pipe and chicken wire. And that's what we did. At those wavelengths, chicken wire is a pretty good mirror.

When we detect a signal, and I truly hope we will, it's going to take a lot of convincing — both internally within the experiment and externally — that the signal is real, so that's what we'll be focusing on at Brown. If we can confirm that signal, we'll be documenting a cornerstone event in cosmic history."

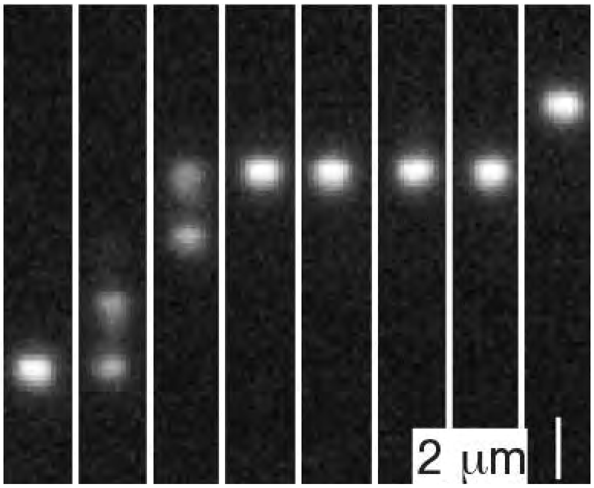
Article by Kevin Stacey, Brown News Service

Research pushes concept of entropy out of kilter

Entropy, the measure of disorder in a physical system, is something that physicists understand well when systems are at equilibrium, meaning there's no external force throwing things out of kilter. But new research by Brown University physicists takes the idea of entropy out of its equilibrium comfort zone. The research, published in *Physical Review Letters*, describes an experiment in which the emergence of a non-equilibrium phenomenon actually requires an entropic assist.

"It's not clear what entropy even means when you're moving away from equilibrium, so to have this interplay between a non-equilibrium phenomenon and an entropic state is surprising," said Derek Stein, a Brown University physicist and co-author of the work. "It's the tension between these two fundamental things that is so interesting."

The phenomenon the research investigated is known as "giant acceleration of diffusion," or GAD. Diffusion is the term used to describe the extent to which small, jiggling particles spread out. The jiggling refers to Brownian motion, which describes the random movement of small particles as a result of collisions with surrounding particles.



Fluorescent stained DNA molecules make their way across of fluid channel pocked with tiny pits. The pits act as "entropic barriers."
Stein Lab / Brown University

Imagine jiggling particles arranged on a surface with undulating bumps like a washboard. Their jiggle isn't quite big enough to enable the particles to jump over the bumps in the board, so they don't diffuse much at all. However, if the board were tilted to some degree (in other words, moved out of equilibrium) the bumps would become easier to jump over in the downward-facing direction. As tilt begins to increase, some particles will jiggle free of the washboard barriers and run down the board, while others will stay put. In physics terms, the particles have become more diffusive — more spread-out — as the system is moved out of equilibrium. The GAD theory quantifies this diffusivity effect and predicts that as tilt starts to increase, diffusivity accelerates. When the tilt passes the point where all the particles are able to jiggle free and move down the washboard, then diffusivity decreases again.

The theory is important, Stein says, because it's one of only a few attempts to make solid predictions about how systems behave away from equilibrium. It's been tested in a few other settings and has been found to make accurate predictions.

For the experiment, Stein and his colleagues placed DNA strands into nanofluidic channels — essentially, tiny fluid-filled hallways through which the molecules could travel. The channels were lined however with nanopits — tiny rectangular depressions that create deep spots within the relatively narrower channels. At equilibrium, DNA molecules tend to arrange themselves in disordered, spaghetti-like balls. As a result, when a molecule finds its way into a nanopit where it has more room to form a disordered ball, it tends to stay stuck there. The pits can be seen as being somewhat like the dips between bumps on the theoretical GAD washboard, but with a critical difference: The only thing actually holding the molecule in the pit is entropy.

Stein and his colleagues wanted to see if the non-equilibrium GAD dynamic would still emerge in a system where the barriers were entropic. They used a pump to apply pressure to the nanofluidic channels, pushing them out of equilibrium. They then measured the speeds of each molecule to see if GAD emerged. What they saw was largely in keeping with the GAD theory. As the pressure increased toward a critical point, the diffusivity of the molecules increased — meaning some molecules zipped across the channel while others stayed stuck in their pits.

> "Non-equilibrium and entropy are two concepts that are kind of at odds, but we show a situation in which one depends on the other"

In addition to the more profound implications, there may also be practical applications for the findings, Stein says. The researchers showed that they could estimate the tiny piconewton forces pushing the DNA forward just by aqnalyzing the molecules' motion. For reference, one newton of force is roughly the weight of an average apple. A piconewton is one trillionth of that.

The experiment also showed that, with the right amount of pressure, the diffusivity of the DNA molecules was increased by factor of 15. So a similar technique could be useful in quickly making mixtures. If such a technique were developed to take advantage of GAD, it would be a first, Stein says.

"No one has ever harnessed a non-equilibrium phenomenon for anything like that," he said. "So that would certainly be an interesting possibility."

The work was led by Stein's graduate student Daniel Kim. Co-authors were Clark Bowman, Jackson T. Del Bonis-O'Donnell and Anastasios Matzavinos, all from Brown. The work was supported by the National Science Foundation.

Excerpted from article by Kevin Stacey, Brown News Service

Research reveals novel quantum state in strange insulating materials

Researchers from Brown University have shown experimentally how a unique form of magnetism arises in an odd class of materials called Mott insulators. The findings are a step toward a better understanding the quantum states of these materials, which have generated much interest among scientists in recent years. The study, published in *Nature Communications*, helps to confirm novel theoretical work that attempts to explain how electrons behave in these strange materials. The work was done in collaboration with scientists at Stanford University and the National High Magnetic Field Laboratory. "We found that the theory holds up well," said Vesna Mitrović, an associate professor of physics at Brown who led the work.

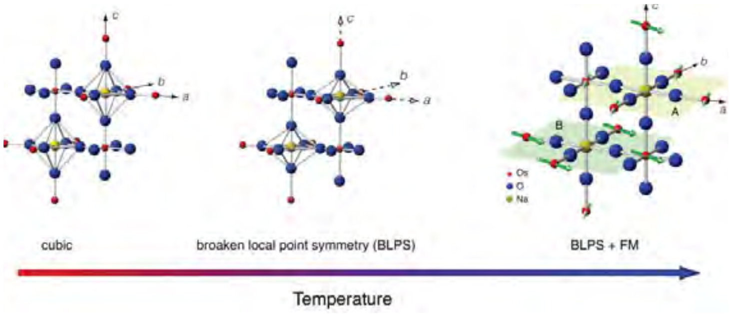
Mott insulators are materials that should be conductors according to traditional theories of electrical conductivity, but act as insulators nonetheless. The insulating state arises because electrons in these materials are strongly correlated and repel each other. That dynamic creates a kind of electron traffic jam, preventing the particles from flowing to form a current. Scientists are hopeful that they can find ways of moving these materials in and out of the Mott insulating state, which would be useful in developing new kinds of functional devices.

Despite the promise of these materials, scientists still don't fully understand how they work. It's difficult to predict electron properties in Mott insulators because the states of electrons are so closely correlated with each other—the state of one electron influences the states of its neighbors. To further complicate matters, many Mott insulators exhibit what is known as spin-orbit coupling, meaning that each electron's spin changes as it orbits an atomic nucleus. Spin-orbit coupling implies that the magnetic moment of electron is affected by its orbiting an atomic nucleus, and therefore the spin of an electron is not well defined. Thus, predicting properties of these materials requires knowledge of interactions between the electrons while the fundamental properties of individual electron depend on their orbital motion.

Mitrović's study focused on a strange type of magnetism that arises when Mott insulators with strong spin-orbit coupling are cooled below a critical temperature. Magnetism arises as a result of alignments between electrons spins. But in this case, because the spins are strongly interacting and their values depend on orbital motion, it's not understood how this magnetism arises in these materials.

> "It shows that this new theory is a good start to understanding magnetism in strongly interacting materials."

Mitrović's colleagues at Stanford started by synthesizing and characterizing thermodynamically a Mott insulating material made of barium, sodium, osmium and oxygen, which Mitrović probed using nuclear magnetic resonance. The particular technique the team used enabled them to gather information about the distribution of electron charges in the material and information about electron spin at the same time.



Cooling a Mott insulator with spin-order coupling below a critical temperature distorts its atomic lattice, which drives the emergence of a unique form of magnetism. Mitrović Lab / Brown University

The work showed that as the material is cooled, changes in the distribution of electron charges cause distortion in the material's atomic orbitals and lattice. As the temperature cools further, that distortion drives the magnetism by causing an alignment of electron spins within individual layers of the atomic lattice.

"We were able to determine the exact nature of the orbital charge distortions that precedes the magnetism, as well as the exact spin alignment in this exotic magnetic state." Mitrović said. "In one layer you have spins aligned in one direction, and then in the layers above and below it the spins are aligned in the different direction. That results in weak magnetism over all, despite the strong magnetism within each layer."

The theory Mitrović was investigating predicted exactly this layered magnetism preceded by distortions of charge. As such, the findings help to confirm that the theory is on the right track. The work is an important step toward understanding and manipulating the properties of this interesting class of materials for real-world applications, Mitrović says. In particular, materials with spin-order coupling are promising for the development of electronic devices that consume less power than ordinary devices.

"If we want to start using these materials in devices, we need to understand how they work fundamentally," Mitrović said. "That way we can tune their properties for what we want them to do. By validating some of the theoretical work on Mott insulators with strong spin-orbit coupling, this work is an important step toward a better understanding." In a larger sense, the work is a step toward a more comprehensive quantum theory of magnetism.

Excerpted from article by Kevin Stacey, Brown News Service

New Courses

PHYS 0150 – The Jazz of Modern Physics

Designed by Professor Stephon Alexander, this course is aimed at both students in the humanities and sciences. It will explore the myriad surprising ways that jazz music is connected to modern physics. No background in physics, mathematics or music is required, as all of these foundational concepts and tools will be introduced. The Jazz of Physics has three interconnected components: (1) Using concepts and analogies from music and acoustics to explore the key conceptual ideas in modern physics such as quantum mechanics/information, general relativity, particle physics, dark energy and big bang cosmology. (2) Exploring the parallels between jazz and physics through the lens of 20th century physics and jazz history, as well as key innovations in both fields with an eye towards future innovations. (3) Students will learn the tools of signification in physics and develop group projects with a final product.

Events

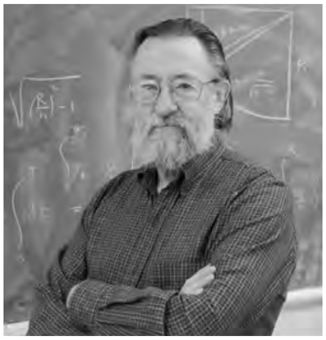
Conferences

Houghton Conference

The Third Tony and Pat Houghton Memorial Lecture Series was held at Brown on May 8-9, 2017. The conference was organized by Professors Bob Pelcovits, Tom Powers, Derek Stein, Jay Tang and See-Chen Ying, and focused on the Non-equilibrium Physics of Soft and Biological Systems. Twelve distinguished scientists from universities in the United States, England, France and Germany gave presentations on computational, experimental and theoretical investigations of a variety of complex systems including active matter, cellular and Brownian systems, and electrokinetic phenomena. More than 60 people attended the conference which was made possible by a very generous bequest from the estate of Tony and Pat Houghton. Tony was a theoretical condensed matter physicist who chaired Brown's Department of Physics from 1992 to 1998.

Slides and videos of many of the talks are available at: https://icerm.brown.edu/video_archive/#/search

Arthur O. Williams Lecture



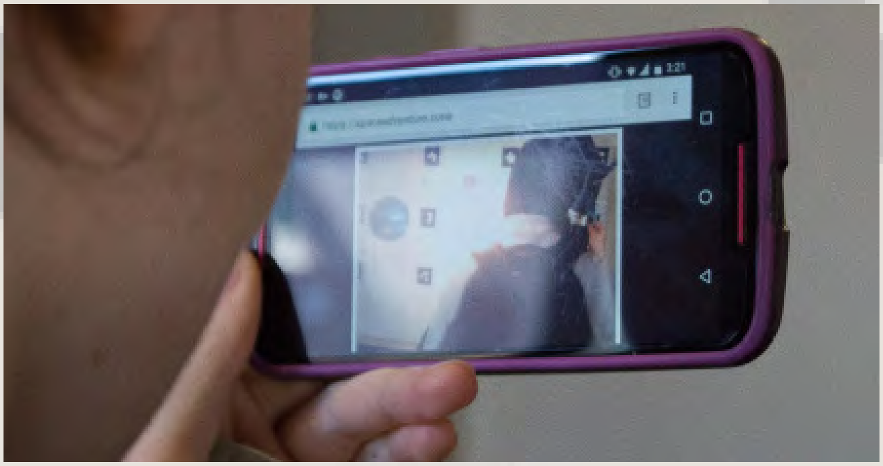
John Reppy, John L Wetherill Professor of Physics Emeritus at Cornell University, delivered the 2017 Arthur O. Williams Lecture. As physics professor at Cornell, Dr. Reppy's research is directed toward an understanding of the macroscopic quantum properties of superfluid 3He, 4He, and the super solid state of solid 4H. He studies quantum properties of superfluids with an emphasis on boundary conditions and phase transitions in systems of reduced dimensionality.

Dr. Reppy earned his PhD from Yale University in 1962, where he spent four years as an assistant professor. In 1966, he joined the Cornell Physics Department, later becoming the John Wetherill Professor of Physics. He is the recipient of numerous awards, including the Fritz London Memorial Prize in 1981 and the NASA Distinguished Public Service Medal for leadership and support to the NASA microgravity fundamental physics program in 2000. Dr. Reppy is also a member of the National Academy of Sciences.

Physics Art Show

This year's well-attended art show featured a wide array of visual and interactive art by faculty, post-docs, staff and students. Creativity and imagination were on full display in the annual exhibition that included paintings, photographs, drawings and installations.

The performance component of the show welcomed Professor Stephon Alexander who performed some improvisational jazz pieces.



Interactive Display by Ben Weiner and Will Maulbetch

Michelle Miller

Christos Zambas & Jordan Bell

Professor Stephon Alexander

In 1958, Mildred Widgoff became the first woman to be appointed to a faculty position in Brown's Department of Physics when she was named Research Assistant Professor. At the time she also held a position at Harvard, and would split her time between the two institutions until 1961 when she joined Brown's faculty fulltime. She was appointed to a full professorship in 1974, and became an Emeritus Professor in 1995. She would remain a valued member of the department community until her passing in 2004.

During her tenure at Brown Widgoff participated in important experiments in the area of meson spectroscopy via photoproduction as part of a group of scientists from Brown, Brandeis University, Harvard, and MIT. As a member of the International Hybrid Spectrometer Collaboration (IHSC), she helped construct a large counter hodoscope system that was installed at Fermilab in the 1980s, and took an active role in the construction of the Large Volume Detector at Gran Sasso to do neutrino astrophysics.

By the time she joined Brown's faculty in 1958, Widgoff was already an accomplished scientist. She received her BA in physics from the University of Buffalo in 1944, and according to her sister, Bernice L. Kliman, upon graduating at the young age of 19 was recruited to work on the top-secret Manhattan Project, then at Columbia University. While the Manhattan Project and other military research endeavors provided new scientific research opportunities for women during the war, the path forward for female scientists in the immediate post-war era was still littered with obstacles.

Despite the relatively inhospitable environment for women in science, Widgoff persisted in her physics studies, and embarked on graduate studies at Cornell University where she worked in the university's celebrated cosmic-ray group under the leadership of Giuseppe Cocconi and Kenneth Greisen. In 1952 she received her PhD with a thesis entitled "Neutrons from Interactions of Mu Mesons in Various Targets". After post-doctoral work at Cornell she joined the research staff of the Brookhaven National Laboratory and in 1955 became a research fellow at Harvard University's Cyclotron Laboratory before coming to Brown.

In addition to her scientific research, Widgoff played an important role in the department's administration, serving as its Executive Director from 1968 to 1980. She was an APS Fellow who served as chair of the organization's New England section, and chaired one of the earliest APS committees on the status of women in physics.

In addition she served on numerous NSF panels on awards for female faculty, and served as a trustee of the American Institute of Physics' Insurance Trust. A dedicated educator, Widgoff was also active with Inner-City Teachers of Science (ICTOS), a group at Brown that worked to improve the teaching of physical sciences in inner city schools.

As she blazed a path for women in physics, Widgoff was beloved by her students and colleagues for her uniquely positive outlook and for her love of physics. Department faculty and staff who knew her still remember her fondly as both a caring and devoted friend and outstanding physicist who contributed much to the fields now called particle physics and particle astrophysics, as well as her revolutionary contributions to detector technology.

Walter E. Massey came to Brown University as its first African American professor of physics in 1970 from the University of Illinois where he had worked on the many-body theory of liquids and solids. Before that, he earned his bachelor of science in physics and mathematics from Morehouse College, and his master's and doctorate in physics from Washington University in St. Louis, MO.

At Brown, Massey did important work in conjunction with Professor Humphrey Maris on the attenuation and velocity of sound in liquid helium at low temperatures. In a paper published in Physical Review Letters in July of 1970, they demonstrated that Soviet Nobel Laureate Lev Landau had made a critical mistake in his theory of excitations in superfluid helium.

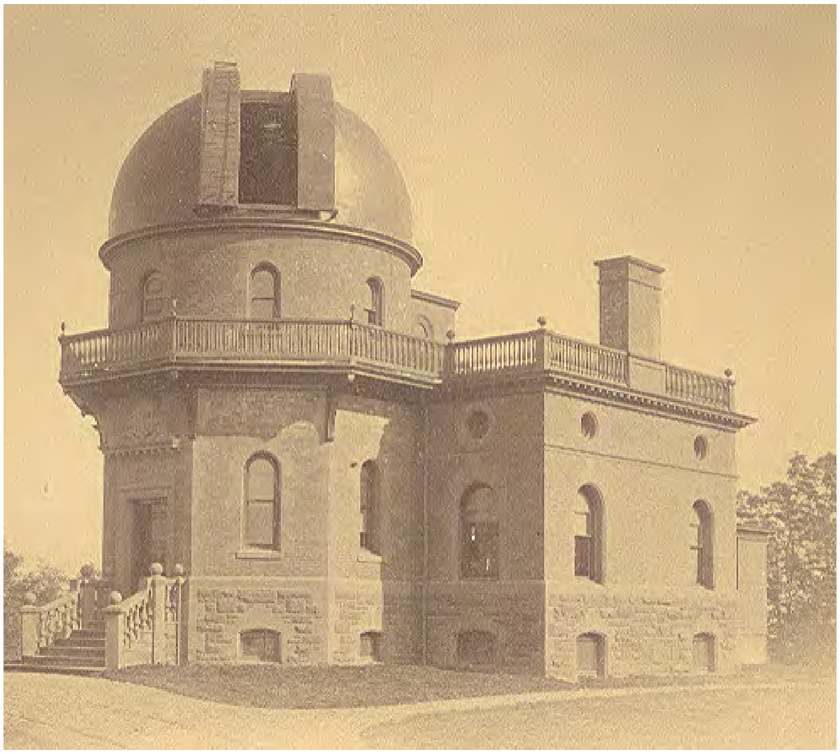
While at Brown Massey became increasingly interested in the problem of how to bring people from historically underrepresented groups into the sciences, and began to focus more of his efforts on administration. He founded the Inner City Teachers of Science program, in which Brown University undergraduates studying to be science teachers served as mentors to High School students in urban areas. Massey also served as Dean of the College before leaving Brown in 1979 to lead the Argonne National Laboratory in Chicago.

In 1990 President George H.W. Bush appointed Massey director of the National Science Foundation where he was a strong proponent for fundamental research and science education, as well as advocating for measures to increase participation in the sciences from minorities and women. He later served as the President of the American Association for the Advancement of Science, chair of the Secretary of Energy Advisory Board, and founded the African Academy of Sciences and the National Society of Black Physicists, along with serving as a science advisor to multiple U.S. presidents.

In 1993 Massey was appointed provost and vice president of academic affairs for the University of California system before returning to his undergraduate alma mater, Morehouse College, to serve as president between 1995 and 2007.

Massey currently serves as chancellor of the School of the Art Institute of Chicago where he served as president from 2010 to 2016. In addition to his science advocacy, Massey has long been an advocate for arts education, and also served as chair of the Association of Independent Colleges of Art and Design. He is the only person to have received both the Enrico Fermi award (given by the Italian Physical Society) and the Public Humanities Award (given by Illinois Humanities). In addition, over his career Massey has been awarded over thirty honorary doctorates and been honored with multiple awards, including the Distinguished Service Citation of the American Association of Physics Teachers.

Ladd Observatory Celebrates 125 Years



A Providence landmark — and a window to the stars for generations of Brown astronomers, students and Rhode Island skywatchers — celebrated its 125th anniversary the week of Oct. 17, 2016.

The Ladd Observatory, located just north of the University's campus on Doyle Avenue in Providence, opened its doors for the first time on October 21, 1891. Ever since, the Ladd has been open for weekly public viewing nights, providing an astonishing view of the Moon, neighboring planets, comets, meteors and distant stars.

"The Ladd is considered a gem by the national astronomical community," said David Targan, associate dean of the college for science education and the Ladd's director. "It's one of the best examples in the country of a continuously operating, finely preserved 19th century observatory. For Brown, it's been an important means of connecting with the community and communicating science, as well as simply giving people a beautiful view of the night sky."

Construction of the Ladd began in May 1890, overseen by renowned astronomer Winslow Upton, who would serve as the facility's first director. Upton was lured to Brown as a professor in 1883 with a promise that the University would build a state-of-the-art observatory. Thanks to a $55,000 gift from former Rhode Island Gov. Herbert Warren Ladd, the University was able to make the observatory a reality.

The facility's main attraction is its colossal refracting telescope. Measuring 15 feet long, with a 1-foot-diameter lens, it's an ideal instrument for viewing intricate surface features on planetary bodies, Targan says. The telescope is powerful enough to see the detailed patterns of Saturn's rings and resolve the borders of Jupiter's atmospheric bands. When viewing the Moon, it brings the rims of craters, the rays of impact ejecta and other features into sharp focus.

The telescope was on the cutting edge when it was built, but it was also among the last of its kind built in the eastern U.S., Targan says.

"Industrialization had started creating more light pollution in the east, so around this time astronomers and telescopes started migrating out west to work in places that were darker, higher in elevation and had clear, dry air," Targan said. "This was really the end of an era for these big telescopes on the East Coast."

The Ladd has multiple telescopes: in addition to the refracting one — which is still made completely from its original parts — there is one for timekeeping, and new portable telescopes. "Rather than electric motors, we have a weight-driven drive. We actually wind it up," said Ian Dell'Antonio, professor of physics. "Once you point it at the sky, the telescope will track the object."

The Ladd's refracting telescope, circa 1898.

Originally, the Ladd was built as the official timekeeping station for the city of Providence. "We would make observations of the stars and then make sure the pendulum clocks would synchronize. … Then we had telegram letters that ran from that to other parts of the city that would cause their clocks to be synchronized to ours," Michael Umbricht, observatory curator, said.

Over the years, the Ladd has been witness to its share of spectacular cosmic events. It's seen numerous meteor showers during its history, and the passing of Halley's Comet twice, in 1910 and in 1986. In 2010, visitors to the Ladd were thrilled by the transit of Venus, the passage of our nearest planetary neighbor across the face of the sun as seen from Earth.

In 1901, Upton trained the Ladd's telescope on an exploding star — a nova — in the constellation Perseus. Though first discovered by an astronomer in Scotland, Upton kept a close watch of it through the Ladd's large refractor, carefully chronicling the evolution of the event. He described the nova to a reporter with the Detroit Free Press, for an article that ran on February 27, 1901.

"Probably the star has met with a catastrophe of stupendous import, possibly a collision with some other body or bodies, perhaps an internal explosion," Upton said. "Should our sun increase its brightness in any such way, and its heat increase also, life on our planet would cease."

That nova was also viewed by an 11-year-old H.P. Lovecraft, the legendary horror writer and Providence native, who used the event as a plot point in his story "Beyond the Wall of Sleep." The Ladd was a favorite haunt of Lovecraft, who was also an avid amateur astronomer. For years before his death in 1937, Lovecraft had his own key to the Ladd, coming and going as he pleased. He spent many nights there reading, writing and looking at the stars.

Targan says the Ladd staff has found library books that Lovecraft had taken out collecting dust in the observatory's attic. Those and other Lovecraft memorabilia now reside in Brown's John Hay Library. And the Ladd remains a destination for Lovecraft fans the world over.

Lovecraft was just one of thousands of Rhode Island astronomy buffs who have flocked to the Ladd over the years. Public viewing nights, now held every Tuesday night, continue to draw large crowds. For Targan, the Ladd represents a return to the very roots of astronomy. In an era when people have access to high-resolution photographs of all manner of celestial objects via the internet, there's still something ineffable about viewing the cosmos directly, Targan says.

"I think our viewing nights offer a visceral experience of looking at the stars that people have had since the dawn of humanity," he said. "The Ladd is a reminder that this is how the study of astronomy got started."

Initially, the plan was to build the observatory in the middle of the College Green. But that plan was scrapped in favor of a location that was (at the time) more rural, away from buildings and city lights. In the 125 years since the Ladd's construction, a busy urban neighborhood has grown up around it. But that growth, and the ambient light that comes with it, hasn't changed the viewing experience much, Targan says.

"What's affected by light pollution are views of faint objects like distant galaxies, which aren't really the strength of a refracting telescope anyway," he said. "Everything else — the details of planets and the Moon, which is what the refractor is best for — is really the same as it ever was."

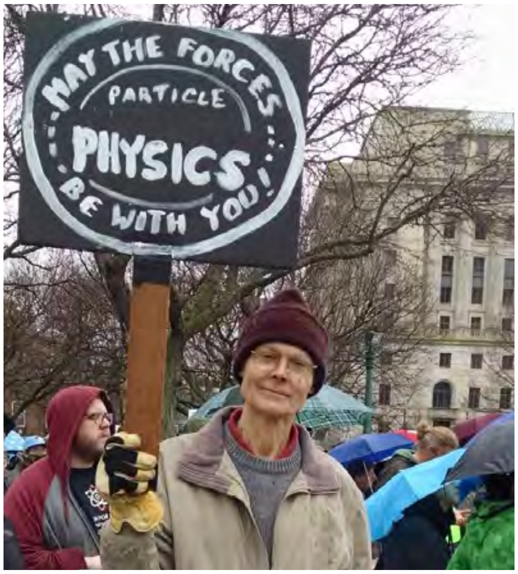
In 2000, the Ladd earned a spot on the National Register of Historic Places. In 2010, the Ladd staff completed a series of renovations to the facility. That work included the restoration of the transit room, which contains instruments that were used to keep the official time for Rhode Islanders for decades.

Today, the Ladd is operated as a working museum to preserve its long history. The observatory is "one of the few in the world" that still looks like it did in the 1890s, said Robert Horton, the manager of the Ladd and other astronomical laboratories. The Ladd "is more of a time capsule, so people can experience for themselves how astronomers worked and operated 100 years ago."

In the future, the Ladd will aim to continue attracting both students and locals. "We are sort of the face of the University to the community where we are teaching science and history, and we are going to continue doing that," Umbricht said. "We are looking to branch out into more than just the sciences."

"We will continue to operate it as a very unique museum. We have a wonderful array of exhibits, and we will continue to restore our equipment over the years and preserve it for generations to come. It's fascinating to think about how many generations have come to visit the place all this time," Horton said.

Excerpted from articles by Kevin Stacey and Bella Roberts, Brown News Service



Professor Dave Cutts at the March for Science in Providence

Kaley Brauer and Amy Butcher celebrate at Commencement

(l-r) Michael Zlotnikov, Thomas Harrington, and Rohitvarma Basavaraju

Three of our PhD students won first place at the University's 2017 Datathon

(l-r) Jessica Tennis, Ricky Oliver, Jovan Nelson and Alvaro Zamora at our Annual Spring Picnic in May

In January, Professor Jim Gates concluded his work on President Obama's Council of Advisors on Science and Technology

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