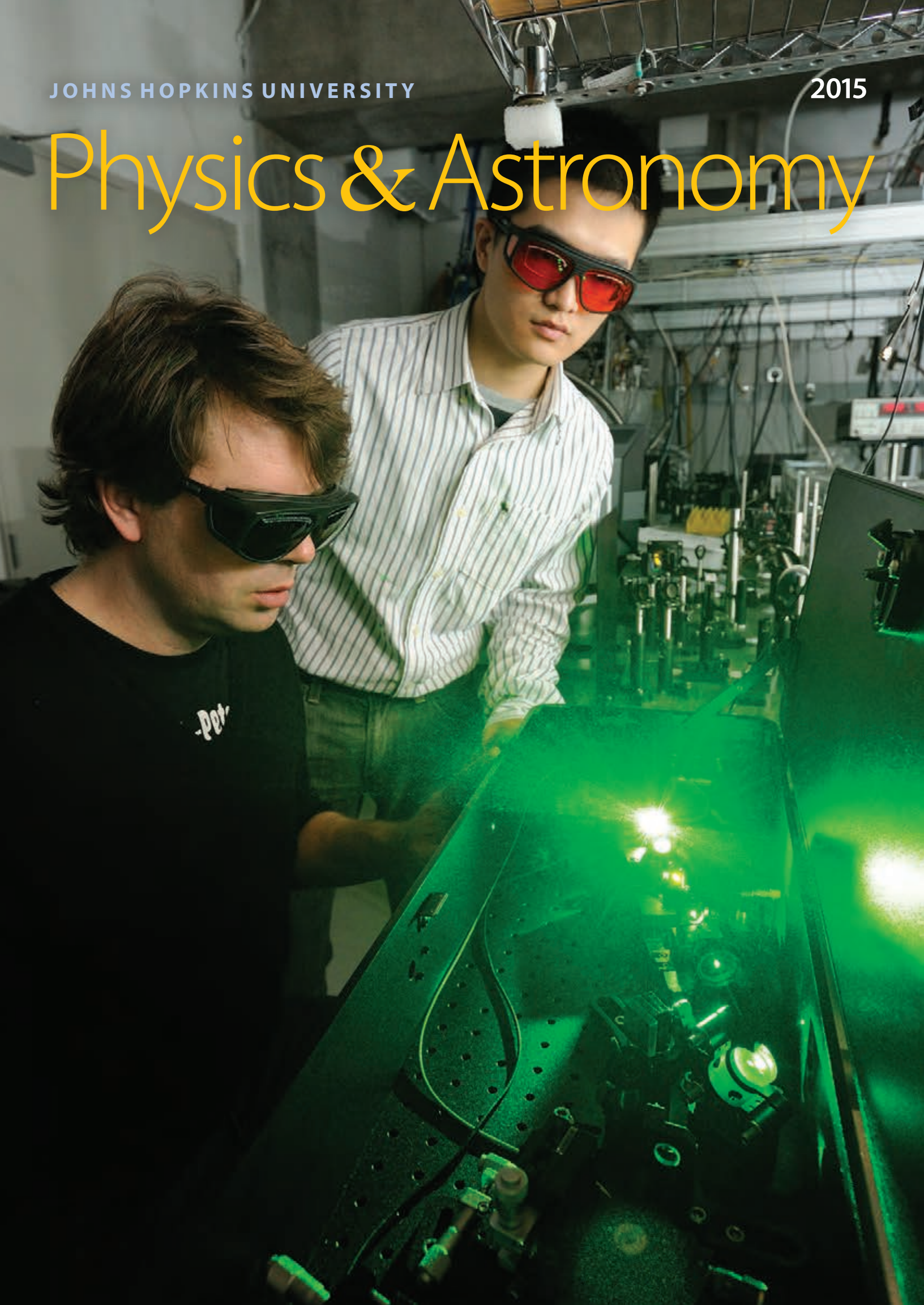


JOHNS HOPKINS UNIVERSITY

2015

Physics & Astronomy



Front cover: Associate Professor Peter Armitage and Postdoctoral Researcher LiDong Pan.

Inside cover: Low-frequency terahertz radiation is used to examine the properties of super-cooled materials in Peter Armitage's lab. See full article on Page 4.

Small inset, right: Ph.D. student Guy Marcus shows visiting high school students one of the department's condensed matter physics labs. The JHU Physics and Astronomy Graduate Student Outreach Organization hosted the students from Bluford Drew Jemison STEM Academy West in Baltimore City.



<http://physics-astronomy.jhu.edu>



[facebook.com/JHUPhysicsAstronomy](https://www.facebook.com/JHUPhysicsAstronomy)



[@JHUPhysicsAstro](https://twitter.com/JHUPhysicsAstro)



Join the Johns Hopkins Physics & Astronomy
LinkedIn Group for alumni, students and faculty



Letter from the Chair

Dear alumni, colleagues, and friends,

This is my first letter to you as the new chair of the Department of Physics and Astronomy. Let me begin by thanking my colleague Professor Dan Reich, not only for his years of devoted service and wise leadership as our former chair, but also for all his help in preparing me to step into his large shoes. He has left the department in great shape..

While many of my colleagues have offered a combination of congratulations and condolences as I begin my new job, I must say that I begin my tenure as chair with unalloyed enthusiasm. I'm sure that as you read through this newsletter, you will understand why I am so enthused. We have an award-winning team of faculty, research scientists, postdocs, and students who continue to push back the frontiers of knowledge in physics and astronomy. We are in the midst of a sea-change in the way we teach our undergraduate students and train our graduate students, with a focus on active learning and early immersion in research. Much of this is made possible by the support of you and other friends of the department, for which we are truly grateful. I invite our graduates to keep in touch, share advice, and let us know of news and accomplishments.

Despite our success, we will never rest on our laurels. Indeed, my colleagues and I are now taking a fresh look at where we want to be as a department in the coming years. Part of the answer is that we will reap the rewards of the projects and facilities that we are developing today. However, we must also chart a path forward that leads in new directions: how can we help lead the most exciting areas of physics and astronomy five or even ten years from now?

Let me close by thanking you for your interest in our department, and for all your support. We have an exciting future ahead, and I am pleased that you are a part of it.

Best,

Timothy Heckman, Chair

The Henry A. Rowland Department of Physics and Astronomy



TABLE OF CONTENTS

Letter from the Chair	1
Petar Maksimović, On the Hunt for New Physics	2
Riding a Terahertz Wave	4
Department News Briefs	6

Physics and Astronomy is an annual publication of the Johns Hopkins University Zanvyl Krieger School of Arts and Sciences Department of Physics and Astronomy. Send correspondence to: jon.schroeder@jhu.edu.

Editor

Jon Schroeder

Writers

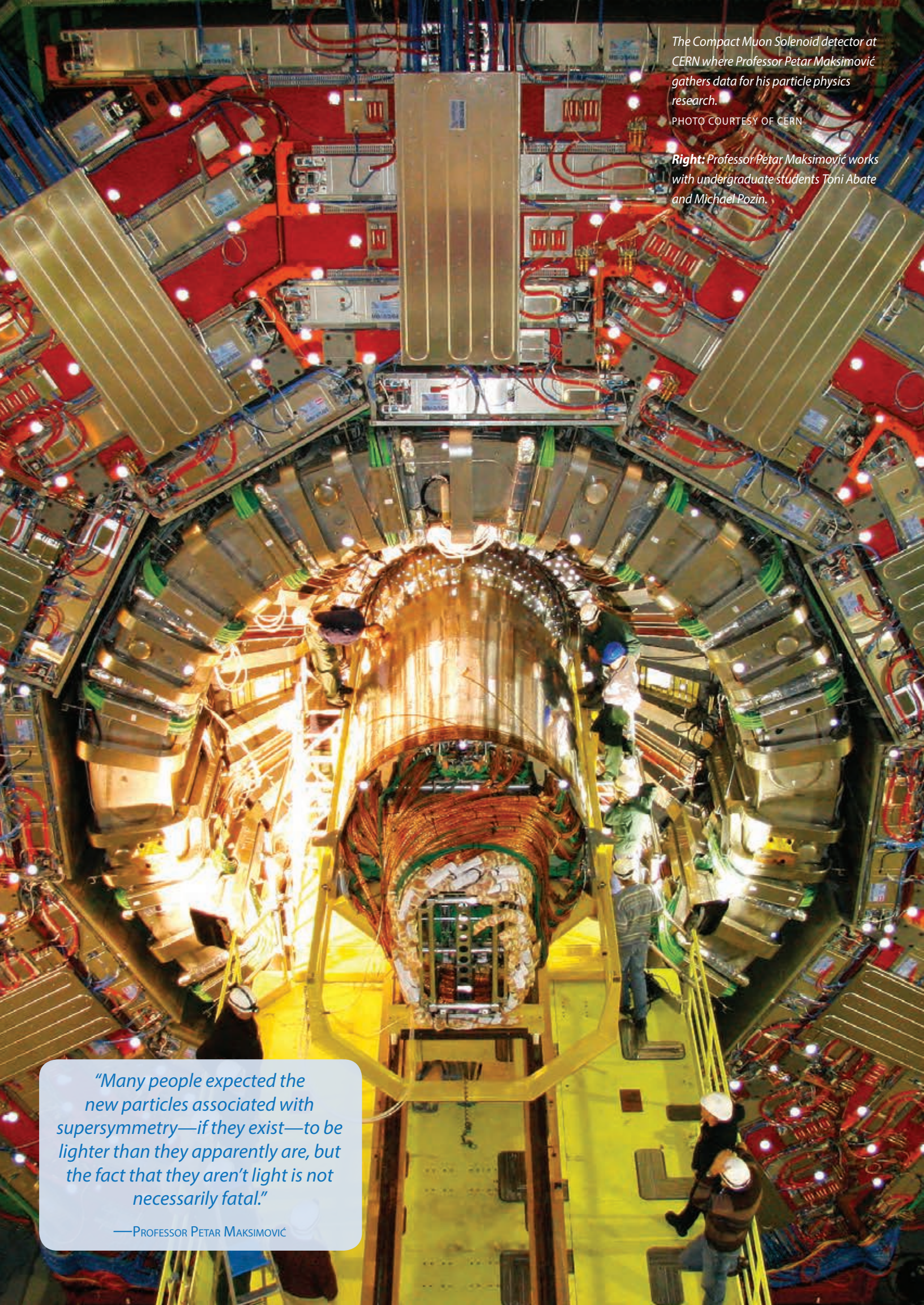
Authur Hirsch
Gabriel Popkin
Jon Schroeder
Joe Sugarman

Graphic Design

Mike Allison
Kathy Vitarelli

Photography

Will Kirk, Homewood Photography
(unless otherwise noted)



The Compact Muon Solenoid detector at CERN where Professor Petar Maksimović gathers data for his particle physics research.

PHOTO COURTESY OF CERN

Right: Professor Petar Maksimović works with undergraduate students Toni Abate and Michael Pozin.

“Many people expected the new particles associated with supersymmetry—if they exist—to be lighter than they apparently are, but the fact that they aren’t light is not necessarily fatal.”

—PROFESSOR PETAR MAKSIMOVIĆ

Petar Maksimović, On the Hunt for New Physics

BY GABE POPKIN

In 2007, when Petar Maksimović started to work on the world's most powerful particle accelerator, the Johns Hopkins physicist faced a choice: look for the Higgs boson, or look for things even stranger. The Higgs, at the time the field's holy grail, needed to fill a major hole in the otherwise amazingly successful theory of fundamental particles known as the Standard Model.

But already, physicists knew that even with the Higgs, the Standard Model had to be incomplete. For one thing, it can't explain gravity. Moreover, observations beginning in the 1970s showed that the model accounts for only around 5% of the universe's energy; a mysterious substance called dark matter makes up another 25%, and an even more mysterious "dark energy" fills in the remaining 70%. Over the following decades, theorists developed a set of theories known collectively as "supersymmetry" suggesting that the Large Hadron Collider (LHC), then nearly completed at the European Organization for Nuclear Research, or CERN, in Geneva, Switzerland, could turn up never-before-observed dark matter particles. Those particles, and others similarly not predicted by the Standard Model, are where Maksimović set his sights.

Maksimović arrived at Johns Hopkins in 2001, after completing a Ph.D. at MIT and a postdoc at Harvard. He began his research career working on the Tevatron at FermiLab, a U.S. Department of Energy facility outside of Chicago. There Maksimović led a team that in 2006 discovered a particle called "sigma-sub-b," an "exotic" heavy cousin of the familiar proton and neutron. Though the finding largely confirmed what theorists had already suspected, it was still one of the highlights of the Tevatron's 18-year run.

Maksimović continued to work part-time on the Tevatron until it shut down in 2011. But even before then he had turned most of his attention to the LHC, where he works on the Compact Muon Solenoid, or CMS, one of the LHC's two main experiments. The CMS is a five-story-high ring of mind-boggling complex electronics whose major components are layers upon layers of sensors similar to those in a digital camera. The sensors are designed to capture information about the collision produced when near-light-speed protons or ions crash at CMS's



center. Typically, several jets of newly created particles spray outward from the collision site; many of those particles are unstable and decay almost immediately into other, lighter particles. CMS's sensors capture snapshots of the decay products as they zoom away. Using sophisticated algorithms that they spend years developing, physicists like Maksimović and his JHU colleague Morris Swartz, among others, can then reconstruct what the original particles' masses and spins were and compare them to known particles or new ones predicted by theorists.

So far, new physics has proven elusive. While the LHC found the Higgs boson between March 2010 and February 2013, Maksimović and his colleagues saw no hint of any other new particles, supersymmetric or otherwise. For some this was disappointing, but Maksimović holds out hope for the theory. "Clearly many people expected the new particles associated with supersymmetry—if they exist—to be lighter than they apparently are," he says, "but the fact that they aren't light is not necessarily fatal."

Maksimović and his colleagues around the world are now eagerly anticipating the LHC's second act. The machine is finally running at full power, meaning that particles are smashing into each other at energies up to 13 tera-electron-volts, in particle physicists' preferred units. That gives Maksimović and his colleagues access to an additional 5 tera-electronvolts—a vast expanse of unexplored energy range.

And already some hints have appeared that the collider could be producing never-before-seen heavy particles, which would decay to pairs of other, lighter bosons. Such a finding would require new physics beyond the Standard Model. But Maksimović is staying cool until enough data come in to determine if the signal reaches the "five-sigma" level—the physics gold standard for a discovery. A five-sigma

event happens by chance less than one in 10 million times, whereas right now the signal from CMS is only around three-sigma, or one in a thousand. "You don't get excited" about three-sigma, Maksimović says.

Still, he will be "waiting with bated breath" as new data pour out of the LHC in the coming months. "It's a very exciting time because this is like starting a new collider," he says. "It's also somewhat stressful, because one has to really pay attention and be involved, because discovery can come fairly quickly."

At the same time Maksimović is conducting cutting-edge research, he is also teaching introductory electricity and magnetism. Maksimović approaches his teaching with just as much energy and intellectual rigor as he does his research. He exposes his introductory physics students not just to the standard 19th-century physics curriculum but also to the modern physics that excites him and his colleagues. He even invites outstanding undergraduates to take part in his current research—a rare opportunity for young scientists. To date, he has worked with 22 undergraduate research assistants. And currently he is having teaching assistants lead discussions directly in the lecture hall, rather than the standard problem solving sessions. He also collects data to determine what is working in his classes, and what needs improvement. His students give him consistently excellent reviews, and in 2012 he was recognized with the JHU Alumni Association Award for Excellence in Teaching.

Maksimović also wins praise for his advising and people skills—a good strength to have in a project that involves collaborating with thousands of other scientists. "He's amazing; I can't rave enough," says Alice Cocoros, a third-year graduate student in Maksimović's group, who recently won a prestigious National Science Foundation graduate research fellowship to support her work at the LHC. She says Maksimović stands out for caring not just about his students' research but also about factors like work-life balance and family decisions. "Sometimes in academia it seems like...you're just supposed to be some physics machine that churns out physics, and [personal concerns] are supposed to be secondary. And it's so not secondary for him. He really treats his students as full people with full lives."

Riding a Terahertz Wave

Peter Armitage makes new discoveries in quantum phenomena

BY JOE SUGARMAN

At first, Peter Armitage, an Associate Professor and principal investigator at the Johns Hopkins-Princeton University Institute for Quantum Matter, used technology developed by others to conduct his experiments. But as his investigations went deeper, he and his research team began to create the technology themselves. Armitage is primarily interested in studying electronic and magnetic properties that exhibit “exotic” phenomena at low temperatures like superconductivity and magnetism. “My background was not in lasers, but I saw physical questions I wanted answered,” he says. “So I had to make the instrumentation to get the answers. Some of the capabilities that we’ve created don’t exist anywhere else on the planet.”

Armitage and his group have created a device to explore quantum materials in the terahertz frequency range, and another that uses broadband microwave frequencies for material analysis. A third device developed by Armitage’s team employs Fourier transform infrared spectroscopy to record the entire infrared spectrum from near to far infrared at the same time.

“The resolution and sensitivity of the terahertz methods that Peter developed are ideally suited for probing the surface conductivity of a new class of topological quantum materials that is just now bursting onto the stage,” says Collin Broholm, the Gerhard H. Dieke professor of physics and astronomy and director of the Institute for Quantum Matter. “His experiments have also opened a new window on exotic forms of magnetism and superconductivity with great technological potential.”

“I try to understand how it is that large ensembles of strongly interacting, but fundamentally simple particles like electrons in solids can act collectively to exhibit

“His experiments have opened a new window on exotic forms of magnetism and superconductivity with great technological potential.”

—PROFESSOR COLLIN L. BROHOLM

emergent macroscopic quantum phenomena like superconductivity,” Armitage says. “Like waves on the sea, the behavior I study is intrinsically collective and is not easily reduced to the properties of individual particles i.e., it is emergent.

“One of the primary ways that we learn about physical systems in general is by shaking them at their natural frequency scales. This is true in cases as varied as masses on springs, to violin strings, to atoms. One might want to use light to probe the natural energy scales of materials. But it turns out that many of the natural frequency scales of these material systems—such as topological insulators, electronic glasses, and heavy fermions (a type of metallic alloy in which the superconducting electrons have unusually large effective masses)—in which I am interested are in parts of the electromagnetic spectrum below that easily accessible with conventional light methods. So my group has spent a lot of time developing very specific probes using the appropriate low-frequency terahertz waves. These techniques give us unique insight into these material systems.

“I saw lots of low-hanging fruit,” admits Armitage who arrived at Johns Hopkins after completing postdocs at U.C.L.A. and

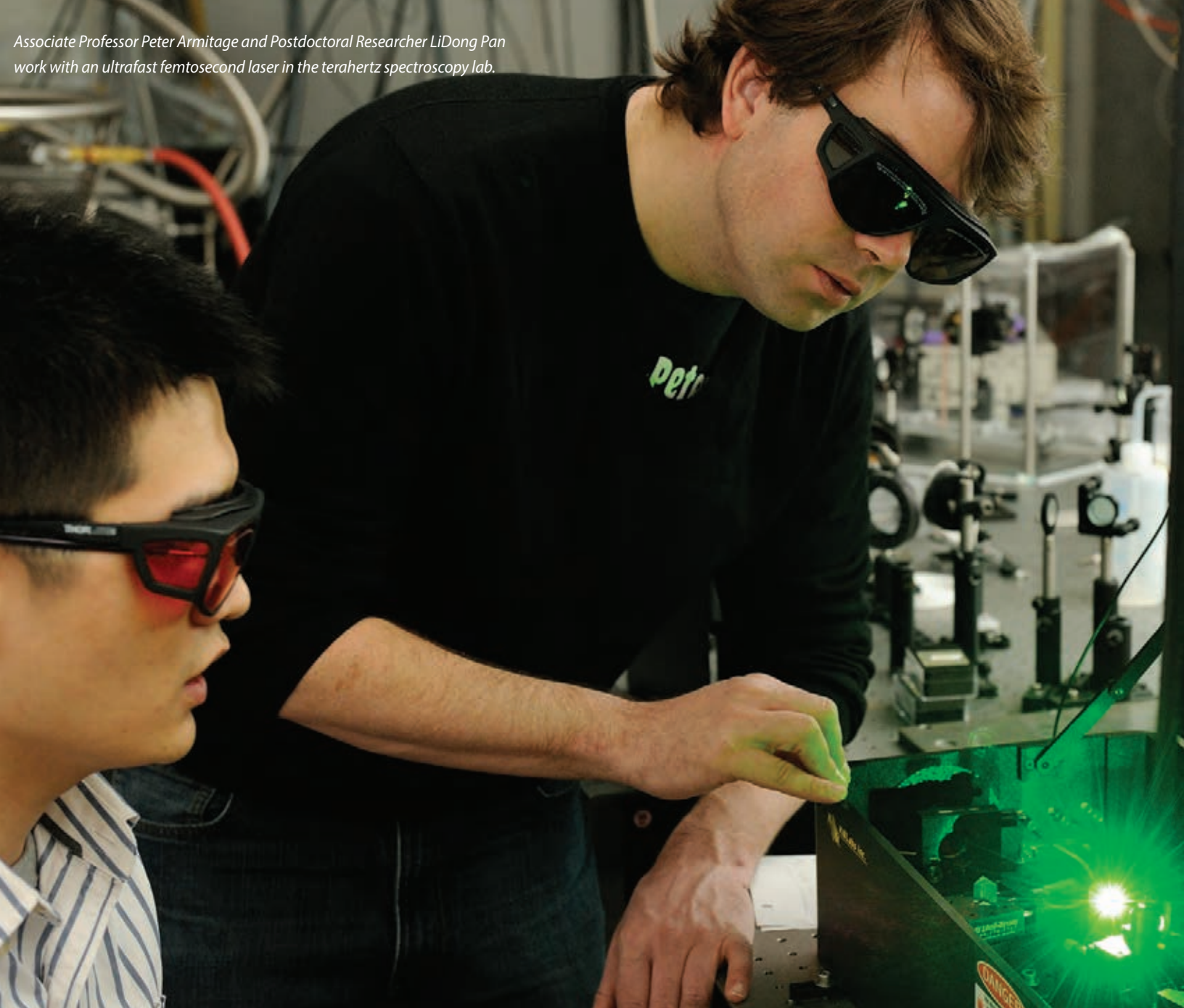
the University of Geneva. “There were techniques that existed and were developed by other groups that I thought were being underexploited and could be used in this area. So I very much changed my direction when I came to Hopkins because I saw there were new things that could be done. The materials I was interested in studying possess properties that make THz an ideal probe.”

Terahertz spectroscopy—a method of using low-frequency terahertz radiation pulsed at super-cooled materials to examine their properties—was in its infancy when Armitage arrived at Johns Hopkins in 2006. Back then, Armitage says, most researchers in the field were electrical engineers or laser research groups, not necessarily interested in using terahertz spectrometers to explore material physics.

Part of Armitage’s lab looks like a high-tech erector set. But this tabletop contraption is no toy, with its complex lattice of optical supports, mirrors, lenses, photoconductive switches, and lasers. It’s a delicately arranged device that employs the relatively new field of terahertz spectroscopy to probe the properties of condensed matter.

“All of these things—the mirrors, the lenses, the supports—are exquisitely tuned to keep the terahertz radiation going around the table,” says Armitage. “It’s hard enough to tune lasers with precision, but when the lasers are invisible and you can’t see where they’re going, it’s a lot of work, a lot of trial and error.”

While Armitage has made a name for himself as a pioneer in a relatively new field, he may be best known throughout the extended Johns Hopkins community as the organizer of the “Professor Extraordinaire” demonstration show at the Department of Physics and Astronomy’s annual Physics Fair, a day-long event involving demonstrations, experiments, and physics contests for students in grades K-12. It’s a role that Armit-



age assumed in his very first year as a faculty member. “I was a newly arrived, untenured assistant professor and I just happened to be standing in the wrong line at lunch one day when I was asked,” he jokes.

Each year Armitage chooses a different theme for the fair--from light to pressure or temperature. Then with the department’s “demonstration czar,” Steve Wonnell, he brainstorms experiments of--often involving dry ice, various “controlled explosions,” infrared cameras--even the infamous Physics Ninja--to illuminate the theme. Armitage is likely the only professor in the department to have fired a Bernoulli “toilet paper cannon” at local TV newscasters on live morning television. “That was one of my earliest teaching innovations, if you will,” he says of the device jerry rigged from two leaf blowers and several rolls of toilet paper that’s used to demonstrate the Bernoulli

principle. “In 30 seconds you can empty two rolls of toilet paper on someone.”

Armitage says he enjoys hosting the Physics Fair because its hands-on nature



ASSOCIATE PROFESSOR PETER ARMITAGE AS “PROFESSOR EXTRAORDINAIRE”

appeals to the experimenter within. “I started off wanting to do theoretical physics and moved into experimental. A major part

of what I do is build things,” he says. “That tinkering around with stuff probably plays a role in what I do for the Physics Fair. ... And every year it’s gotten a little more goofy.”

His playful, upbeat attitude has made him a favorite among students over the years. It’s a trait that initially attracted doctoral student Grace Bosse to his lab. “He’s a very funny guy and very positive,” says Bosse. “I’m pessimistic. I know everything is going to go wrong, but Peter is the opposite. He’s like, ‘Well, of course it’s going to work. Just do it.’”

Armitage says he plans to expand on his work in terahertz spectroscopy, as new discoveries continue to drive the need to create new technology. “I think we’ve made a big impact in an underexploited area,” he says. “Now I have former postdocs off doing their own work in the field. I feel like we’ve established a bit of a niche, which has been very satisfying.”

NEWS BRIEFS

Kaplan Selected for Alfred I. duPont-Columbia Award and Communication Award of the National Academies of Sciences for *Particle Fever*



David E. Kaplan, Professor, theoretical particle physicist and documentary producer, has been the recipient of three distinct honors this year. He received the 2015 Alfred I. duPont-

Columbia University Award in Journalism as well as the 2015 Communication Award of the National Academies of Sciences, Engineering, and Medicine for his contributions to the production of *Particle Fever*, the feature-length documentary about the identification of the Higgs boson at the Large Hadron Collider near Geneva, Switzerland, in 2012. In addition, Kaplan was named Fellow of the American Physical Society in 2015.

Particle Fever was one of 14 journalistic works to receive the Alfred I. duPont-Columbia University Award in Journalism in 2015 and was selected by the duPont jury from hundreds of entries and evaluated by a board of viewers. Winning documentaries are honored for their storytelling and impact in the public interest. The documentary received critical acclaim for making complex theoretical arguments about particle physics comprehensible. The film was shot over seven years and follows both experimental and theoretical physicists as they approach the announcement from the European Organization for Nuclear Research (CERN), of the confirmed existence of the Higgs boson, also known as the “God particle.”

The 2015 Communication Award of the National Academies of Sciences, Engineering, and Medicine, which is supported by the W.M. Keck Foundation as part of the Keck Futures Initiative, includes a \$20,000 prize and recognizes excellence in communicating science, engineering, and medicine to the general public. *Particle Fever* was selected from 344 entries of works published or aired in 2014 and was evaluated by the National Academies of Sciences communication

awards selection committee. The committee cited the documentary “an engrossing, minute-by-minute diary of the roller-coaster nature of scientific discovery.”

“Our goal was to make a film that allowed people to experience my world through this dramatic time in scientific history,” said Kaplan, “We are honored and very excited to receive these awards.”

Professor Daniel Reich, former chair of the department, credits Kaplan with making a critical event in particle physics accessible to the general public. “His film illustrates the many human stories behind scientific discovery,” Reich said.

“[Particle Fever is] an engrossing, minute-by-minute diary of the roller-coaster nature of scientific discovery.”

—NATIONAL ACADEMIES OF SCIENCES
COMMUNICATION AWARDS SELECTION COMMITTEE

Kaplan’s ability to convey scientific developments to the public, and his ideas about new physics, have been recognized by the American Physical Society (APS), naming him a Fellow in 2015. The citation from the APS for Kaplan’s Fellowship is as follows: “For contributions to models for new physics beyond the Standard Model, collider phenomenology, and dark-matter theory, and for his role as an inventive and effective leader in public outreach.”

Cocoros Receives National Science Foundation Graduate Fellowship for LHC Research



Third-year graduate student **Alice Cocoros** has earned a Graduate Research Fellowship from the National Science Foundation (NSF). The fellowship recognizes outstanding graduate

students who are pursuing research-based master’s and doctoral degrees.

In the past two years, Cocoros has worked with Professor Petar Maksimović and has collaborated with theorists and experimentalists throughout the department for her particle physics research. She has developed a variable that serves as a signal-background discriminant for data collected at the Large Hadron Collider at CERN with the Compact Muon Solenoid experiment. With the NSF fellowship, she will be able to use this variable to look for new heavy particles and supersymmetric particles in the newest data. She also hopes to use new data to look for a particular variety of supersymmetry where the lightest supersymmetric particle decays to electrons and muons that are closely surrounded by quarks and gluons.

In addition to her graduate research, Cocoros is the current chair of the Physics and Astronomy Diversity Group and a member on the Hopkins Diversity Leadership Council. She also participates in hands-on learning events throughout Baltimore with the Physics and Astronomy Graduate Student Outreach Organization.

Kamionkowski Honored With Dannie Heineman Prize for Astrophysics



Professor **Marc Kamionkowski** was named one of two winners of the 2015 Dannie Heineman Prize for Astrophysics, one of the top prizes in the field, awarded by the American Astronomical Society and the American Institute of Physics.

The honor, awarded annually to outstanding mid-career scientists, carries a cash prize of \$10,000 that will be split between Kamionkowski and his corecipient, David Spergel of Princeton University.

The two researchers were honored “for their outstanding contributions to the investigation of the fluctuations of the cosmic microwave background (CMB), which have led to major breakthroughs in our understanding of the universe,” according to the selection committee.

Kamionkowski, a theoretical physicist, specializes in cosmology and particle physics. He studies data collected from telescopes and other instruments to suggest a history of the universe that conforms to the laws of physics. His work has often set the stage for successful experimental research conducted by other scientists.

“Marc Kamionkowski’s ground-breaking theoretical work on cosmic background radiation has helped drive experimental progress in the field, work that has forever changed how we view the universe,” said Fred Dylla, the American Institute of Physics’ executive director and CEO.

“Marc and David have taught us how to read the subtle bumps and swirls in our exquisite image of the early universe to reveal what happened in the moments of creation,” said David J. Helfand, a past president of the American Astronomical Society.

Kamionkowski joined the faculty at Johns Hopkins in 2011. He has received numerous awards for his work, including the E.O. Lawrence Award for Physics in 2006, and he was named a Simons Foundation Investigator in 2014.

Kamionkowski began his work on cosmic background radiation—leftover thermal energy from the Big Bang—in the 1990s, when the leaders of NASA’s Cosmic Background Explorer (COBE), were beginning

“Kamionkowski’s groundbreaking theoretical work on cosmic background radiation has helped drive experimental progress in the field, work that has forever changed how we view the universe.”

—FRED DYLLA, EXECUTIVE DIRECTOR
AMERICAN INSTITUTE OF PHYSICS

to announce results. (Professor **Charles L. Bennett**, was one of those leaders.) “It seemed like a promising area for investigation,” said Kamionkowski. He co-wrote several papers with Spergel proposing a way to determine the spatial geometry of the universe, using temperature maps of the cosmic microwave background.

“I think that our work helped provide the motivation for these experiments,” he said. “By the beginning of the next decade, we were already starting to see measurements like those we had envisioned.”

Later, Kamionkowski studied the polarization of the CMB, again spurring experimentalists to measure this phenomenon. The JHU-built Cosmology Large Angular Scale Surveyor (CLASS) telescope array, is one example. Kamionkowski’s work has advanced the field of precision cosmology, which has helped to provide data on the age, shape, composition, and velocity of the universe. Within the department, Nobel laureate and Thomas J. Barber Professor, **Adam Riess**, discovered that the expansion rate of our universe is speeding up, not slowing down as previously expected. The age of the universe (13.8 billion years), was determined by NASA’s Wilkinson Microwave Anisotropy Probe mission, of which Charles

L. Bennett was the principal investigator.

“One of the goals of my research,” Kamionkowski says, “has been to think of ways we can use the CMB and other cosmological measurements to learn about the very early universe or physical phenomena that might occur in a later universe.” The aforementioned CLASS telescope array will help bring Kamionkowski’s research to life by studying the CMB to determine what happened in the first microsecond of the universe.

Kamionkowski is the third consecutive Heineman Prize winner connected to Johns Hopkins. The 2013 winner, Rachel Somerville, held joint appointments at JHU and the Space Telescope Science Institute. Piero Madau, the 2014 recipient, held appointments at JHU and STScI from 1989 to 1999.

Matthew Earl Establishes Endowment for Assistant Professorship

Matthew A. Earl Ph.D. (JHU Physics B.A. ‘94) and his wife, Diane McBee, have generously created a new endowment to support a future assistant professorship position within the department. The endowment was developed to attract outstanding young scientists to the faculty. Earl is a retired Associate Professor of Medical Physics, at the University of Maryland School of Medicine and a member of the Johns Hopkins Physics and Astronomy Advisory Council. “I’ve been supporting the department since graduate school and my wife, Diane, and I felt that it was time for us to support the faculty,” said Earl. “Previously we endowed a scholarship for Physics and Astronomy undergraduate majors and more recently recognized the importance of faculty research and teaching. We will enjoy meeting the Earl Professor and learning about their work.”

NEWS BRIEFS

Chien Receives IUPAP Magnetism Award and Néel Medal



Chia-Ling Chien, the department's Jacob L. Hain Professor, has received the prestigious 2015 International Union of Pure and Applied Physics Magnetism Award

and Néel Medal from the Commission on Magnetism within the IUPAP.

"I am delighted to receive the award, which should be shared with my students and post-docs over the years," Chien said.

Chien was cited for pioneering discoveries in magnetic materials and nanostructures. The IUPAP Magnetism Award and Néel Medal are awarded every three years to a scientist who has made extraordinary contributions to the field of magnetism. The award is the highest honor bestowed by the IUPAP Commission on Magnetism.

Professor Daniel Reich praised Chien for his unique perspectives on magnetism's challenges.

"He consistently has come up with new ways of approaching difficult problems, and has repeatedly carried out experiments that cut to the heart of the big scientific questions in our field."

—PROFESSOR DANIEL REICH

"Professor Chien has made a host of very important contributions to the field of magnetism over the past three decades," Reich said. "He consistently has come up with new ways of approaching difficult problems, and has repeatedly carried out experiments that cut to the heart of the big scientific questions in our field."

Chien's prolific impact on the field of magnetism can be seen in his more

than 400 published journal articles and over 18,000 citations. He has researched nearly every branch of magnetism, from new exotic magnetic materials to giant magnetoresistance to superconductivity.

The IUPAP Commission on Magnetism was established in 1957 to promote the exchange of information and views among the members of the international scientific community in the field of magnetism. Chien received his award at the 2015 International Conference on Magnetism in Barcelona this past summer.

McCandliss Named Director of the Center for Astrophysical Sciences



Research Professor **Stephan McCandliss** became Director of the Center for Astrophysical Sciences (CAS) on July 1, 2015, replacing Dr. A. Hermann Pfund Professor Timothy Heckman,

who became Chair of the department. CAS leads in research across the entire range of astrophysics, from cosmology to galactic structure to planets, using observational, numerical and theoretical methods.

Since coming to Hopkins 27 years ago, McCandliss has focused on building experimental spectroscopic instruments, flown on sounding rockets, to study far-ultraviolet emissions from the faint gas and dust clouds surrounding comets, planets, stars and galaxies. Those observations have provided the data for eight doctoral theses and a number of follow-on studies from ground-based and space-based observatories. He is currently preparing to launch his 17th sounding rocket mission to search for resonant hydrogen emission escaping from the star-forming galaxy NGC 1365.

Wylezalek Becomes Inaugural Akbari-Mack Postdoctoral Fellow

Postdoctoral Researcher **Dominika Wylezalek** has been

appointed as the inaugural Akbari-Mack Postdoctoral Fellow in Physics and Astronomy. The fellowship is made

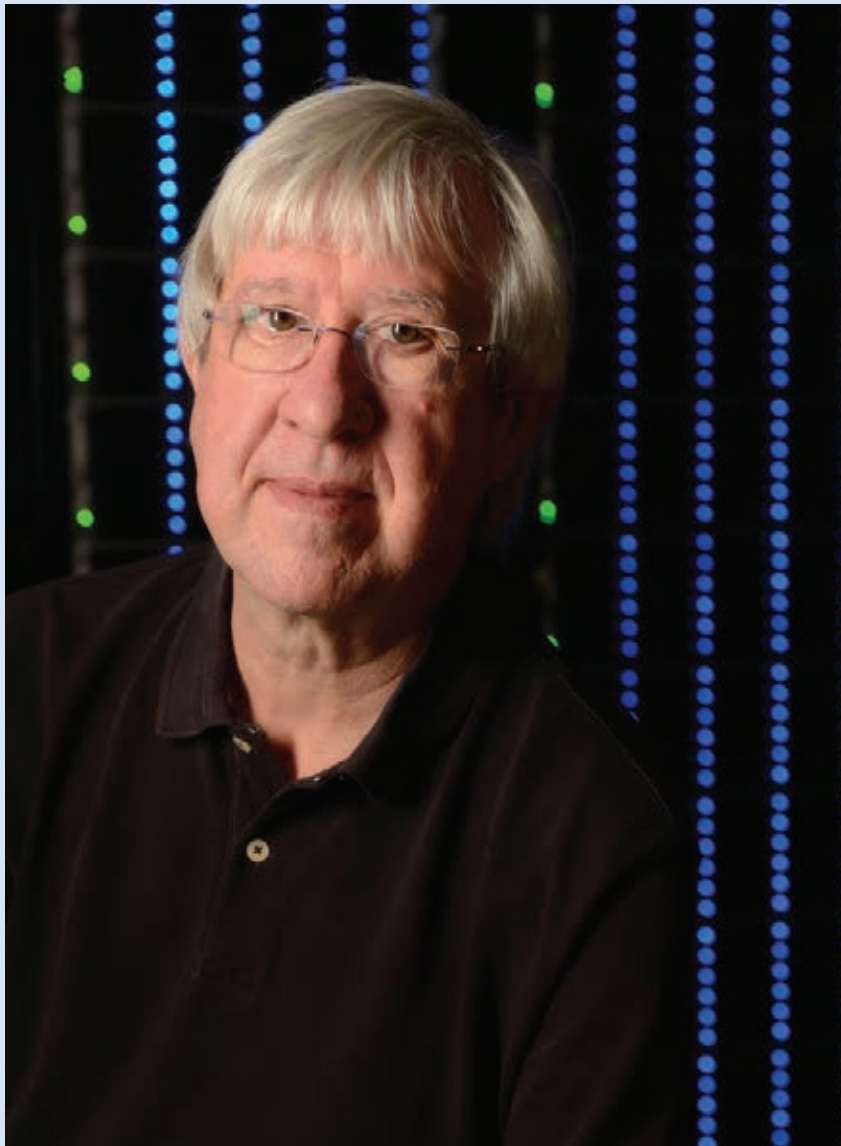
possible by the generous support of Dr. Homaira Akbari and Mr. Roszell Mack. Dr. Akbari is a former postdoctoral researcher in particle physics at JHU and currently chairs the Department's Advisory Council. The Akbari-Mack Postdoctoral Fellowship was created to help advance the careers of outstanding young scientists in the Department.

"I am very honored and grateful to have been awarded with the Akbari-Mack fellowship" said Wylezalek, "[the fellowship] will make a major contribution towards my research on the impact of supermassive black holes on their host galaxies and their role in galaxy evolution."

Wylezalek arrived at Johns Hopkins in October 2014 as a member of Prof. Nadia Zakamska's research group. Wylezalek's current research centers on analyzing observations from the Gemini observatory and the Hubble Space Telescope that will allow her to measure the galaxy-wide impact of actively accreting black holes.

Wylezalek earned her Bachelor of Science degree in Physics from the University of Heidelberg in 2010. From there she moved to the University of Cambridge where she completed a Master of Science degree in 2011. Wylezalek was then awarded an international Max Planck graduate fellowship in Astrophysics and embarked on her Ph.D. studies at the European Southern Observatory near Munich, Germany.

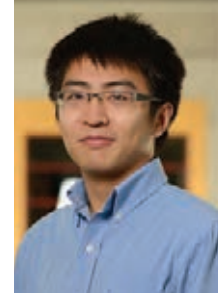




Szalay Named Bloomberg Distinguished Professor; Receives IEEE Computer Society Sidney Fernbach Award

Alexander Szalay, Physics and astronomy faculty member and the founding director of the Institute for Data Intensive Engineering and Science (IDIES), as well as an Alumni Centennial Professor of Astronomy, has been named a Bloomberg Distinguished Professor. In addition, Szalay has been selected as the recipient of the 2015 IEEE Computer Society Sidney Fernbach Award. Szalay was recognized “for his outstanding contributions to the development of data-intensive computing systems and on the application of such systems in many scientific areas including astrophysics, turbulence, and genomics.” Szalay is also a professor in the Department of Computer Science, and he will begin to teach a new course in data science through the Bloomberg Distinguished Professorship. The course will offer a mix of statistics, computer science, and basic sciences that he thinks will become the fundamental language used by the next generation of scientists. “The Bloomberg Distinguished Professorships break down a lot of barriers between different schools,” Szalay says. “The ‘One University’ slogan couldn’t be recognized in a nicer way.”

Dai Awarded NASA Einstein Postdoctoral Fellowship



Liang Dai, a fourth-year graduate student, has been awarded a prestigious NASA Einstein Postdoctoral Fellowship. The purpose of the fellowship is to support postdoctoral

research related to NASA’s Physics of the Cosmos program. Dai was one of roughly 10 awardees out of 148 applicants. Dai studies how observations of the large-scale distribution of mass in the Universe can help shed light on the physical phenomena that occurred at the birth of the Universe. Dai will begin his fellowship at the Institute for Advanced Study in Princeton in Fall 2015 after completing his Hopkins Ph.D., under the supervision of Prof. Marc Kamionkowski.

Sarica Named 2015 Gardner Fellow

Third-year graduate student **Ulascan**

Sarica is the recipient of the 2015 William Gardner fellowship.

Sarica will be supported by the fellowship to further his research on the properties of the recently discovered Higgs boson, such as its quantum numbers and lifetime, using the upgraded experiment with the Compact Muon Solenoid detector at the Large Hadron Collider at CERN.

Sarica is the seventh Gardner fellow. The fellowship was founded by William Gardner (JHU Physics Ph.D. ‘68), who received his Ph.D. in physics under Professor Warren Moos and had a successful career in fiber optics and telecommunications at Bell Laboratories. Gardner now generously provides support for one of the department’s highest priorities—enabling graduate students to dive into research from the start.



NEWS BRIEFS

CLASS Telescope Designed to Explore Origins of Universe Moving Toward 'First Light'

Pieces of the Cosmology Large Angular Scale Surveyor telescope (CLASS), built at Johns Hopkins by professors, post-doctoral researchers, and students working at Bloomberg Center, were sent by sea, highway, and dirt road, on a six-week trek to the Atacama Desert in northern Chile. Members of JHU's CLASS team will ultimately reassemble the telescope, which will stand 24 feet tall at an elevation of about 17,000 feet.

CLASS is designed to detect subtle patterns in the cosmic microwave background (CMB) a relic thermal energy of the hot infant universe more than 13.8 billion years old. The CLASS project will examine 70% of the sky—the most yet for a ground-based CMB instrument—for evidence of a polarization pattern in the CMB. That evidence would test the prevailing hypothesis about how the

universe expanded. If "inflation" advocates are correct, quantum fluctuations created gravitational waves that left a fingerprint on the CMB. That fingerprint would be a polarization pattern imprinted on the CMB (see **Marc Kamionkowski** article on page 7).

Alumni Centennial Professor of Physics and Astronomy and a Johns Hopkins University Gilman Scholar, **Charles L. Bennett**, is the project co-leader.

"It's going to be great to work our way toward first light," said Bennett, referring to the first telescope observations from Chile that are expected to be made this winter. "It's very exciting after 12 years" from the earliest discussions of the CLASS concept, he said.

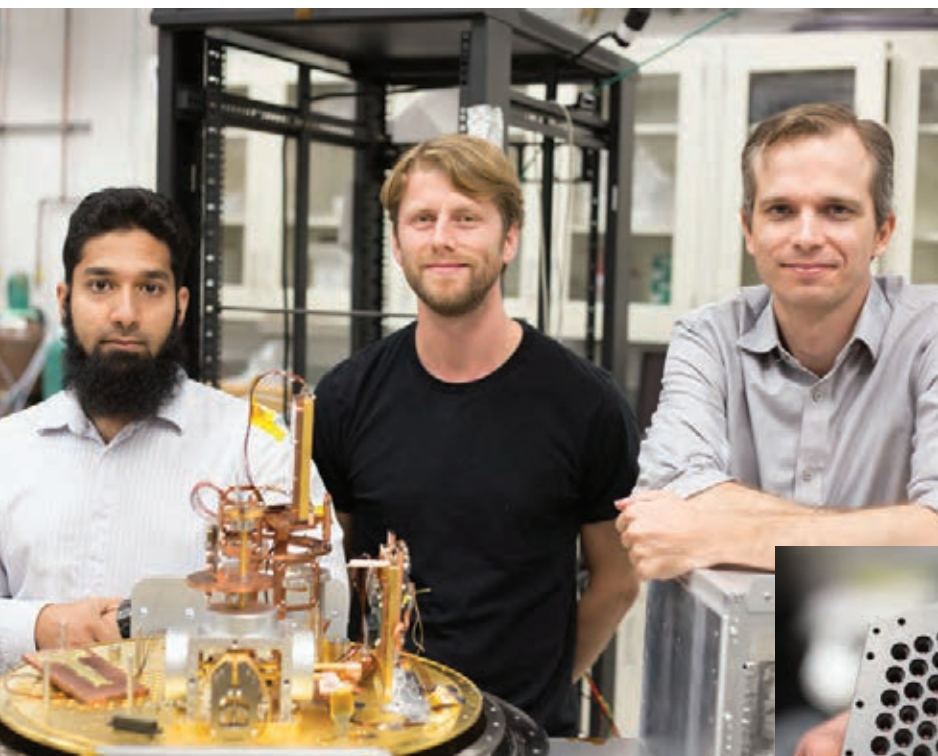
"We're all excited that everything is coming together," added Assistant Professor **Tobias Marriage**, who is co-leading the CLASS project alongside Bennett.



Above: The CLASS telescope array is packed in storage containers for shipment.



Left: The CLASS shipping route from Baltimore to Iquique, Chile, on the way to 17,000 feet altitude in the Atacama Desert.

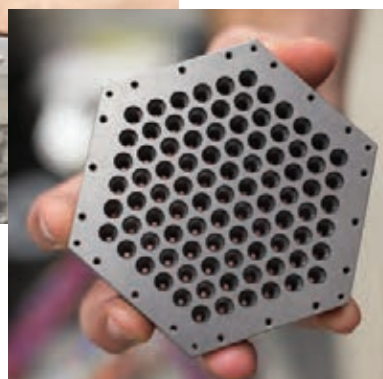


Above: Graduate student, Aamir Ali, Assistant Research Scientist Thomas Essinger-Hileman, and Assistant Professor Tobias Marriage

Marriage, Essinger-Hileman, and Ali Receive Research Seed Funding from Matthew Polk

Assistant Professor **Tobias Marriage**, Assistant Research Scientist **Thomas Essinger-Hileman**, and graduate student **Aamir Ali** have been selected to receive funding generously gifted by Matthew Polk. Mr. Polk (JHU Physics B.A. '71), is the former Chairman and Co-founder of Polk Audio, Inc. and member of the Johns Hopkins Physics and Astronomy Advisory Council. Polk's goal for the gift was to support a project within the department that was in its infancy and showed promise for paradigm-shifting technological innovation. The trio is using the funding to develop space-science

applications of a novel aluminum-silicon alloy (inset). Supported by Polk's gift, Ali has gained valuable research experience by making cryogenic measurements of the alloy's mechanical, thermal and superconducting properties critical to space-science applications.



Bennett Honored with 2015 Tomassoni Chisesi Prize



Charles L. Bennett, the Alumni Centennial Professor of Physics and Astronomy and a Johns Hopkins Gilman Scholar received the 2015 Caterina Tomassoni and Felice Pietro

Chisesi Prize in June at the University of Roma “La Sapienza” in Italy.

The Tomassoni Chisesi Prize committee awarded Bennett the Prize for “leadership in two experiments on the Cosmic Microwave Background (CMB) that literally changed our view of the universe: Cosmic Background Explorer (COBE), leading to the discovery of primordial spatial fluctuations in the CMB, and Wilkinson Microwave Anisotropy Probe (WMAP), leading to precise measurements of the cosmological parameters and establishing the de facto Standard Cosmological Model” (mentioned in **Marc Kamionkowski** article on page 7).

The Prize, in honor of the memory of Caterina Tomassoni and Felice Pietro Chisesi, recognizes and encourages outstanding achievements in physics. The award consists of 50,000 Euros, an allowance for travel to the award ceremony, and a special “Schola Physica Romana” medal.

“It is hard to overstate the degree to which the cosmic microwave background satellites have clarified our understanding of the universe,” said Nobel-Prize recipient Professor Adam Riess, “the recognition of this work is well deserved.”

Bennett’s experimental research on the CMB has endured for 30 years. The CMB is the afterglow from the hot infant universe, which has been traveling across the universe for 13.8 billion years. Bennett’s leadership and participation in the creation of experimental instruments and telescopes has helped to better understand the origin and evolution of the universe through observational studies of the CMB. His work led to what is called the Standard Cosmological Model. With

Tobias Marriage, Johns Hopkins Assistant Professor of physics and astronomy, Bennett is currently building the Cosmology Large Angular Scale Surveyor (see article on preceding page), a telescope array designed to study the first trillionth of a trillionth of a second of the history of the Universe.

“I have had the unusual privilege of working with two fantastic space mission science teams during my career. I learned so much from these superb scientists. It was a pleasure to work with them. I am grateful to them and to the Prize selection committee,” said Bennett.

“For leadership in two experiments on the Cosmic Microwave Background (CMB) that literally changed our view of the universe: Cosmic Background Explorer, leading to the discovery of primordial spatial fluctuations in the CMB, and Wilkinson Microwave Anisotropy Probe, leading to precise measurements of the cosmological parameters and establishing the de facto Standard Cosmological Model”

— TOMASSONI CHISESI PRIZE COMMITTEE

Bennett is the recipient of several notable awards and honors throughout his career. Those honors include the 2013 Jansky Prize, the 2012 Gruber Cosmology Prize, the 2010 Shaw Prize in Astronomy, the 2009 Comstock Prize in Physics, the 2006 Harvey Prize, and the 2005 Draper medal. He has twice received the NASA Exceptional Scientific Achievement Medal and also received the NASA Outstanding Leadership Medal for WMAP.

Kaplan Selected for National Science Foundation CAREER Award



Assistant Professor **Jared Kaplan** has received a CAREER Award from the National Science Foundation. The award helps to fund Kaplan’s research in Conformal Field Theory (CFT):

quantum theories that combine special relativity with scale invariance or invariance under the uniform stretching of space and time. The research funded by this award will use foundational principles to study CFT and apply these discoveries to phenomenology, quantum gravity, and black hole physics.

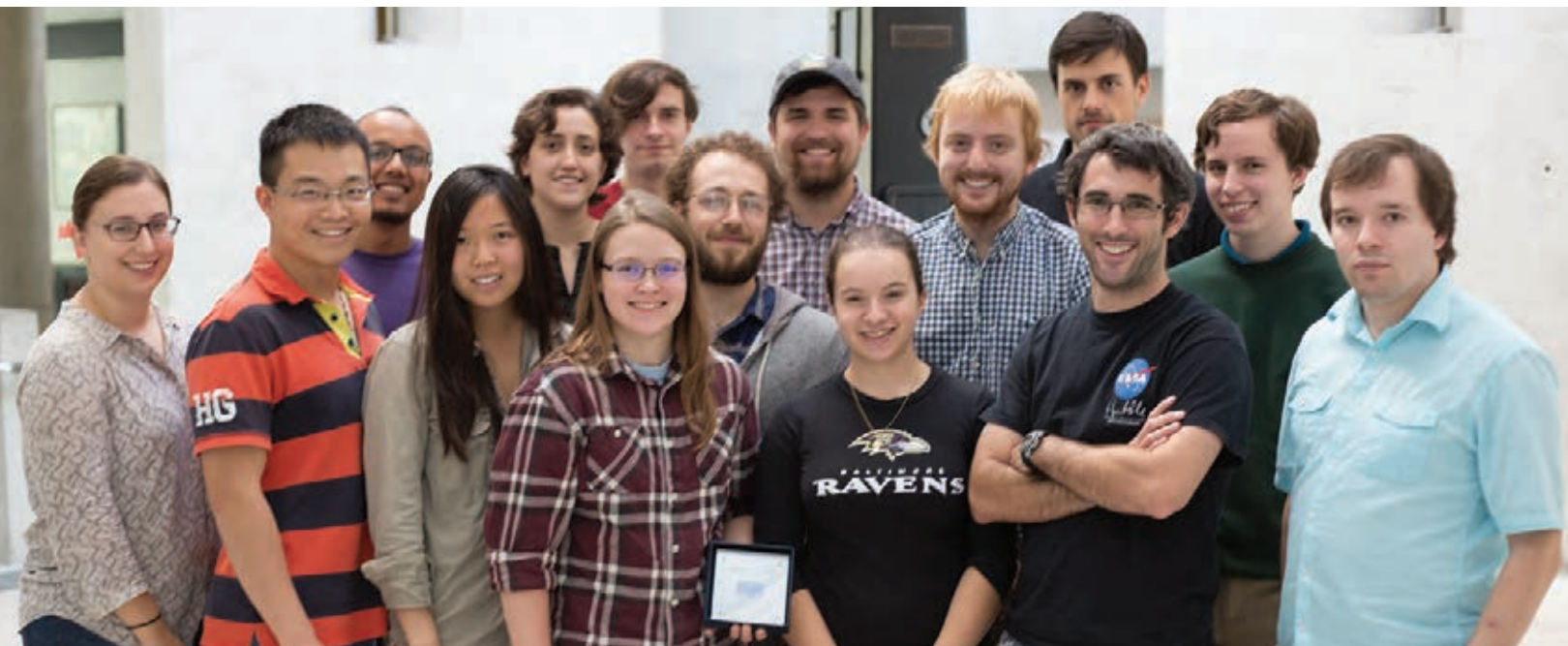
Fuhrman Named 2015-2016 ARCS Scholar



Fourth-year graduate student **Wesley Fuhrman** received a 2015-2016 Achievement Rewards for College Scientists (ARCS) Scholarship for research in novel quantum phenomena

and materials that combines experimental techniques such as neutron scattering with theoretical methods to unveil the underlying structure responsible for surface quantum states in order to discover and control their unique properties. The ARCS Foundation advances science and technology in the United States by providing financial awards to academically outstanding U.S. citizens studying to complete degrees in science, engineering and medical research.

NEWS BRIEFS



PAGS Outreach Organization Receives Prize for Their Participation in “Ode to Hubble”

The JHU Physics and Astronomy Graduate Student Outreach Organization received a piece of the original Hubble Space Telescope solar array for their participation in the European Space Agency/Hubble “Ode to Hubble” competition. Their entry was a music video parody of the 80s song “Take on Me” titled “HST,” showing their appreciation for the Hubble Space Telescope. It featured many members of the Physics and Astronomy Department and of the Space Telescope Science Institute. The outreach group plans to show off the solar array section during events to bring a little piece of space science to Baltimore City students.

Above, from left to right: Rachael Alexandroff, Zhilei Xu, Sumit Dahal, Caroline Huang, Alexandra Greenbaum, Katie Harrington (Front), Kirill Tchernyshyov (Back), Duncan Watts, Derek Brehm, Alice Cocoros, Raymond Simons, Julian Munoz Bermejo, Jonathan Aguilar, Ian Lowry, and Jake Mokris



Remembering Stephen Murray

Our friend and colleague, Steve Murray passed away on August 10 of this year. Prior to joining JHU as a Research Professor, he held an appointment for many years at the Harvard Smithsonian Center for Astrophysics. Prof. Murray was a major figure in the world of high energy astrophysics, serving as the Principal Investigator of the High Resolution Camera on NASA’s Chandra X-Ray Observatory. He is also very well known for his role as Principal Investigator for the NASA Astrophysics Data System, which has transformed the way we do astrophysics research. At JHU, Steve was a valued source of fresh ideas and far-sighted vision who (among other things) helped launch a new undergraduate course in space studies. Even more, he was a true gentleman, and his passing is a great loss.

Hal Weaver is the Project Scientist for the New Horizons Mission to Pluto

The New Horizons flyby of Pluto was arguably the biggest science story of 2015, and Hal Weaver (JHU Physics Ph.D. '82) has been a leader in the mission since it secured funding from NASA. Weaver, who is a member of the Principal Professional Staff at the JHU Applied Physics Laboratory, and is also a Research Professor in the JHU Department of Physics and Astronomy, is the Project Scientist for the New Horizons mission. He is a Co-Investigator on the science team and, as Project Scientist, is their prime interface with the mission's engineers. "The data we



Hal Weaver

got from the flyby was spectacular; it really went beyond all of our expectations," says Weaver. "We didn't really know what to expect because this is a mission for which you can't say 'been there, done that' for."

Scientists have been thrilled by the amazing

diversity of terrain on both Pluto and its largest moon, Charon. On Pluto they have discovered water ice mountain ranges as high as the Rockies in the USA, evidence for glacier-like flow of a sheet of exotic ices comprised of molecular nitrogen, methane, and carbon monoxide, and an atmosphere sporting photochemical haze layers. Charon has chasms larger than the Grand Canyon, tectonic structures, and a polar hood that might be comprised of material siphoned from Pluto's surface. Nix and Hydra, two of Pluto's four small satellites, have finally been resolved for the first time and are smaller, brighter, and rotating faster than anticipated.

The data collected by New Horizons has unobscured mankind's portrait of the solar system. "We had never flown by a Kuiper belt object before," Weaver explains. "It's a new category of object in the solar system, and this was the initial reconnaissance." Flyby data have been streaming back to Earth since the spacecraft's closest encounter with Pluto and the data will continue to download until November 2016. Beyond the images and data collected about Pluto and its moons, Weaver hopes to continue the exploration of the farthest stretches of the solar system by conducting flybys of two additional Kuiper belt objects by 2020. Weaver is currently working with NASA to develop a second phase of the New Horizons mission that would allow the spacecraft to reach those targets.

Weaver describes his position of Project Scientist on New Horizons as, "the person who understands the 'spirit' of the scientific objectives that the team is trying to accomplish, and who also has enough of an understanding of the technical aspects to successfully communicate with the engineering team." Weaver mastered that balancing act from the start of the mission. There was the issue of securing hard-to-attain nuclear fuel for the spacecraft—the team ended up using spare Plutonium-238

from NASA's Cassini mission. Making a January 2006 launch window was also critical. "Had we missed that launch window, the Pluto flyby would have been delayed by at least 3.5 years," says Weaver, "the gravity assist we got from Jupiter gave us a 20 percent speed boost." Even until just days before the Pluto flyby, Weaver and his team were observing the space ahead of the probe and were prepared to shift its trajectory to minimize the chances of striking dust and debris. "When traveling at 32,000 miles an hour, even hitting a piece of dust the size of a grain of rice can blow a hole in the spacecraft," says Weaver.

Prior to the launch of the New Horizons probe and during the cruise to Pluto, Weaver and his colleagues used the Hubble Space Telescope to scour the Pluto system for potential collision hazards. During the summer of 2005, Weaver led a team that discovered Pluto's moons Nix and Hydra, which are approximately 5000 times fainter than Pluto. In 2011 and 2012, Weaver was again part of a team that uncovered even smaller satellites of Pluto: Kerberos and Styx. Because these moons are so small and have such low gravity, they are "debris generators" when struck by meteoroids traveling through the Kuiper belt. The carefully selected path of the spacecraft as it flew past Pluto ultimately turned out to be safe, and the spacecraft emerged completely healthy on the other side of Pluto.

Weaver earned his Ph.D. in physics from the JHU Physics & Astronomy Department working with Professor Paul D. Feldman as his thesis advisor.



New Collaborative Learning Space Opens at Bloomberg Center

Formerly a reading room, Bloomberg Center room 464 has undergone a complete transformation. Thanks to the generosity of Matthew R. Witten (JHU Physics B.A.'95), the room has been completely renovated and reconfigured to encourage collaborative problem solving. The sun-filled room is now an

ideal atmosphere for discussion sessions and study groups. Witten is co-founder of a radiation therapy solutions firm called Witten Clancy Partners and an adjunct associate professor of physics at Hofstra University in New York. He also serves on the Johns Hopkins Physics and Astronomy Advisory Council.

