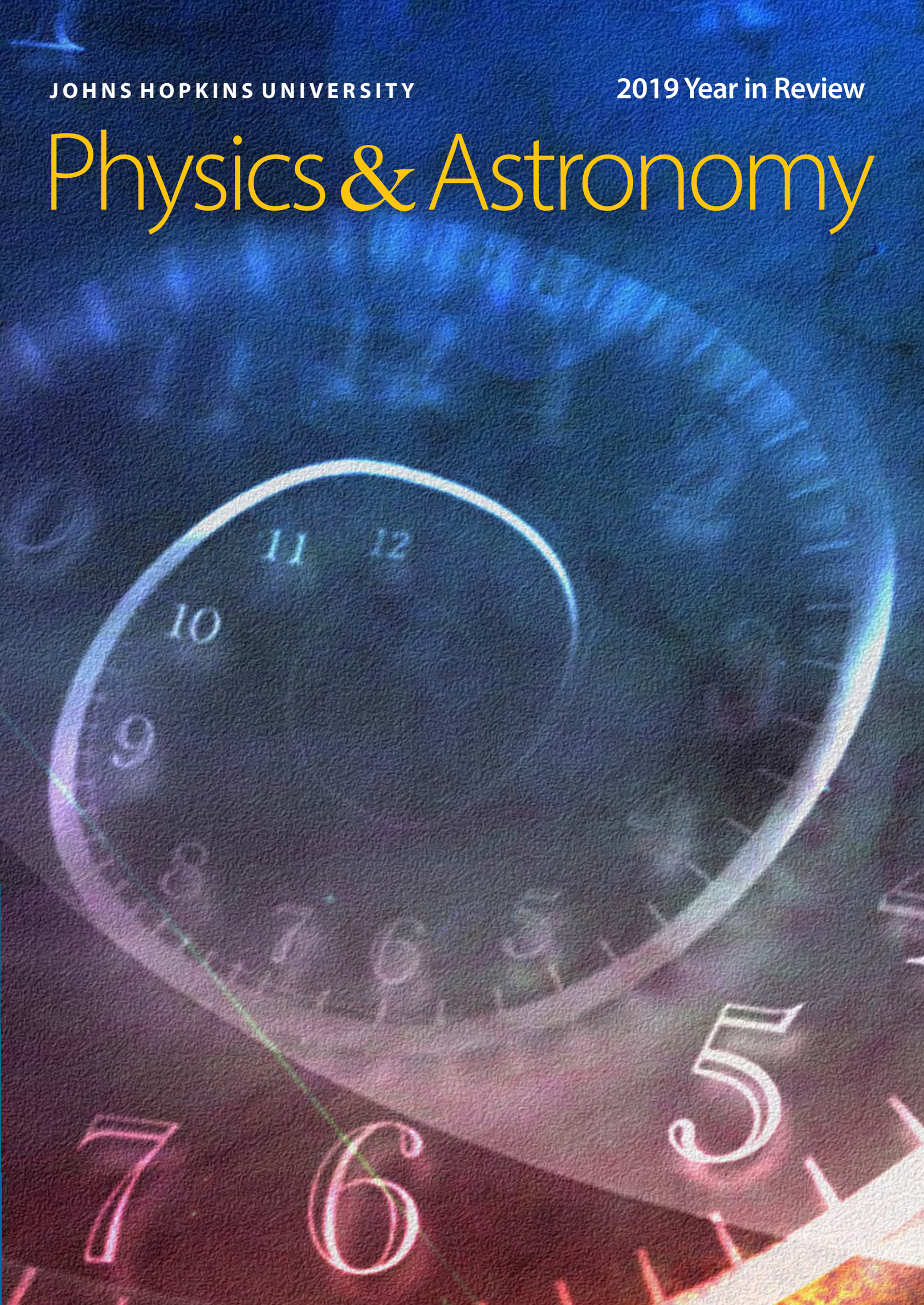
JOHNS HOPKINS UNIVERSITY

2019 Year in Review

Physics & Astronomy



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Front cover: Artist depiction of the universe expanding over time. Six members of the department weigh in on the subject of universe expansion in "Minding the Gap: Hopkins Physicists are at the Heart of a Cosmic Puzzle" on page 2.
Credit: Rolff Images

Letter from the Chair

Dear alumni, colleagues, and friends,

Another banner year has passed for our department, and I hope you will share in my excitement and pride as you read this newsletter. Our department continues to grow and thrive, with many accomplishments along the way by our faculty, science staff, students, and alumni.

First of all, please join me in welcoming two new faculty members. Both are part of a plan to expand our research in particle physics into a new area in which experiments that probe the most fundamental laws of physics are probed in university labs (complementing giant particle accelerators like the LHC). This approach is made possible by using novel new technology developed as part of the quantum revolution. Surjeet Rajendran, recruited from Berkeley, has pioneered several such new approaches with wide-ranging applications. Danielle Speller, who will join us this summer from Yale, will be building a major new laboratory in our building to search for a particular kind of dark matter called axions. With an additional recruitment effort underway in this area, we are in the midst of positioning our department for success for years to come in an exciting and rapidly developing new area of physics.

Our faculty, students, and alumni continue to be honored with major awards. You will learn more about these throughout the newsletter. Here are a few highlights:

* Among our faculty, Joe Silk was awarded the 2019 Gruber Prize in Cosmology, Marc Kamionkowski was elected to the National Academy of Sciences, Emanuele Berti was named a Fellow and President of the International Society of General Relativity and Gravitation, Colin Norman was elected as a Fellow of the American Association for the Advancement of Science, Andrei Gritsan, Michael Falk (joint with Materials Science and Engineering), and Oleg Tchernyshyov were elected as Fellows of the American Physical Society, and Associate Professor Brice Ménard received the President's Frontier Award.

* Among our undergraduate students, David Carcamo, Ross Dempsey, Wenzer Qin, and Katherine Xiang earned first place in the 2019 International Theoretical Physics Olympiad for Undergraduates, and Ross Dempsey and Wenzer Qin received the Donald E. Kerr Memorial Award. Graduate student Melissa Diamond is the 2019 Gardner Fellow, Kirsten Hall was selected to participate in the 69th Lindau Nobel Laureate Meeting, and Liza Sazonova received the 2019 EJ Rhee Teaching Award.

* Among our alumni, C. Megan (Meg) Urry was elected as a member of the JHU Society of Scholars, Liang Wu received the McMillan Prize in 2019 for his research in condensed matter physics, Nhan Tran received an Early Career Research Award from the U.S. Department of Energy, Ulascan Sarica received the Springer Award for an outstanding Ph. D. thesis, and Tarini Konchady was appointed the new Media Fellow of the American Astronomical Society.

We have had some amazing breakthroughs in research in the department this year. Several are featured in articles in the newsletter, but I wanted to share a few more here.

* CBS News aired an interview with the Director of the Institute for Data Intensive Engineering and Science, our own Alex Szalay, discussing his research collaboration on pancreatic cancer. This provides a dramatic example of the ways in which the methods developed for Big Data for astrophysics can have very unexpected applications.

* In a segment titled "Telescope In Chile's Mountains Looks For Signals To Explain How The Universe Began," NPR Science Journalist Joe Palca interviewed Associate Professor Toby Marriage and others to share the science behind the Cosmology Large Angular Scale Surveyor (CLASS) project.

* Principal Research Scientist Johannes Staguhn's team used a new instrument they designed and built, called the Goddard-IRAM Superconducting 2-Millimeter Observer, or GISMO, to reveal one of the largest concentrations of gas and newly-formed stars, located in the inner part of our Milky Way galaxy.

* Postdoctoral Fellow Tommi Tenkanen published a paper as an editor's suggestion in Physical Review Letters that provides a new explanation for dark matter and explains how it may have been produced during the inflationary epoch.

We have also had some sad news this year. Professor Emeritus Yung-kuen Lee, a long-time distinguished member of our faculty, passed away. We also lost Dick Zdanis, who was not only a Hopkins alum, but also served as a faculty member in our department and as an accomplished member of the JHU administration. We will sorely miss them both, and salute their careers and lives.

Finally, I want to extend my gratitude to two our alumni in particular for their dedication and hard work in service to the department. David Kupperman (as Chair) and Noor Islam (as Vice Chair) are enthusiastically working to continue to strengthen our departmental Advisory Council. I also want thank all of you for your continuing interest in, and support of, our mission of pushing back the frontiers in research and of educating and training leaders of tomorrow in science and technology. I am looking forward to working with you and sharing our accomplishments in the coming year.

Best,

Timothy Heckman

Dr. A. Hermann Pfund Professor

Artist depiction of a type 1a supernova in deep space

Credit: Paul Paladin

MINDING THE GAP: HOPKINS PHYSICISTS ARE AT THE HEART OF A COSMIC PUZZLE

BY ANNIE PRUD'HOMME-GÉNÉREUX

The gap is small. One group of researchers pegs the value of the Hubble Constant at 68, and another, 74.* Considering the scale of what it measures – the expansion rate of the Universe – the difference is astonishingly small. Yet, to researchers at Hopkins, it's a chasm of cosmic proportions.

To explain what is happening, Bloomberg Distinguished Professor and Nobel Laureate Adam Riess uses an analogy. "Imagine that you measure the height of a two-year-old and predict how tall he will be using a growth chart. Years later, you wouldn't be surprised if that man was a couple of inches taller or shorter. But, if he was a full two feet taller, you would say "Whoa!" and you would question the accuracy of that growth chart."

That's sort of what is happening in cosmology.

A century ago, Edwin Hubble discovered that galaxies farther from us are receding faster than those that are nearer. It was as though the Universe is swelling up like a loaf of bread in an oven. Generations of researchers embarked on a quest to determine its expansion rate. This value, called the Hubble Constant, matters. It is closely related to the age, size, composition, shape, and fate of the Universe with the context of General Relativity (GR).

"We are in the midst of solving a puzzle. We don't know everything, but we know there is something wrong. And when something's wrong, it's a time to learn something new."

—Bloomberg Distinguished Professor Chuck Bennett

Leading the WMAP satellite mission, Bloomberg Distinguished Professor Chuck Bennett collected precise measurements of the early Universe shortly after the Big Bang. His team then applied the known laws of physics (GR) to predict what the Universe should look like today. The result was the Standard Model of Cosmology, which quantifies many parameters of our Universe, including the "growth chart." Bennett emphasizes that, "the Model works really, really well. I mean, not just a little well; Extraordinarily well."

Bennett's team inferred a value for the Hubble Constant. Given the Standard Model's success, everyone expected that it would line up with observations of the current Universe.

Except, it doesn't. Not exactly.

While Bennett's team toiled away, Riess's team used the Hubble Space Telescope to measure the Hubble Constant directly. Building on the approach pioneered by Hubble himself, Riess measured the distance to objects in our cosmic neighborhood and the speed at which they recede from us. Type 1a supernovae, exploding stars 10 billion times brighter than our Sun, enabled his team to extend observations farther into space than ever before. Riess's methods also removed previous uncertainties and achieved unparalleled precision.

And that's when the "Hubble Tension" first appeared.

At first, Riess's and Bennett's findings were only somewhat at odds. The researchers assumed that, as the methods improved, the results would align, and the discrepancy would go away.

Graeme Addison, an Assistant Research

** The Hubble Constant is the fractional rate of expansion of the Universe measured in kilometers per second per megaparsec. Since a megaparsec is $3x10^{19}$ kilometers, the unit is simply inverse seconds*

Scientist at Johns Hopkins, completed a re-analysis of the WMAP data with the latest of other cosmic probes and arrived at the figure 68.34±0.61. Meanwhile, Riess's increasingly refined measurements clocked it at 73.5 ±1.4. The Hubble Tension became the "Hubble Crisis."

Then came the European Space Agency's Planck satellite measurements of the early Universe that were independent of the WMAP data. It pegged the Hubble Constant at 67.4±0.5, compatible with WMAP but far from Riess.

Bennett points out that "there's another technique that came up recently using strong gravitational lensing, by a team called H0Li-COW. They get almost exactly the same answer and precision as Riess but do it using an entirely different technique."

Meanwhile, Graeme Addison calculated a value for the Hubble Constant that aligns with WMAP and Planck results using an entirely independent methodology that uses no data from either of these space missions.

So, what does that mean? There are two possibilities. The first is that there is an underestimated measurement error.

"Half of the professionals in the field say 'Oh, it's just an error in measurement,'" says Bennett. "What they are missing is that there are multiple measurements and you can ignore any one of them and still have the problem. That's why we don't believe it's a measurement error."

That leaves the second, more tantalizing possibility to explain the Hubble Tension.

"When you line up the results of different teams and sort them out by which answer they give," explains Bennett, "it cleanly divides between early Universe measurements and late Universe measurements. This splits up by physics, not by technique. There is a physics effect going on."

Riess agrees. "We are starting at opposite ends of the Universe's history using our understanding of the Universe to connect those ends. If we consistently get a different answer, then maybe our understanding is missing something."

If that's the case, is it our understanding of the current Universe or the early Universe that's in need of a tune-up?

"The feeling in the field is that it's quite hard to do anything with evolution in the late Universe," says Addison. "So, there is a lot of interest in changing the properties of the early Universe."

William R. Kenan, Jr. Professor Marc Kamionkowski and his team proposed a model that adds something to the early Universe. "We call it early dark energy," says Kamionkowski. In the Standard Model, there are two episodes of rapid expansion. One is observed today and results from a sort of anti-gravity called dark energy. The other takes place at the very beginning of the Universe during a period of cosmic "inflation." Kamionkowski proposes that there is a third period of accelerated expansion. He explains that "early dark energy behaved much like dark energy behaves in the Universe today, but it operated at earlier times and with much more energy than today."

"We are starting at opposite ends of the Universe's history using our understanding of the Universe to connect those ends. If we consistently get a different answer, then maybe our understanding is missing something."

—Bloomberg Distinguished Professor and Nobel Laureate, Adam Riess

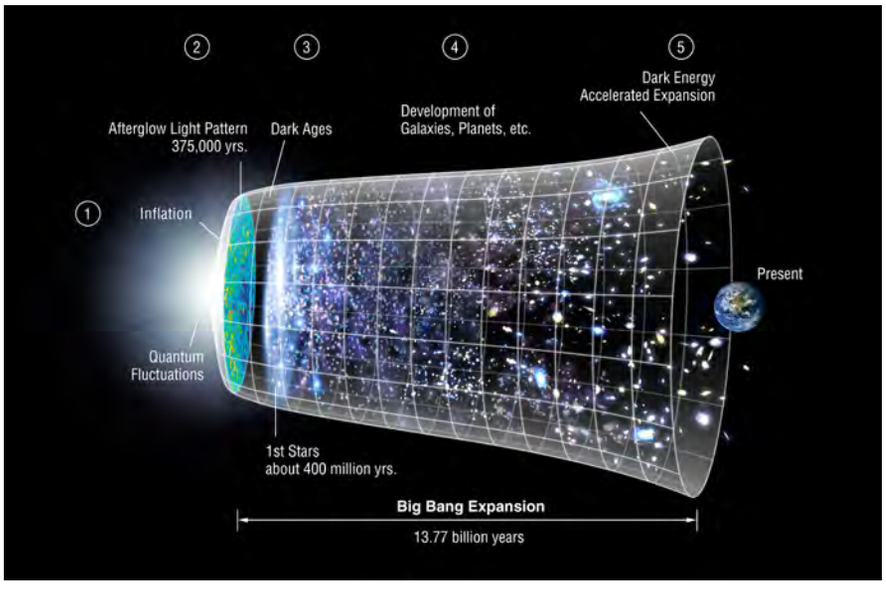
"A lot of colleagues at other institutions rechecked our calculations and built upon them," says Kamionkowski. "There is now close to 100 papers based on this model." While the model has garnered much enthusiasm, it isn't perfect. It doesn't completely bridge the discrepancy, leaving theorists scratching their heads.

What could cause this early dark energy to appear, exert its effect, and then disappear? Professor David Kaplan, a particle theorist who explores the basic laws of nature, proposed an underlying mechanism. Much like water freezes to form ice, Kaplan theorizes that at some point in the early Universe, dark energy underwent a phase transition that altered its properties. This would allow it to vary in strength at a moment in time.

"We are in the midst of solving a puzzle," says Bennett. "We don't know everything, but we know there is something wrong. And when something's wrong, it's a time to learn something new."

Theoretical physicist Surjeet Rajendran, an Associate Professor who recently joined the Hopkins physics faculty was drawn to this puzzle. "Over the last few years, the experimental community is more convinced that there is a crisis. If experimentalists take it seriously, that's the reason for me to think about it." When asked what he thinks is going on, he admits: "It's embarrassing to say that I have no idea." And that's precisely why he's interested. "It is a great puzzle. Some part of our world is not obeying our expectations of it. For a theorist, that's a great thing to work on!"

"The way discoveries are made are not these eureka moments," reflects Kaplan. "It's an evolution of thought - when things are going so well and all of the sudden there is a fly in the ointment. And this has some of the feelings of one of those things that is annoying, something funny..."



Standard Model of Cosmology
Credit: NASA WMAP Science Team

NEWS BRIEFS

Surjeet Rajendran Joins Faculty

Surjeet Rajendran's research interests span both theory and experiment. He has invented novel experimental techniques, many of them currently under development, to search for gravitational waves and a variety of dark matter candidates. On the theoretical side, he conceived of new cosmological mechanisms to solve the hierarchy and cosmological constant problems. Rajendran did his undergraduate work in mathematics at Caltech, and graduated with a Ph. D. in Physics from Stanford. Following postdoctoral stints at MIT, Johns Hopkins, and Stanford, he served as the Henry Shenker Assistant Professor of Physics at UC Berkeley.

Danielle Speller Joins Faculty

Danielle Speller is a researcher in experimental nuclear and astroparticle physics. Her work centers on understanding the nature of matter and mass through low-energy, cryogenic searches for physics beyond the standard model. Professor Speller is a collaborator on both the Cryogenic Underground Observatory for Rare Events (CUORE) and the Haloscope at Yale Sensitive to Axion Cold dark matter (HAYSTAC), as well as related R&D projects. Her graduate work was with the Super Cryogenic Dark Matter Search experiment (SuperCDMS).

Professor Speller was a Park Scholar at North Carolina State University in Raleigh, North Carolina, and graduated with a double-major in physics and applied mathematics. She earned her Ph.D. from the University of California, Berkeley, and joined the Maruyama Lab at Yale University's Wright Laboratory in 2017 as a Postdoctoral Associate. She will join the Physics Department in July 2020 as an Assistant Professor of Physics.

Brice Ménard Receives President's Frontier Award, Gives the Hans Jensen Lecture at University of Heidelberg

Associate Professor **Brice Ménard** received the $250,000 President's Frontier Award to support his exploration of new ways to analyze astronomical data. He said it was unexpected to see university President Ronald J. Daniels, Provost Sunil Kumar, Krieger School of Arts and Sciences Dean Beverly Wendland, and other colleagues walk into the classroom where he was teaching to surprise him with the news in February 2019.

Associate Professor Brice Ménard is surprised mid-lecture by Preident Ronald J Daniels, Provost Sunil Kumar, Vice Provost Denis, Wirtz, and Beverly Wendland is James B. Knapp Dean of the Krieger School of Arts and Sciences
Credit: Will Kirk

"What is most striking about Brice's contributions is the unique insight he has been able to gain working with astronomical data sets that were widely available to others," said Dr. Beverly Wendland, James B. Knapp Dean of the Krieger School. "He used his imagination and expertise to conceive of new and potentially far-reaching applications of these data in novel ways that has often led to new and important results."

The President's Frontier Award was established with a $1.25 million donation from trustee Louis J. Forster, '83 and Kathleen M. Pike, '83. Forster and Pike helped design the award with the goal of supporting exceptional scholars among the Johns Hopkins faculty who are on the cusp of transforming their fields. The award will recognize one person each year for five years with $250,000 in funding for their work.

Ménard also gave the Hans Jensen Lecture at the University of Heidelberg as part of the doctoral program's biannual "Heidelberg Physics Graduate Days." The lecture is named for Hans Jensen, who shared the 1963 Nobel Prize for the nuclear shell model and is intended to honor speakers who have made fundamental contributions to a research area in modern physics. Ménard presented his talk in October, and it was titled "The Complexity Frontier."

Joe Silk Awarded the 2019 Gruber Prize in Cosmology

Homewood Professor Joe Silk was awarded the 2019 Gruber Prize in Cosmology, along with Nick Kaiser. The citation reads: "Through different but complementary approaches to the same problems in cosmology, Nicholas Kaiser and Joseph Silk provided the theoretical basis and new methodologies for making and interpreting many of the observations that have redefined our understanding of the universe on the smallest and largest scales." Silk joins department members Adam Riess and Chuck Bennett as recipients of the prestigious honor.

Emanuele Berti Named Fellow and President of International Society of General Relativity and Gravitation

In July, at the annual meeting of the International Society of General Relativity and Gravitation (ISGRG), Professor Emanuele Berti was named an ISGRG Fellow, and was also voted as the new President-Elect of the society. He will rotate in as President in three years. Prof. Berti joins many prominent researchers who have been officers or committee members of the ISGRG in the past. Berti's research centers on black holes and gravitational waves.

Colin Norman Becomes an American Association for the Advancement of Science Fellow

Prof. Colin Norman has been elected as a Fellow of the American Association for the Advancement of Science. This is lifetime distinction in honor of his invaluable contributions to science and technology.

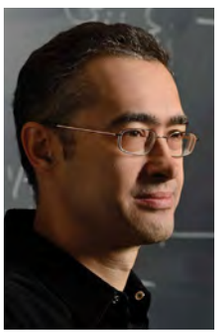
Fellows are elected each year by their peers serving on the Council of AAAS, the organization's member-run governing body. The tradition of electing AAAS Fellows began in 1874. Since then, the recognition has gone to thousands of distinguished scientists, such as astronomer Maria Mitchell, elected in 1875, inventor Thomas Edison (1878), anthropologist Margaret Mead (1934), computer scientist Grace Hopper (1963) and popular science author Jared Diamond (2000).

American Physical Society Elects Andrei Gritsan, Michael Falk & Oleg Tchernyshyov as Fellows

Professors Andrei Gritsan, Michael Falk (joint with Materials Science and Engineering), and Oleg Tchernyshyov have been elected as Fellows of the American Physical Society. No more than ½% of APS members can be elected as Fellows in any year, so this is indeed a great honor. The citations are as follows:

Andrei Gritsan
"For significant contributions to the discovery and to the characterization of the Higgs Boson at the CERN Large Hadron Collider, and for significant contributions to the measurement of sin2α at the SLAC PEP II collider."

Michael Falk
"For fundamental advances in our understanding of the mechanical response of amorphous solids through the use of innovative computational methods and theories that reveal the connection between local rearrangements and large-scale response."



Oleg Tchernyshyov
"For seminal advances in magnetic solitons and the development of collective coordinate formalism of dynamics of magnetic solitons for ferromagnetic thin wires, skyrmion crystals and extended domain walls."

Peter Armitage and Satoru Nakatsuji Selected as Canadian Institute for Advanced Research Fellows


Professor Peter Armitage and Research Professor Satoru Nakatsuji were selected to be part of the new class of the Canadian Institute for Advanced Research (CIFAR) fellows. CIFAR is a Toronto-based institute-without-walls that brings together leaders in targeted research areas to solve particular problems. Peter and Satoru were selected for their leadership in quantum matter research. CIFAR fellows and program advisors share and critique preliminary findings and data, often prior to publication, and gain insights from peers across disciplines. The environment of intellectual freedom afforded by CIFAR fosters deep collaboration and trust between program members.

Undergraduates Earn First Place at International Theoretical Physics Olympiad

David Carcamo, Ross Dempsey, Wenzer Qin, and Katherine Xiang earned first place in the 2019 International Theoretical Physics Olympiad for Undergraduates. The team solved 6 challenging problems on modern research topics within a 24-hour time frame. The JHU team outlasted over twenty other competitors from around the world in the 2019 competition.

The International Theoretical Physics Olympiad is a competition designed by Ph. D. students and postdoctoral fellows for undergraduate students interested in theoretical physics research. The goal is to find people interested in theoretical science and to help students gain experience with modern research skills.

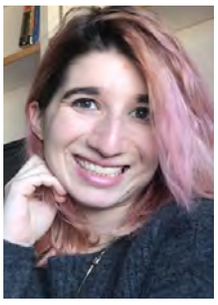
Marc Kamionkowski and Rachel Osten Chosen for the National Academy of Sciences' Decadal Survey in Astronomy and Astrophysics


Marc Kamionkowski, the department's William R. Kenan, Jr. Professor, and Associate Research Scientist Rachel Osten have been selected to the steering committee for the upcoming National Academy of Sciences decadal survey in Astronomy and Astrophysics. Our department is the only department with more than one member contributing to the survey.

Far Ultraviolet Spectroscopic Explorer (FUSE) 20th Anniversary Reunion

In June, JHU hosted a reunion of those who worked on the Far Ultraviolet Spectroscopic Explorer (FUSE) mission. FUSE was operated by JHU for NASA from a control room in the Bloomberg building from June 1999 until October 2007, with a large local cadre of scientists, engineers, post-docs and students. June 2019 marks the 20th anniversary of the FUSE launch, and thus, an appropriate time to celebrate!

Melissa Diamond Named 2019 Gardner Fellow and Earns Rowland Teaching Award for Outstanding Teaching and Innovation



Graduate student Melissa Diamond is the 2019 Gardner Fellow in recognition of her outstanding research in astrophysics. Diamond is a third-year grad student working with Professor David Kaplan. Her current research is focused on a project analyzing how polarized light from AGNs or other objects could be used to detect particles/fields with axion-like couplings to photons.

Diamond is the 11th Gardner Fellow. The Gardner Fellowship was founded by William Gardner (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.

Diamond is also a teaching assistant in the department, and has earned the 2019 Rowland Teaching Award for Outstanding Teaching and Innovation based on reviews by her students. The Rowland Teaching Award for Outstanding Teaching and Innovation was established to honor teaching assistants who have exhibited talented teaching skills and notable interaction with students, in the instruction of undergraduate courses.

Ross Dempsey and Wenzer Qin Receive Donald E. Kerr Memorial Award

The 2019 Donald E. Kerr Memorial Awards went to undergraduates Ross Dempsey and Wenzer Qin for their outstanding performance as undergraduate phyics majors. The Donald E. Kerr Memorial Award was established forty years ago in 1979.

Kirsten Hall Participates in the Lindau Nobel Laureate Meeting

Credit: Christian Flemming/Lindau Nobel Laureate Meetings

Graduate student Kirsten Hall was selected to participate in the 69th Lindau Nobel Laureate Meeting that took place over the summer in Lindau, Germany. Only the 600 most qualified young scientists are given the opportunity to enrich and share the unique atmosphere of the Lindau Nobel Laureate Meetings each year. Kirsten was also selected as a panelist to discuss the "Dark Side of the Universe," dark matter and dark energy, with four Nobel Laureates: Bloomberg Distinguished Professor Adam Riess, David Gross, Brian Schmidt, and George Smoot.

Space@Hopkins Hosts CubeSat Workshop, Names New Space Fellow

Directed by Bloomberg Distinguished Professor Charles L. Bennett, Space@Hopkins brings together researchers from across the university who focus on civilian space studies. In June, Space@Hopkins hosted the Small Space Missions Workshop, which explored the scientific capabilities of lightweight cube satellites. Participants included researchers from several university divisions, as well as employees from NASA's Wallops Flight Facility in Virginia, where many CubeSat missions are launched.

Space@Hopkins also welcomed a new Space Fellow in 2019, Ph. D. candidate Liza Sazonova, pictured with Department Chair, Timothy Heckman when receiving the 2019 EJ Rhee Teaching Award.

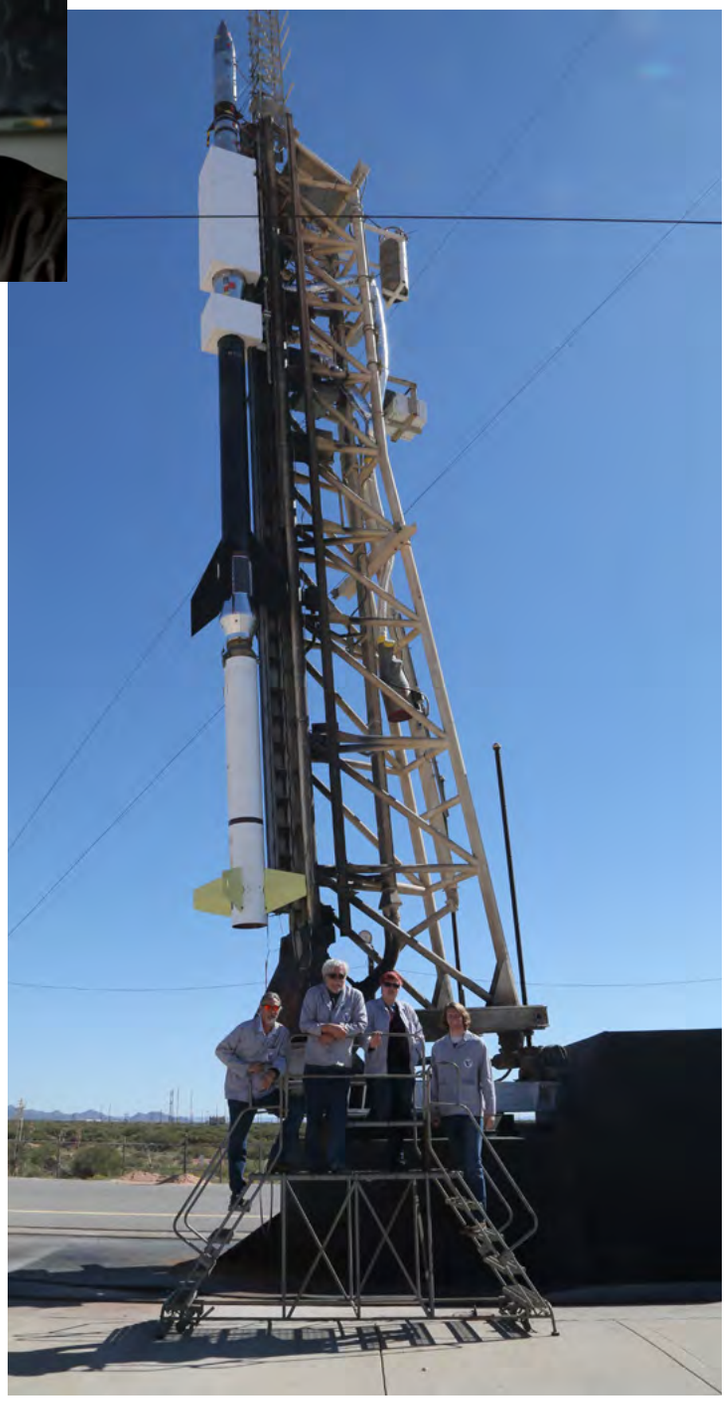
Marc Kamionkowski Named to National Academy of Sciences and Presents Halley Lecture at Oxford University

Marc Kamionkowski was among 100 new members and 25 foreign associates to be selected for membership to the National Academy of Sciences in 2019. The National Academy of Sciences is a private, nonprofit institution established under a congressional charter signed by President Abraham Lincoln in 1863. Kamionkowski was honored for his research that focuses primarily on particle dark matter, inflation and the cosmic microwave background, and cosmic acceleration.

Kamionkowski also delivered the Halley Lecture at Oxford University in 2019. This lecture is named for Edmond Halley, for whom the comet is named and is intended to honor scientists who have made important contributions to astronomy or geophysics. Kamionkowski gave the talk in May, and it was titled "Is Dark Matter Made of Black Holes?"

Sounding Rocket Mission to Observe Star-Forming Galaxy M33 a Success

Stephan McCandliss, Russ Pelton, Anna Carter, and Brian Welch (pictured below), experimenters from the department, completed their mission in October to observe far-UV emissions from the star-forming galaxy M33 for the purpose of understanding how metals created in clusters of hot stars in the galaxy are ejected into the circumgalactic medium. On October 29, the team successfully launched and recovered a NASA/JHU Black Brant IX sounding rocket 36.352 UG from White Sands Missile Range in New Mexico. Within the sounding rocket was NASA's Far-ultraviolet Off Rowland-circle Telescope for Imaging and Spectroscopy, or FORTIS, which was lifted to an altitude of 162 miles above the earth for six minutes of observing time.



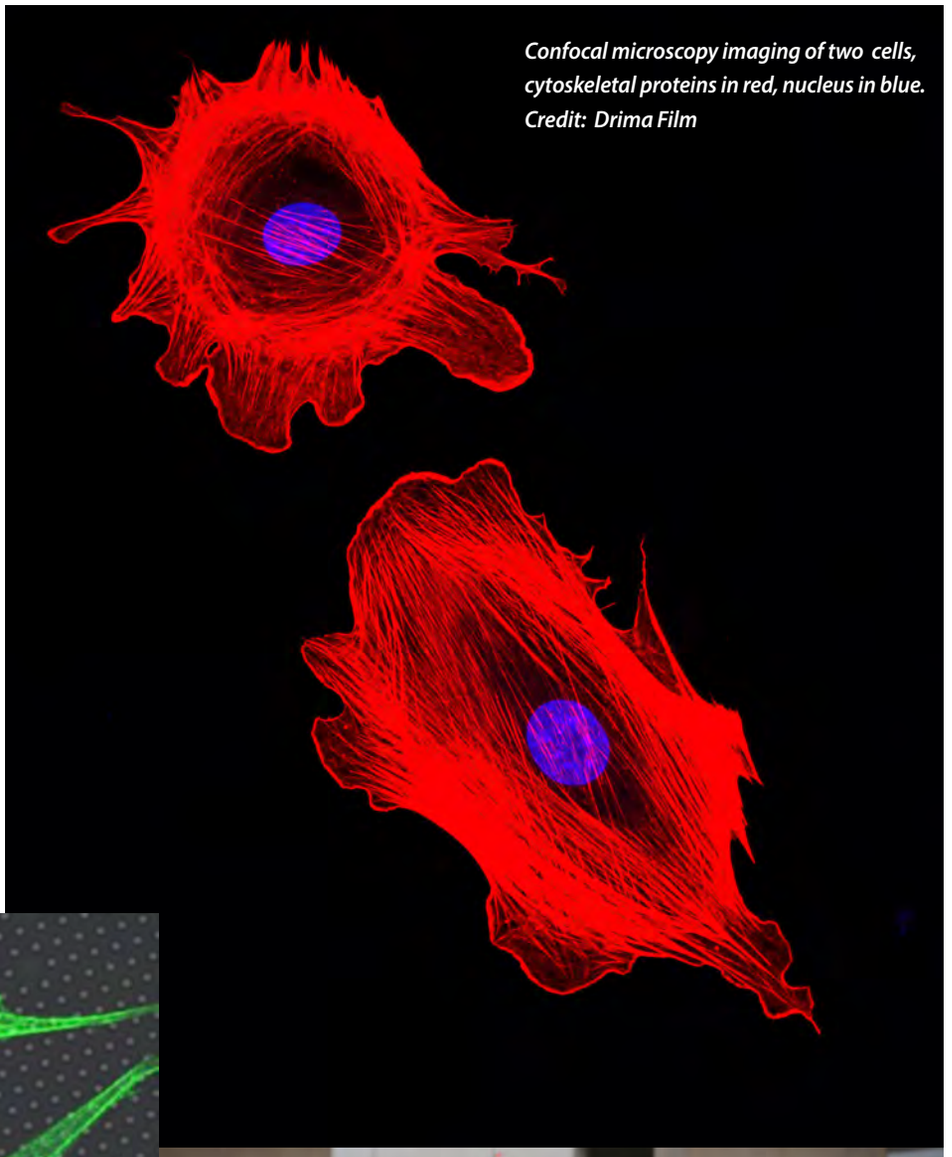
After about a minute observing M33, FORTIS focused on its brightest clusters of stars and supernovae to measure the speed and composition of their winds. "This will all give us an idea of how that material is circulating and just how much of it is being moved," said Professor Stephan McCandliss.

Like many sounding rocket missions, FORTIS will pursue these science questions while testing new tools. For this flight, FORTIS is using a next-generation microshutter array that builds on a design used for NASA's James Webb Space Telescope. The updated instrument will allow FORTIS to measure up to 40 separate targets at a time, in wavelengths of far-ultraviolet light beyond what earlier versions could resolve.

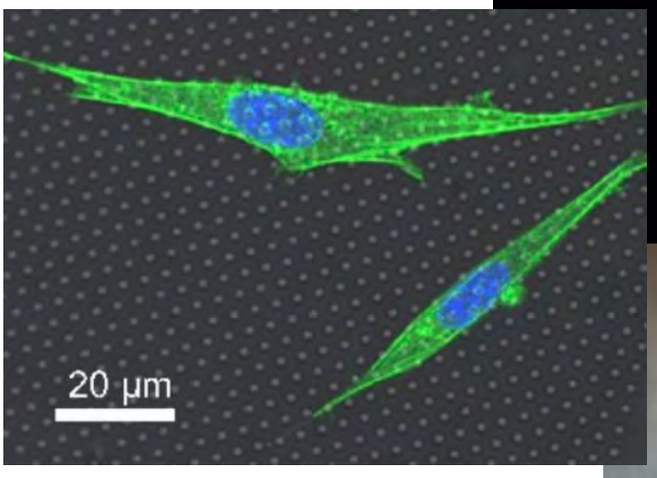
"It's new science enabled by new technologies," said McCandliss. "We want to train our workforce into bigger and better missions."

What Gives Animal Cells Their Agency?
Yu Shi, Dan Reich, et al. Measure Cytoskeletal Fluctuations

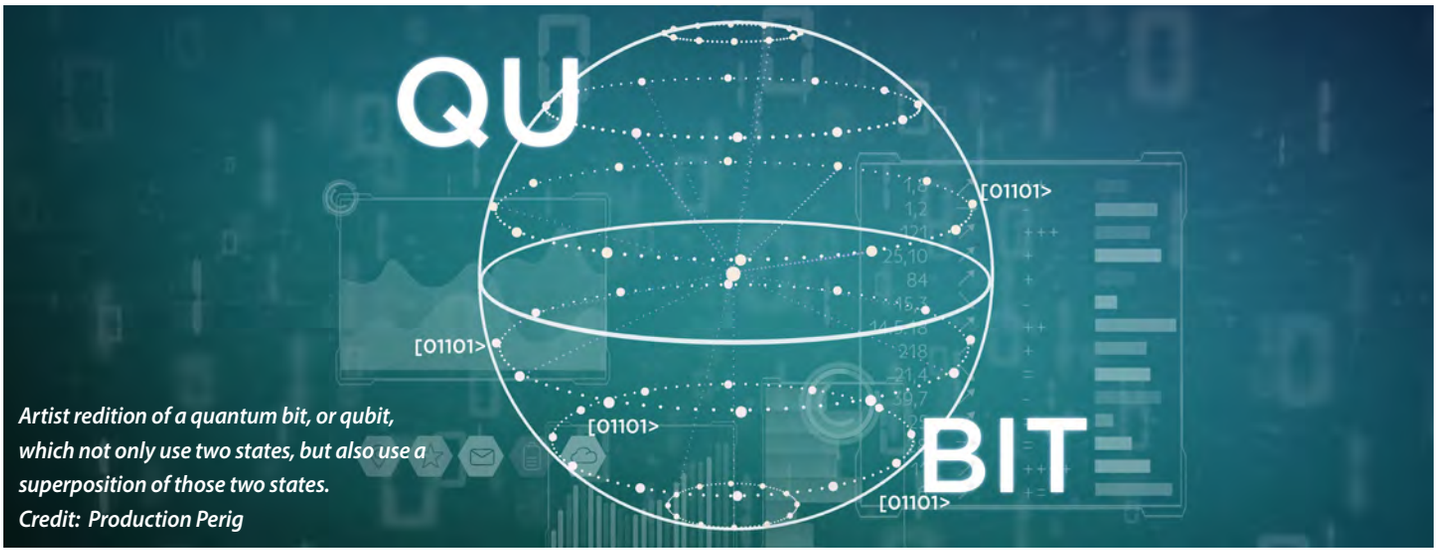
Recent Ph. D. graduate Yu Shi was the lead author of a paper published in the Proceedings of the National Academy of Sciences in 2019 that examines cellular dynamics. The ability of animal cells to crawl, change their shape, and respond to applied force is due to their cytoskeleton: a dynamic, cross-linked network of actin protein filaments and myosin motors. Shi, along with Professor Daniel Reich, and two co-authors from the University of Pennsylvania, created a method using micropost arrays to measure cytoskeletal motion, forces, and rheology with high precision and statistical power, employing substrates containing arrays of flexible microscopic posts. The team's results show that motion of the cytoskeletal network is dominated by rare large events and imply that future models of cytoskeletal dynamics may need to incorporate the concepts of jamming, self-organization and mechanical marginality, phenomena similar to those seen in avalanches and earthquakes. The paper is titled "Dissecting fat-tailed fluctuations in the cytoskeleton with active micropost arrays."



Confocal microscopy imaging of two cells, cytoskeletal proteins in red, nucleus in blue. Credit: Drima Film



Above: An image from Shi's paper of 3T3 fibroblasts immunostained for actin (green) and nuclei (blue). Right: Yu Shi toasts with his thesis advisor, Professor Daniel Reich, after earning his Ph. D. in December 2019, Photo Credit: Jon Schroeder



Artist redition of a quantum bit, or qubit, which not only use two states, but also use a superposition of those two states.
Credit: Production Perig

C.L. Chien's Team Report Discovery of New Superconducting Material

Quantum computers with the ability to perform complex calculations, encrypt data more securely, and more quickly predict the spread of viruses may be within closer reach thanks to a discovery by C.L. Chien's research team.

"We've found that a certain superconducting material contains special properties that could be the building blocks for technology of the future," says Yufan Li, a Postdoctoral Fellow and first author of the paper, which will be published in Science.

Today's computers use bits, represented by an electrical voltage or current pulse, to store information. Bits exist in two binary states, represented in computing as "0" or "1." Quantum computers, based on the laws of quantum mechanics, use quantum bits, or qubits, which not only use two states, but also use a superposition of those two states. A famous example of qubit is Schrodinger's cat, a paradox that posits that a hypothetical cat that may be both dead and alive at the same time.

"A more realistic, tangible implementation of qubit can be a ring made of superconducting material, known as flux qubit, where two states with clockwise- and counterclockwise-flowing electric currents may exist simultaneously," says Professoer Chia-Ling Chien, an author on the paper.

The ability to use qubits makes quantum computers much more powerful than existing computers when solving certain types of problems, such as those relating to artificial intelligence, drug development, cryptography, financial modeling, and weather forecasting. But in order to exist between two states, qubits using traditional superconductors require a very precise external magnetic field be applied on each qubit, thus making them difficult to operate in a practical manner.

In the new study, Li and colleagues found that a ring of β-Bi2Pd naturally exists between two states in the absence of an external magnetic field. Current can inherently circulate both clockwise and counterclockwise, simultaneously, through a ring of β-Bi2Pd.

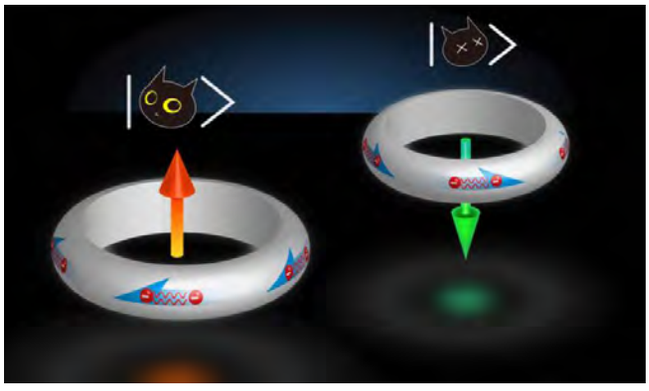
"A ring of β-Bi2Pd already exists in the ideal state and doesn't require any additional modifications to work," Li says. "This could be a game changer."

The next step, says Li, is to look for a specific type of particle called Majorana fermions within β-Bi2Pd. Majorana fermions are particles that are also anti-particles of themselves and are the basis for the development of the next level of disruption-resistant quantum computers—topological quantum computers. Majorana fermions depend on a special type of superconducting material—a so-called spin-triplet superconductor with two electrons in each pair aligning their spins in a parallel fashion—that has thus far been elusive to scientists.

Through a series of experiments, Li and colleagues found that thin films of β-Bi2Pd have the special properties necessary for Majorana fermions to exist, and are hopeful that the discovery of these special properties will lead to finding Majorana fermions in the material.

"Ultimately, the goal is to find and then manipulate Majorana fermions, which is key to achieving fault-tolerant quantum computing for truly unleashing the power of quantum mechanics," says Li.

— Chanapa Tantibanchachai



A visual representation of a qubit, which can exist simultaneously between two states. A famous example of a qubit is Schrodinger's cat, a hypothetical cat that can be both dead and alive. Similarly, a flux qubit, or a ring made of a superconducting material, can have electric current flowing both clockwise and counterclockwise at the same time.
Credit: JHU Hub

ALUMNI UPDATES

C. Megan Urry Elected a Member of the JHU Society of Scholars

Prof. C. Megan (Meg) Urry, who received her Ph. D. from the department in 1984, was elected as a member of the JHU Society of Scholars in 2019. Urry was a member of the senior science staff for many years at the Space Telescope Science Institute, before moving to Yale where she served as Chair of the Physics Department. She also served as a past President of the American Astronomical Society. She is currently the Israel Munson Professor of Physics & Astronomy and Director of Yale Center for Astronomy and Astrophysics. Her research centers on Extragalactic Astronomy, Active Galactic Nuclei, Galaxy Structure, Formation and Evolution, High Energy Astrophysics, and Black Holes.

Inductees into the Society of Scholars—established in 1967 by university President Milton S. Eisenhower—are former graduate students, postdoctoral fellows, house staff, or junior or visiting faculty who have served at least one year at Johns Hopkins, but are no longer affiliated and have since made great strides in the fields of physical, biological, social, or engineering sciences or the humanities. Potential inductees are nominated by Johns Hopkins faculty members. Since its inception, 688 individuals have been elected to membership in the society, including 15 other members elected in 2019.

Ulascan Sarica Receives Springer Award

Ulascan Sarica, who earned his Ph. D. from the department in 2018, has received the Springer Award for an outstanding Ph. D. thesis. Sarica worked on studies of the Higgs boson with Prof. Andrei Gritsan for his Ph. D. thesis. Dr. Sarica is currently a postdoctoral fellow at University of California, Santa Barbara.

The Springer Award is comprised of a monetary prize to the student, as well as publication of the thesis in the Springer collection of outstanding dissertations, Springer Theses. Springer is a global publishing company that publishes books and peer-reviewed journals in Science, Humanities, Technology, and Medicine.

Please keep in touch!
We would love to hear from you.
Please contact Pam Carmen in the Chair's Office at

pcarmen@jhu.edu

Liang Wu Receives McMillan Prize for Research in Condensed Matter Physics

Liang Wu, who earned his Ph. D. from the department in 2015, received the McMillan Prize in 2019 for his research in condensed matter physics. Specifically, Wu earned the prize "for novel terahertz and optical spectroscopy experiments on topological insulators and semimetals."

The McMillan Prize is an annual award given by the Department of Physics at the University of Illinois to an outstanding young researcher in condensed matter physics in memory of former professor William L. McMillan. It's the most prestigious award for young researchers in condensed matter physics. Liang received this prize for work he did—in part—in Prof. Peter Armitage's lab at JHU. Former winners of this award include department members Peter Armitage and Tyrel M. McQueen.

Nhan Tran Receives Early Career Research Award from U.S. Department of Energy

Nhan Tran, who earned his Ph. D. from the department in 2011, is currently a Wilson Fellow at Fermi National Accelerator Laboratory. In 2019, Tran earned the U.S. Department of Energy Early Career Research Award. The DOE Early Career Research Award is a prestigious award designed to bolster the nation's scientific workforce by providing support to exceptional researchers during the crucial early years, when many scientists do their most formative work. Tran earned his Ph. D. at JHU under the supervision of Prof. Andrei Gritsan.

Tarini Konchady Named Media Fellow of the American Astronomical Society

Tarini Konchady, who earned her B.S. from the department in 2017 has been named the new Media Fellow of the American Astronomical Society. Konchady is an active member of the broader astronomy community: she's an author and editor for the graduate-student-run astronomy blog Astrobites, she co-organizes a chapter of Astronomy on Tap, and she's been spotted at the Capitol as a member of the AAS's Congressional Visits Day delegation. Konchady is currently studying Mira variables to help calibrate the extragalactic distance scale

IN MEMORIUM

Professor Emeritus Yung-kuen Lee passed away in September of 2019. Lee emigrated to the United States from what is now South Korea when he received a scholarship to study at JHU in 1953. He graduated Phi Beta Kappa in 1957, received an M.A. in Physics from the University of Chicago in 1958, and received a Ph. D. in Physics from Columbia University in 1962.

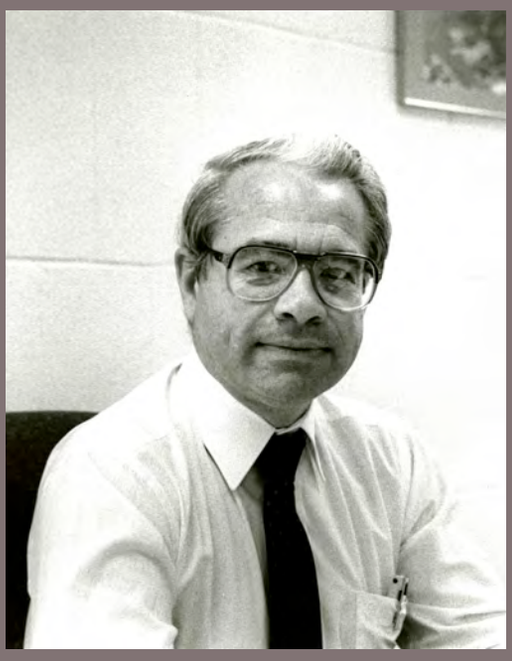
Professor Lee's area of specialty was experimental nuclear physics. In 1963, Yung Lee, Luke Mo, and Prof. C.S. Wu, using a Columbia University atom smasher, performed precise measurements of the boron-12 and nitrogen-12 beta-ray spectra. The measured data matched the theoretical prediction within 3%, and verified the Conserved Vector Current (CVC) model of the weak nuclear interaction. The weak interaction is responsible for the decay of all but the heaviest radioactive isotopes, and the CVC was an important step on the path to the present-day Standard Model of particle physics.

Lee moved to Baltimore in 1964 when he became a professor of physics at JHU. In addition to his numerous academic achievements, Lee also helped JHU students organize to obtain Korean language instruction at the university. He was a founding member of a Korean congregation that met for worship at Lovely Lane Methodist Church in Baltimore. Professor Lee was also chairman of the board of directors for the Baltimore Korean Language School on Taylor Avenue.

IN MEMORIUM

Richard A. Zdanis, an alum, who went on to serve in the JHU administration and as professor in the department for many years, passed away in May of 2019.

A Baltimore native, Zdanis spent two years at Princeton after earning his doctorate at Johns Hopkins in 1960. He returned to the Hopkins physics and astronomy department as assistant professor in 1962. Celebrated for his research on high-energy physics, he advanced quickly, earning the rank of professor in 1969 and co-chairing the department's high-energy group. He conducted early particle physics research at the National Laboratory at Brookhaven, Long Island, New York, and then moved to the newly completed Stanford Linear Accelerator Center in Palo Alto, California.



Zdanis also served as associate provost of Johns Hopkins from 1975 to 1979; as vice president for administrative services from 1977 to 1979; and as vice provost from 1979 to 1988. As vice provost, he led several significant initiatives, including the sale of the Garrett Coin Collection in four separate auctions from 1979 to 1981. Originally estimated to fetch approximately $8 million, the coins were collectively auctioned for more than $25 million, raising critical funds at a time when the university was facing fiscal difficulties. Zdanis also played a key role in formulating Hopkins' successful response to NASA's request for proposals for the Space Telescope Science Institute. NASA awarded the institute to Hopkins in September 1981.

Zdanis served on the Space Telescope Institute Council of the Association of Universities for Research in Astronomy, which provides oversight and advocacy for the Space Telescope Science Institute, from 1990 to 1994 and as its vice chair from 1993 to 1994. He served as a member of the AURA board of directors from 1993 to 2000, and as the vice chair of the board from 1994 to 1997. He was an active member of the board of trustees of Associated Universities from 1976 to 1996, including as chairman of the board from 1981 to 1983, and as an honorary trustee from 1996 until his death.

"He had a distinguished career in high-energy physics and university administration," said Professor Emeritus H. Warren Moos, "He was an advocate at a time when Hopkins was expanding the sciences, and his portfolio was science, so he was a major contributor through his activities in the provost's office."

— Rachael Wallach

Richard A. Zdanis (left) with the JHU Society of Scholars, 1980. Photo Credit: James K. Lightner

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On the Airwaves

Adam Riess Featured on National Public Radio's "On Point Radio"

Bloomberg Distinguished Professor Adam Riess was a guest on NPR's On Point Radio in May of 2019 to discuss his new research about the age of the universe. Listen to the interview now by scanning the QR code below with your smartphone.

Cosmology Large Angular Scale Surveyor Telescope Featured on National Public Radio's "All Things Considered"

In a segment titled "Telescope in Chile's Mountains Looks for Signals to Explain How the Universe Began," NPR Science Journalist Joe Palca interviews Associate Professor Tobias Marriage and others to share the science behind the Cosmology Large Angular Scale Surveyor (CLASS) project. The Co-Principal Investigators of the CLASS telescope are Bloomberg Distinguished Professor Charles Bennett and Associate Professor Tobias Marriage.

NPR Science Journalist Joe Palca (left) interviews Associate Professor Toby Marriage (center) and others to share the science behind the Cosmology Large Angular Scale Surveyor (CLASS) project in Chile's Atacama Desert.