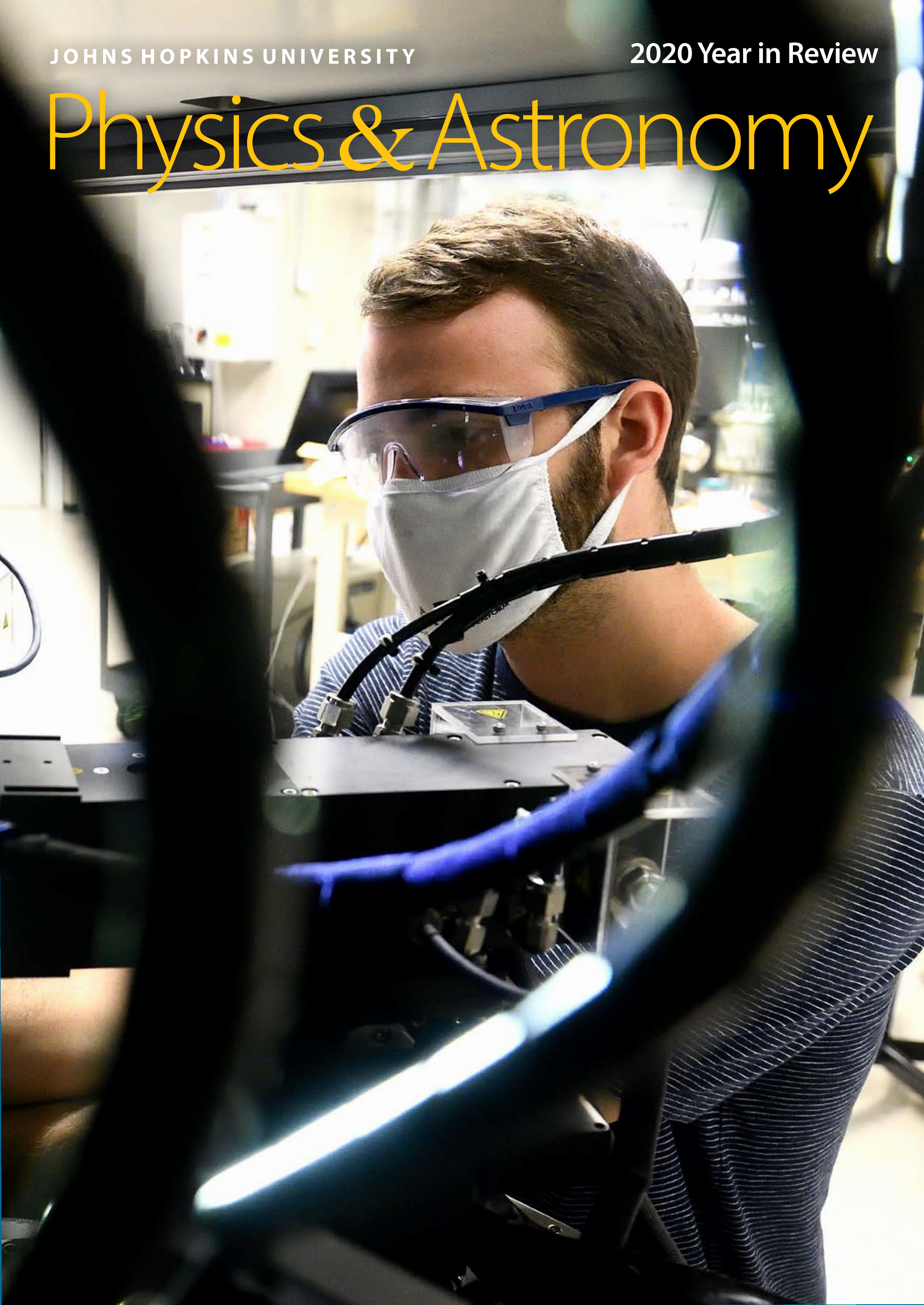
JOHNS HOPKINS UNIVERSITY

2020 Year in Review

Physics & Astronomy



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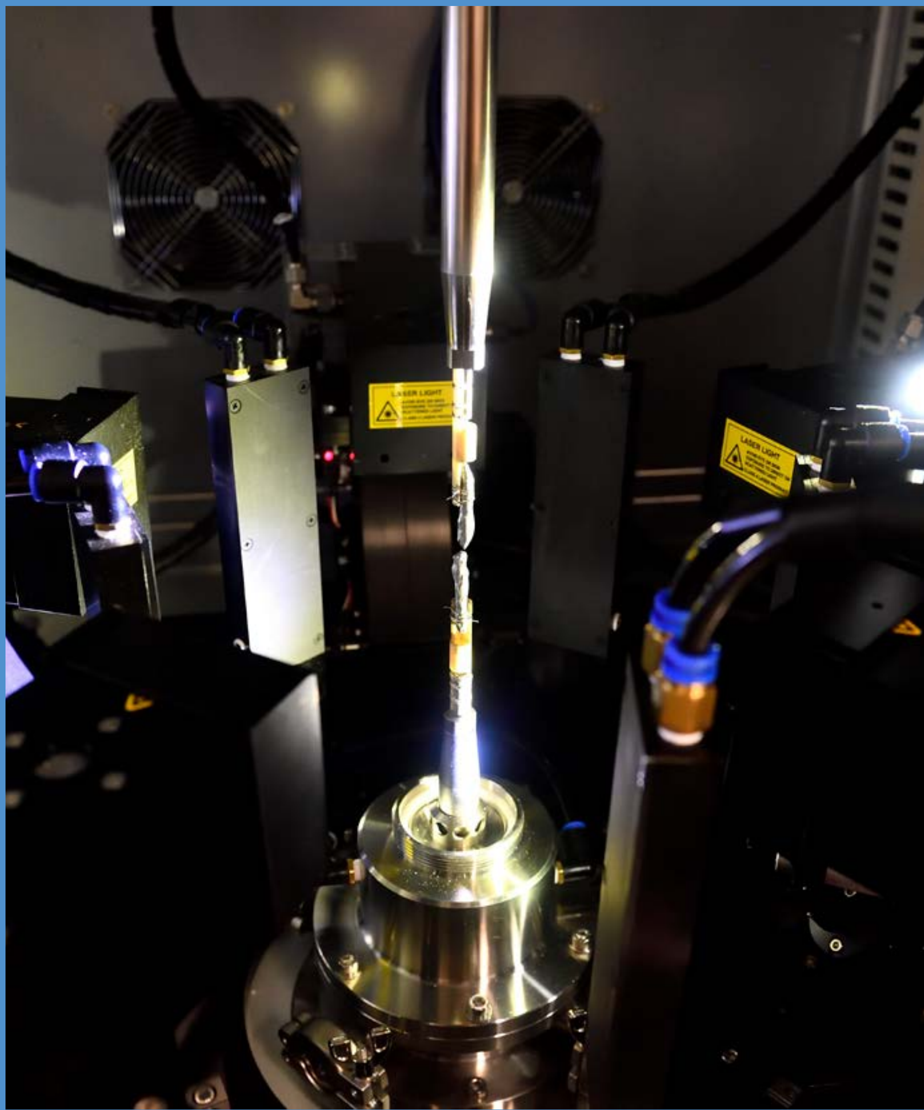

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Front cover: Lucas Pressley, a trainee in the PARADIM lab, works with a new electronic material with unprecedented performance and functionality (pictured above). Learn how the PARADIM lab altered their procedures to safely operate during the COVID-19 pandemic in the article on page 4: Making Stuff Up: The PARADIM Bulk Crystal Growth Facility Creates the Materials of Tomorrow.

Letter from the Chair

Dear alumni, colleagues, and friends,

It won't surprise any of you to learn that the year 2020 was a very challenging and stressful one for our department. Despite that, our department has continued to maintain our excellence in research and education. This newsletter will fill you in on the many accomplishments by our faculty, science staff, students, and alumni. Normally, I would use this letter to provide some highlights. This time I wanted instead to showcase the resilience shown by the department in the face of adversity.

The first challenge was the abrupt transition to on-line instruction that happened in March. Fortunately, we had a brief grace period over Spring Break to prepare. This was truly a team effort involving faculty and graduate TA's redesigning their classes on-the-fly, which was only made possible by the assistance of both the university and departmental technical staff. I also wanted to give a shout-out to our students who adapted with great flexibility and understanding. This was a real "all-hands-on-deck" situation and we all came through with flying colors. The summer was spent making detailed plans for the possibility of at least some in-person instruction in the fall. It was also used to really up-our-game in terms of delivery of top-notch on-line instruction. In the end, instruction was fully remote, but all the prior experience and planning has made this semester a success in this mode. We do not know what the Spring semester will hold. The university is again planning for a possible hybrid of on-line and in-person instruction made possible by an aggressive plan for testing of students, faculty, and staff. Whatever happens, we will be ready.

The COVID-19 shut down has also impacted our research. Much of our research is conducted in laboratories in our building, and cannot be done without some in-person presence. The university worked with us to devise detailed plans for in-person activity in these labs, predicated on strict adherence to social distancing. In-person capacity at any given time was significantly reduced and strict protective personal equipment requirements were in place. This was a big success in part because the individual laboratory Principal Investigators worked directly with their team to craft individual plans compliant with a general framework. Non-lab-based research has remained in the on-line only mode. We have all carried on, but have lost the opportunity for the normal in-person one-on-one and group meetings that are so critical to making progress. These can be done using Zoom, but there is really no substitute for tackling difficult problems face-to-face. This is especially harmful to our younger scientists: students and postdocs needing mentorship and junior faculty anxious about their rate of progress.

Probably the most difficult problems we face are just the impact of social isolation and reduced efficiency. Many of our graduate students and postdocs are living alone and have been cut off from regular interactions with their peers, friends, and family. Some of us are able to share our home with family members as we work, but this can make it more difficult to focus on our work. That said, we will ultimately pull through this and hopefully emerge with a better appreciation of the importance of our social fabric and of one-another.

I also wanted to say that our department – like so much of the country – was deeply moved by seeing the need for racial justice, and was motivated to do what can to help make our department a more diverse, inclusive, and supportive place. Over the summer I met with students and postdocs and held two on-line department-wide town hall meetings to discuss what concrete steps we could take. Thanks to these conversations we have: 1) eliminated the need for applicants to our graduate program to take the GRE (which has been shown to deter some underrepresented minority applicants) 2) created a new department-wide Committee on Diversity and Inclusion to identify areas needing improvement and develop consensus-based solutions 3) reconfigured our graduate admissions and recruitment committee with additional focus on diversity 4) redoubled our efforts to fund the Henry A. Rowland Department of Physics & Astronomy Summer Research Fellowship program to bring in underrepresented minority undergraduate physics students for summer research internships (which you will learn more about in this newsletter). In the end, I am confident we will emerge as a more diverse community made possible by enthusiastic contributions from all quarters of the department.

So, this letter is really meant to thank all those who made it possible for us to navigate through some very turbulent waters. I also want to extend my gratitude to two of 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 and its support of our department. I also want to 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 as we hopefully move towards a semblance of normalcy.

Best regards,

Tim Heckman

MAKING STUFF UP:

THE PARADIM BULK CRYSTAL GROWTH FACILITY CREATES THE MATERIALS OF TOMORROW

BY ANNIE PRUD'HOMME-GENEREUX

It's a very special delivery.

About once a month, researchers at the PARADIM Bulk Crystal Growth Facility place a small parcel in the mail. They wrap the precious cargo in bubble wrap and packing peanuts, apply a "fragile" sticker, and write "nontoxic mineral crystals" on top to describe its content. Mail carriers ferry the parcel across the country. Unbeknownst to them, they are transporting substances that – up until a few days ago – had never existed.

That bears repeating. The contents of these boxes had never occurred in the 13.8 billion-year history of the Universe.

Until now.

Produced within the Bloomberg Center for Physics and Astronomy, these materials will make up the next generation body armor, solar panels, quantum computers, sensors, and lasers.

New. Exotic. Filled with possibilities. That's the business of the Bulk Crystal Growth Facility.

Mojammel Khan, Associate Director of the PARADIM Bulk Materials Discovery Facility, examines a novel electronic material with unprecedented performance and functionality.

"Most people don't typically think about this, but materials underlie everything in our life," explains Professor Tyrel McQueen, the director of the facility. "Everything is built out of something. Materials are made of atoms and the reason they behave the way they do is all about the way in which these atoms are arranged."

He brings up bone, his favorite example. "Bone is a remarkable material because it is simultaneously strong and flexible. Normally things that are very strong are brittle – think of a ceramic dinner plate – whereas things that are malleable are soft and easy to bend. Bones somehow combines those two properties. And, we know why that is: it is because of the atomic structure of bone that is not random but highly structured."

McQueen's team goes about purposefully designing and synthesizing substances with desired properties. Outfitted with unique, cutting-edge equipment, his facility allows researchers to combine atoms in new ways to engineer the materials of tomorrow – materials that will make technologies faster, smarter, and greener.

The project got its start four years ago when McQueen joined forces with colleagues at Cornell, Princeton, and Clark Atlanta University. They proposed a national user facility giving researchers around the country access to unparalleled expertise and leading-edge equipment. Researchers propose projects and, through a competitive process, are invited to use the facilities. Funded by the National Science Foundation to the tune of $28 million, the founders named the collaboration PARADIM, short for the Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials.

"The users who come here may have a problem that we alone may be able to help with," says Lucas Pressley, a doctoral candidate working at PARADIM. "Or, where the users may be able to synthesize their new material in one to two years, we can do it in a week or a month."

There are two established strategies for synthesizing new materials. The first is to lay down each atom in a controlled fashion – an atomic-scale 3D printer. But, there is a problem with this strategy. "There are a mind bogglingly large number of atoms in a sample the size of a screwdriver," explains McQueen. "Even if positioning atoms is super fast, say once every femtosecond, it is still going to take you in the order of the age of the Universe to build a screwdriver by that approach." Clearly, while that level of control is enviable, it is not scalable.

The other option is to take large quantities of starting materials and melt them. This is the process used to make steel. "That gives you a lot of control at the scale of the screwdriver but that doesn't allow you to control the individual atoms," says McQueen.

This leaves an interesting gap. "How do you make something that's the size of a screwdriver with some level of atomic control?", asks McQueen. That's what PARADIM sets out to do.

It does it by growing crystals. The atoms in a crystal organize themselves into an ordered, repeating pattern, and they do it rapidly. A common experience with this phenomenon is watching frost grow on a window. The pattern we observe with our eyes echoes what is happening at the atomic scale.

"The analogy I really like is that of a corn field where you can see uniform rows going in one direction," explains Pressley. "You can think of those plants arranged in rows as the arrangement of atoms if they are in a single crystal." This ordered array of atoms in a crystal makes it easier to study the material and can give rise to emergent properties. These novel properties may in turn be useful in building electronics, for example by capturing a device's waste heat and converting it into electricity.

So, how do researchers grow crystals?

"Ideally you would have a planetary simulator," laughs Pressley about the extreme conditions of heat and pressure required to disrupt the bonds between atoms in the starting material. Once melted, the material is slowly cooled, giving the atoms a chance to find new partners and arrange themselves into the ordered configuration of the crystal.

At PARADIM, this means using furnaces. Lots of specialized furnaces. Some aim focused laser beams at the starting compounds; others reflect the heat of powerful bulbs with mirrors; and others induce rapidly oscillating currents in the material to heat it up. Temperatures can reach 3,000°C (5,432°F) – that's twice the temperature of Hawaiian lava.

"It's very focused and confined heat," explains Mekhola Sinha, a doctoral student and PARADIM researcher who helped set up the facility four years ago. "We apply the heat to only a small area to heat that portion of the sample."

Researchers around the country flock to the Bulk Crystal Growth Facility to access these unique furnaces and learn how to use them. "The paradigm here is not just 'you send us a sample and we send you a crystal'," says Pressley. "There is knowledge gained from working with us. You are learning the process and becoming a better scientist as a result of it."

"I am going to wear a GoPro camera on my head. You guys are going to see exactly what I see with a live feed. You are going to puppeteer me."

—Nicholas Ng, graduate student

But, in the wake of the COVID-19 pandemic, few people are around. The pervasive hum of the ventilation system that keeps the PARADIM equipment cool is now deafening. Remarkably, this has not stopped the activities of the facility.

"A lot of our equipment, since Day 1, was set-up to be run remotely," asserts McQueen. "We have always offered this to users. They have almost universally declined and chosen to come and do it with their own two hands."

"Once the samples are loaded [in a furnace]," explains Pressley, "you can go home and sit on your couch and run the crystal growth while watching TV." The furnaces are equipped with cameras and monitoring equipment that allow researchers anywhere in the world to see what is happening – and control it – in real time.

Mojammel Khan makes adjustments on an ultra high temperature induction furnace, a signature tool in the PARADIM lab.

The team came up with even more innovative ways to conduct its activities remotely. Each summer, PARADIM trains a cohort of researchers – students and professors – in the methods used to make and characterize new materials. The participants roll up their sleeves and try their hand at a one-week synthesis project.

"This couldn't happen this year," reports PARADIM doctoral trainee Nicholas Ng. "What we said to them is, I am going to wear a GoPro camera on my head. You guys are going to see exactly what I see with a live feed. You are going to puppeteer me. You are going to drive my hands and tell me what to do. Tell me how much of each element to put in, what kind of tube to use, and the best course of action here."

"Our participants reported that the school was quite successful," says McQueen.

Ng, who enjoys working with the unique equipment, has prepared a pitch to attract colleagues to PARADIM. With a mischievous smile, he admits, "I tell them, 'come hit your compounds with the power of the Sun in a little box'."

Postdoctoral Research Associate Lisa Pogue operates an arc melter in the McQueen Lab.

NEWS BRIEFS

New Summer Research Fellowship Aims to Foster More Diversity in Physics and Astronomy

2020 marked the inaugural summer for the new Henry A. Rowland Department of Physics & Astronomy Summer Research Fellowship program. Led by Assistant Professor Ibrahima Bah and Assistant Professor Kevin Schlaufman, the program seeks to foster diversity in physics and astronomy by offering competitively awarded summer research opportunities to undergraduates from minority groups underrepresented in physics and astronomy. In addition to mentored research experiences, the fellowships include enrichment activities designed to enhance fellows' communication skills and to prepare them for future careers in research.

UMBC Meyerhoff Scholar Kassidy Kollmann was selected as the first fellow selected. She worked with Associate Professor Toby Marriage to use data collected by the Cosmology Large Angular Scale Surveyor (CLASS) telescope in the northern Atacama Desert of Chile to precisely quantify the degree of polarization in the cosmic microwave background (CMB). At the same time, Kassidy received guidance from Prof. Marriage in the graduate application process. While the ongoing COVID-19 pandemic forced Kassidy's fellowship into the cloud, she still profited from her experience. Kassidy plans to continue her studies and earn a PhD in physics -- possibly at JHU.

Assistant Professor Ibrahima Bah (left) and Assistant Professor Kevin Schlaufman

Brice Ménard Takes a Page from Deep Space to Study Deep Earth

Using a new technique originally designed to explore the cosmos, Associate Professor Brice Ménard and co-authors, have unveiled structures deep inside the Earth, paving the way towards a new map revealing what Earth's interior looks like. The findings were published in Science.

Similar to the way doctors use ultrasounds to look inside the human body, earth scientists use seismic waves to probe the Earth's interior. However, their task is much harder: they need to wait for an earthquake to record data, and when this happens, it only provides information in a piecemeal manner; the data is restricted to a tiny region and most of the time it's impossible to distinguish weaker echoes from noise.

Credit: Getty Images/iStockphoto

The unusual team of space and earth scientists used a novel algorithm called the Sequencer that was originally developed to find interesting trends in astronomical data sets. They used it to analyze thousands of seismograms, or records of vibrations of the ground following an Earthquake, collected over the past 30 years.

"With this new way to look at the data globally, we were able to see weak signals much more clearly," says astrophysicist Ménard. "We were finally able to identify the seismic echoes and use them to create a map."

"Imagine you're outside in the dark. If you clap your hands and then hear an echo, you know that a wall or vertical structure is in front of you. This is how bats echolocate their surroundings," explains Postdoctoral Associate Doyeon Kim, a seismologist at the University of Maryland and co-author on the paper.

Using this principle, the team used the Sequencer algorithm to parse through thousands of seismograms for echoes to create a new map showing details of the Earth's mantle, just above the liquid iron core, at a depth of 3,000 kilometers. The map shows a large area under the Pacific and reveals hot and dense regions below Hawaii and the Marquesas islands in French Polynesia. Similar to the times when European explorers drew the first incomplete maps of America, these scientists are charting the Earth's interior.

The Sequencer algorithm, developed by Ménard and graduate student Dalya Baron, has the ability to automatically find interesting trends in any type of data set, and has now enabled discoveries in astrophysics and geology. The team now looks forward to seeing what researchers in other fields will find with this technique.

— Chanapa Tantibanchachai

Tim Heckman Named Fellow of the American Association for the Advancement of Science

Timothy Heckman, Department Chair and Dr. A. Herman Pfund Professor, is among 489 distinguished scholars recognized this year as fellows of the AAAS, the world's largest general scientific society. Fellows are selected annually for their contributions to their respective fields and the body of science as a whole.

Heckman is being recognized for his contribution to the understanding of galaxy development and its relationship to the properties of galaxies, particularly supermassive black holes.

Chia-Ling Chien Presented with the 2020 Achievement Award of the IEEE Magnetics Society

Professor Chia-Ling Chien has been presented with the 2020 Achievement Award of the Institute of Electrical and Electronics Engineers (IEEE) Magnetics Society. This is the highest award bestowed by the IEEE Magnetics Society, given in recognition of exceptional technical accomplishments in the field of magnetics.

The citation for Prof. Chien's award reads: "For pioneering discoveries in magnetic materials, nanostructures, and spin phenomena; for training young researchers; and providing invaluable service to the community."

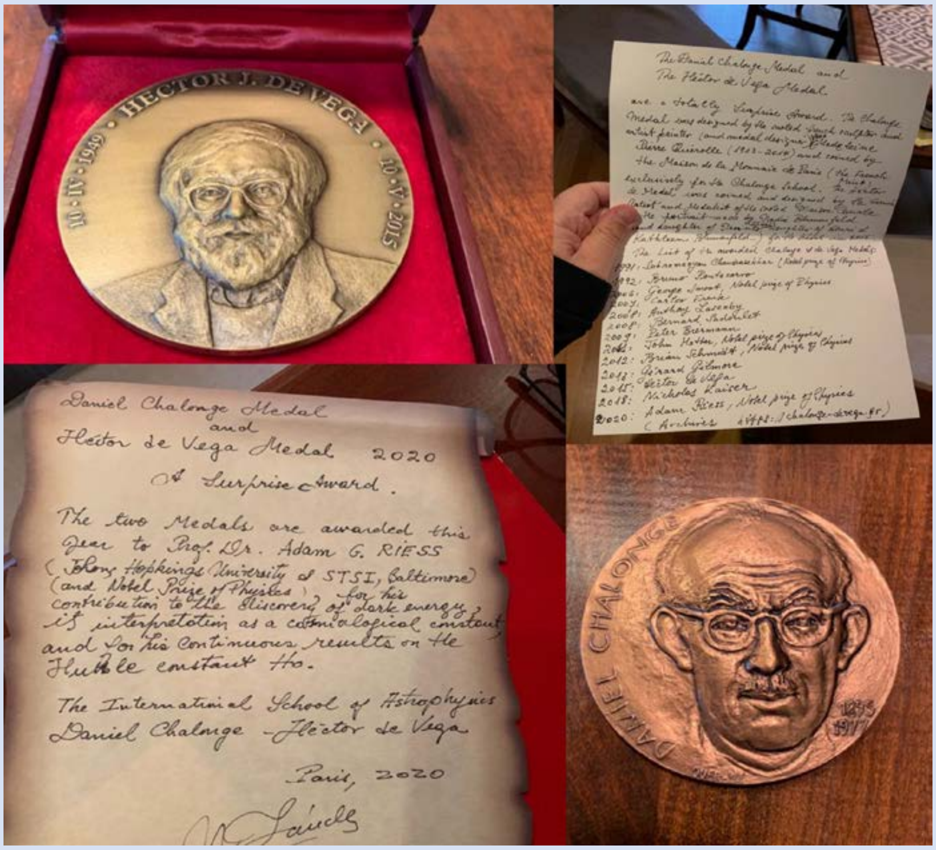
Alex Szalay Receives the Viktor Ambartsumian International Science Prize

Bloomberg Distinguished Professor Alex Szalay is one of three recipients of the 2020 Viktor Ambartsumian International Science Prize. The award is in recognition of Professor Szalay's "pioneering work on demonstrating that the Dark Matter in the Universe might be a neutral, weakly interacting particle and for his contributions to data-driven, statistical cosmology."

The Viktor Ambartsumian International Science Prize is an important award in astronomy/astrophysics and related sciences. It is awarded to outstanding scientists having significant contribution in physical-mathematical sciences from any country and nationality. The Prize has been awarded once every two years since 2010.

Adam Riess Receives 2020 Chalonge-de Vega Medals from the International School of Astrophysics

Bloomberg Distinguished Professor Adam Riess has received the 2020 Chalonge-de Vega Medals from the International School of Astrophysics in Paris. The citation for the award reads: "for his contribution to the discovery of dark energy, interpretation as a cosmological constant and for his continuous results on the Hubble constant."



The Hector de Vega Medal (upper left) and the Daniel Chalonge Medal along with a handwritten surprise award letter and a listing of previous recipients of the medals.

Credit: Adam Riess

NEWS BRIEFS

Professors Peter Armitage and Collin Broholm Each Receive $1.6M Grants from the Gordon and Betty Moore Foundation's Emergent Phenomena in Quantum Systems Initiative

Many of us are probably familiar with some of the broad concepts within the (very) micro world of quantum mechanics—the idea that an electron can be in two places at the same time, for example. But we don't often give these concepts much thought because we don't encounter them in our daily lives, out here in the macro world. And scientists can't yet explain how what they call the "weirdness" of the quantum world creates the familiar physical properties of our everyday experience.

But quantum physicists, by studying enormous numbers of electrons at once, have begun to construct experiments they hope will eventually reveal how the weirdness becomes life as we know it. If they can enlarge the "weird" phenomena into a scale that's observable, they might be able to learn more about how those phenomena manifest.

"This all comes from electrons," says Professor Peter Armitage. "By themselves, they're not very interesting. But put together a billion billion billion of them, and all of this remarkable behavior comes out."

Professors Peter Armitage (left) and Collin Broholm

Credit: Jon Schroeder

Armitage is one of two department physicists to receive competitive awards in 2020 to explore fundamental aspects of quantum materials. The awards come from the Gordon and Betty Moore Foundation, which fosters path-breaking scientific discovery, environmental conservation, patient care improvements, and preservation of the special character of the Bay Area of California. The foundation's Emergent Phenomena in Quantum Systems Initiative is a $185-million funding program whose goal is to accelerate progress in the field of quantum materials. Armitage and Professor Collin Broholm will each receive $1.6 million over five years to develop new techniques for measuring intrinsic quantum mechanical correlations in solids. The grants are intended to fund basic science research—a risk, because there's no guarantee the work will yield the hoped-for results, but a risk that also holds the potential to transform our thinking about quantum material.

In order to understand quantum phenomena writ large, physicists need methods to accurately measure them—something they don't yet have. So Armitage and Broholm will use their grants to develop new tools to explore uncharted ways of measuring quantum materials in the hopes of revealing details about their properties. Already, both have made names for themselves in the arena of building instruments and apparatus, and applying them in ways not usually considered.

Along with other colleagues at the Hopkins-based Institute for Quantum Matter, they will work to create a quantum fluid, a material that is neither gas, solid, nor liquid, and that features quantum factors like "entanglement"—one of the weirdness' weirder features. A particle is "entangled" when its magnetic spin, which can never be predicted for just one particle, is always opposite of the spin of a particle it's entangled with. Even weirder: particles can be entangled over hundreds of kilometers.

"When you carry out a measurement in one location, this influences all future outcomes of measurements in the other location," says Broholm, who is completing his first five-year grant from Moore and who directs the Institute for Quantum Matter. "It's a very jarring concept because it means there's a non-local aspect to physical reality."

Once they create a quantum material, their goal is to be able to prove that solid state entanglement exists within it. Each is working on different methods—Broholm using neutrons, and Armitage using photons—to prove and detect entanglement in the quantum fluid. To determine whether entanglement is present, they must use entangled neutrons or photons to test how well their entanglement is sustained in the process of interacting with the quantum material.

"We're trying to detect if the material is entangled, so we need to use something that is itself entangled," Broholm says. "It's not been done before, and it's a pretty wild idea."

The grant provides an unusual opportunity to use "out-there" ideas to push the boundaries of understanding, Broholm says. "We're very fortunate to have two of us who have gotten this award, which gives us lots of freedom to follow our noses about what we think is interesting," Armitage adds.

— Rachel Wallach

Tyrel McQueen and Surjeet Rajendran Join New Quantum Information Science Research Centers, Developed Under the U.S. Department of Energy

Two department members will join a sweeping effort by the U.S. Department of Energy Office of Science to launch five new Quantum Information Science Research Centers to develop the next generation of quantum devices.

Professor Tyrel McQueen, a member of both the department of Physics & Astronomy and the department of Chemistry, will be part of the Co-design Center for Quantum Advantage, housed at Brookhaven National Lab in Long Island, New York. The center is charged with developing materials, hardware, and software to advance quantum computing. Associate Professor Surjeet Rajendran will work with another center, the Superconducting Quantum Materials and Systems Center, based at Fermilab in Illinois. That center will aim to develop new quantum sensors and build a futuristic quantum computer with superconducting technologies.

The two join dozens of experts from across the country who will work to advance quantum information technology and develop quantum-based applications in computing, communication, and sensing.

Quantum information science takes advantage of quantum bits, or qubits, in place of traditional binary bits of "1" or "0." Quantum computers have the potential to solve problems that would be practically impossible for traditional supercomputers to solve. However, qubits are inherently unstable and difficult to steady. The new centers will focus on developing more reliability in quantum devices.

"I will serve as a theorist who will invent ways to use quantum sensors to discover new physics such as dark matter, dark energy, and gravitational waves," Rajendran says. The center will benefit from Rajendran's previous research that has led to the development of quantum sensing tools to search for axions, hidden photons, scalar dark matter, and gravitational waves.

The Co-design Center for Quantum Advantage will develop quantum computer hardware and software with the goal of having a quantum computer outperform a classical one for certain computations. In particular, the center will work on quantum advantage in computations for high-energy and nuclear physics, chemistry, materials science, condensed matter physics, and other fields.

"It's my pleasure to contribute to the development of new materials that enable the next generation of quantum devices," McQueen said.

The research centers are enabled by the National Quantum Initiative Act, approved in 2018 to accelerate quantum information science and technology applications.

Professor Tyrel McQueen (left) and Associate Professor Surjeet Rajendran

Lucie Afko Participates in Bloomberg Distinguished Professors Summer Program Analyzing CLASS Telescope Data

Sophomore physics major Lucie Afko, whose television growing up was usually tuned to the Science Channel so she could learn about black holes, wormholes, and such, was "very excited" to get involved with the time-crunching project through a Bloomberg Distinguished Professors summer program. "I worked with a team of cosmologists (led by Bloomberg Distinguished Professor Chuck Bennett and Associate Professor Toby Marriage) trying to figure out what happened in the first few seconds of the universe with data from the Cosmology Large Angular Scale Surveyor (CLASS) telescope," she says.

She didn't visit the telescope on a remote desert mountaintop in Chile, but instead worked remotely to improve one of the detectors. "It's an upgrade of sorts," Afko says, "trying to make one of the telescopes more sensitive."

There are physical chips inside each detector that take in all kinds of electromagnetic radiation—a lot more than is actually needed. The chip, then, needs to dispel the excess energy, and do so without causing interference.

"So, what I was doing was trying to design a chip that will dispel that excess radiation in a controlled way so it's not just going everywhere and messing up the rest of the detectors," Afko says. "The bulk of my research was making simulations using fancy software called HFSS [High-Frequency Structure Simulator]."

After about 10 weeks of painstaking trial-and-error modeling, she had the simulations performing as desired and ready for their last set of tests.

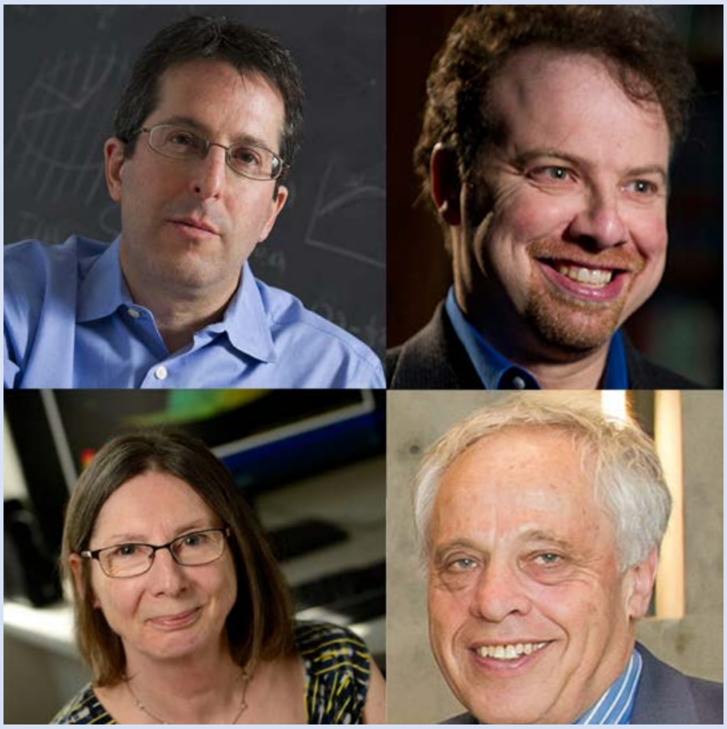
"I learned that I asked a lot of questions, which I'm finding out is actually not a bad thing," Afko says of the project. "I learned some of the ins and outs of working with other people. And I also learned that cosmology is pretty cool. I think it's giving my love for particle physics a run for its money."

NEWS BRIEFS

Yi Li Receives 2020 Johns Hopkins Catalyst Award

Assistant Professor Yi Li has been chosen as a 2020 Johns Hopkins Catalyst Award recipient. This is in recognition of her exceptional work as an early-career investigator, which embodies the spirit of discovery that defines Johns Hopkins University. The 2020 Catalyst Award honorees will each receive a $75,000 grant to support their work over the next year. They also will have the opportunity to participate in mentoring sessions and events designed to connect the Catalyst Award honorees at similar stages in their careers.

As a condensed matter theorist, Li is interested in exploring exotic quantum phases of matter and their organizing principles, particularly novel topological insulators and topological superconductivity in condensed matter and ultra-cold atom systems, itinerant ferromagnetism, as well as non-perturbative analytic and quantum Monte Carlo approaches to strongly correlated quantum systems.



Marc Kamionkowski, Adam Riess, Rosemary Wyse, and Joseph Silk Become AAS Fellows

The American Astronomical Society (AAS) announced a new accolade in 2020: Fellow of the AAS, and four department members are part of the inaugural class. Professors Marc Kamionkowski, Adam Riess, Joseph Silk, and Rosemary Wyse were recognized for "original research and publication, innovative contributions to astronomical techniques or instrumentation, significant contributions to education and public outreach, and noteworthy service to astronomy and to the Society itself."

Jonathan Bagger to Become CEO of American Physical Society

Research Professor Jonathan Bagger, a theoretical physicist in the department, has been selected to succeed Kate Kirby as American Physical Society (APS) Chief Executive Officer in 2021. Bagger has a long history of service to APS. Most recently, he chaired the APS Task Force on Expanding International Engagement. He was elected a Fellow of APS in 1997 for his contributions to the theory and phenomenology of supersymmetry, supergravity, and supercolliders. He served on the editorial boards of Physical Review Letters (1990-

1993) and Physical Review D (1998-2007), the chair line of the APS Division of Particles and Fields (2001-2004), the APS Council (2001-2004), and the APS Executive Board (2003-2004).

Bagger has directed TRIUMF, Canada's particle accelerator center in Vancouver, British Columbia since July 2014. He was previously Krieger-Eisenhower Professor in the department, where he also served as chair of the department and held several senior administrative positions at JHU.

Undergraduate Vedant Chandra and Graduate Students Hsiang-Chih Hwang and Sihao Cheng Lead Successful White Dwarf Research

A team of student researchers supervised by Associate Professor Nadia Zakamska recently authored a study in *The Astrophysical Journal* describing their new measurement of the white dwarf mass-radius relationship. The paper was led by undergraduate student Vedant Chandra, graduate students Hsiang-Chih Hwang and Sihao Cheng, and is titled "A Gravitational Redshift Measurement of the White Dwarf Mass-Radius Relationship."

At the heart of every white dwarf star—the dense stellar object that remains after a star has burned away its fuel reserve of gases as it nears the end of its life cycle—lies a quantum conundrum: as white dwarfs add mass, they shrink in size, until they become so small and tightly compacted that they cannot sustain themselves, collapsing into a neutron star.

This puzzling relationship between a white dwarf's mass and size, called the mass-radius relation, was first theorized by Nobel Prize-winning astrophysicist Subrahmanyan Chandrasekhar in the 1930s. Now, the JHU researchers have developed a method to observe the phenomenon itself using astronomical data collected by the Sloan Digital Sky Survey and a recent data set released by the Gaia Space Observatory. The combined data sets provided more than 3,000 white dwarfs for the team to study.

"The mass-radius relation is a spectacular combination of quantum mechanics and gravity, but it's counter intuitive for us—we think that as an object gains mass, it should get bigger," says Zakamska. "The theory has existed for a long time, but what's notable is that the dataset we used is of unprecedented size and unprecedented accuracy. These measurement methods, which in some cases were developed years ago, all of a sudden work so much better and these old theories can finally be probed."

The team obtained their results using a combination of measurements, including primarily the gravitational redshift effect, which is the change of wavelengths of light from blue to red as light moves away from an object. It is a direct result of Einstein's theory of general relativity.

"To me, the beauty of this work is that we all learn these theories about how light will be affected by gravity in school and in textbooks, but now we actually see that relationship in the stars themselves," says fifth-year graduate student Hsiang-Chih Hwang, who proposed the study and first recognized the gravitational redshift effect in the data.

The team also had to account for how a star's movement through space might affect the perception of its gravitational redshift. Similar to how a fire engine siren changes pitch according to its movement in relation to the person listening, light frequencies also change depending on movement of the light-emitting object in relation to the observer. This is called the Doppler effect, and is essentially a distracting "noise" that complicates the measurement of the gravitational redshift effect, says study contributor Sihao Cheng, a fourth-year graduate student.

To account for the variations caused by the Doppler effect, the team classified white dwarfs in their sample set by radius. They then averaged the redshifts of stars of a similar size, effectively determining that no matter where a star itself is located or where it's moving in relation to Earth, it can be expected to have an intrinsic gravitational redshift of a certain value. Think of it as taking an average measurement of all the pitches of all fire engines moving around in a given area at a given time—you can expect that any fire engine, no matter which direction it's moving, will have an intrinsic pitch of that average value.

These intrinsic gravitational redshift values can be used to study stars that are observed in future data sets. The researchers say that

Planetary nebula NGC 2440's central star, HD62166, is possibly the hottest known white dwarf star discovered yet. White dwarfs exhibit puzzling quantum phenomena: As they gain mass, they shrink in size.

Credit: Pixabay / WikiImages

upcoming data sets that are larger and more accurate will allow for further fine-tuning of their measurements, and that this data may contribute to the future analysis of white dwarf chemical composition.

They also say their study represents an exciting advance from theory to observed phenomena.

"Because the star gets smaller as it gets more massive, the gravitational redshift effect also grows with mass," Zakamska says. "And this is a bit easier to comprehend—it's easier to get out of a less dense, bigger object than it is to get out of a more massive, more compact object. And that's exactly what we saw in the data."

The team is even finding captive audiences for their research at home—where they've conducted their work amid the coronavirus pandemic.

"The way I extolled it to my granddad is, you're basically seeing quantum mechanics and Einstein's theory of general relativity coming together to produce this result," Chandra says. "He was very excited when I put it that way."

— Saralyn Cruickshank

NEWS BRIEFS

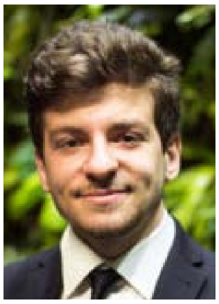
Graduate Students Melissa Diamond, Joshua Kable, Yasuo Oda, and Vincent Morano Receive 2019-2020 Graduate Teaching Awards

The graduate program committee recognizes an outstanding performance by co-head teaching assistants **Melissa Diamond** and **Joshua Kable** who have performed significantly above and beyond the call of duty this term, and have made major substantive contributions to the success of their extremely large course (AS.171.104, Physics for Biological Majors, nearly 400 undergraduates) this semester. Joshua Kable receives this year's E.J. Rhee Teaching Award. Melissa Diamond was already recognized for her outstanding performance with a teaching award in 2019, and the committee thanks her for continued excellence.

Yasuo Oda, most recently head teaching assistant for the Physics Laboratory for physical science majors, is awarded the 2020 Rowland Prize. Yasuo is an excellent teacher who cares a lot about his students and their experience and understanding. He also served this past year as the TA Representative of the JHU Physics and Astronomy Graduate Students outreach association, working to improve the teaching across the department.

Vincent Morano, a teaching assistant for courses for physics majors (Electricity and Magnetism and Classical Mechanics), is recognized for his outstanding work and exceptional evaluations, and receives the 2020 Graduate Teaching Assistant Award.

Chris Lygouras Named 2020 Gardner Fellow



First year graduate student Chris Lygouras has been awarded the department's 2020 William Gardner Fellowship. Lygouras is researching quantum materials with the Institute for Quantum Matter under the supervision of Professor Collin Broholm. He has already been involved in multiple research projects and will expand on these projects with the help of the Gardner Fellowship during the upcoming semesters.

Lygouras is the 12th Gardner Fellow. The fellowship was founded by William Gardner (PhD, '68), who received his PhD 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.

K. D. Kuntz Participates in STORM, NASA's New Mission to Study the Earth's Magnetosheath

Research Scientist K. D. Kuntz will contribute to the Solar-Terrestrial Observer for the Response of the Magnetosphere (STORM) mission that has been selected by NASA for Phase-A study, in preparation for a possible launch in 2026. STORM would provide the first-ever global image of the size and shape of the Earth's magnetosheath, the vast region where the Earth's magnetic field interacts with the solar wind. STORM would track the way energy flows into and throughout near-Earth space.

Led by David Sibeck at NASA's Goddard Space Flight Center, both the department and the JHU APL are contributing to this mission. The department's role is to help design and test the very wide field X-Ray Imager (XRI) at the heart of the STORM mission.

Kuntz is designing the optic and related sunshade, running simulations of the instrument, and designing pre-flight tests of the optics. By measuring the solar wind induced charge exchange in the near-Earth environment, STORM will provide the measurements vital to removing this bright, time-variable X-ray emission from astrophysical observations of the Galactic halo and the intergalactic medium, which have been the main objects of Kuntz's interest.

Peter Armitage Awarded Multidisciplinary Research Grant from U.S. Army and Department of Defense

Professor Peter Armitage has been selected to lead a multi-institution Multidisciplinary University Research Initiative (MURI), funded by the U.S. Army and the Department of Defense. Armitage will lead one of eight teams selected for the initiative to develop disruptive solutions to some of the most promising challenges important to Army modernization. Specifically, Armitage's team will focus on the implementation of axion electrodynamics in topological films and devices. The MURI award is a $6.25 million-dollar effort over 5 years that will investigate and utilize the electrodynamic response of topological materials.

Peter Armitage Explores the Future of the Correlated Electron Problem with 46 Scientists Via Collaborative Software

Professor Peter Armitage recently finished editing a paper called "The Future of the Correlated Electron Problem." This is a unique manuscript that attempts to summarize the collective views of 46 junior scientists (beginning assistant professors, postdocs, and senior students) on the future of correlated electron systems. The content of the paper is the result of the vigorous discussions and deliberations that took place at JHU during a three-day workshop in January that brought together the junior scientists. The manuscript was written through collaborative writing software such as Google Docs, Slack, and Overleaf. 80% of the text was written collectively in the first 72 hours following the workshop. All 47 coauthors (including Armitage) contributed to the writing and proofing. Ultimately, this process resulted in a unique paper that was made possible by modern collaborative software.

Kirsten Hall Named Schmidt Science Fellow

Kirsten Hall, who competed her PhD with Associate Professor Toby Marriage and Associate Professor Nadia Zakamska over the summer, has been named one of the 22 early-career scientists who comprise the 2020 cohort of Schmidt Science Fellows, a program of Schmidt Futures, in partnership with the Rhodes Trust. The new Schmidt Science Fellows aim to harness interdisciplinary approaches to tackle long-term societal challenges, including infectious disease,

climate change, and biodiversity loss.

Kirsten is an astrophysicist interested in the evolution of galaxies over all of cosmic time. She has combined state-of-the-art data sets with advanced theoretical modeling to uncover the relationship between star-forming galaxies and dark matter and to measure the impact of growing supermassive black holes on their host galaxies. As a Schmidt Science Fellow, Kirsten now aims to move into climate science to use her expertise with large data sets to convert raw data from atmospheric monitoring satellites and ground-based data into actionable information. By being able to trace emissions back to their sources, she hopes to improve vitally important climate models.

Surjeet Rajendran Receives Two Gordon and Betty Moore Foundation Fundamental Physics Innovation Awards

Associate Professor Surjeet Rajendran is the recipient of two Gordon and Betty Moore Foundation Fundamental Physics Innovation Awards this year.

These awards hope to stimulate ideas on innovative ways in which emerging technologies can be used to address pressing problems in fundamental physics. The awards support a variety of ways to bring people together to discuss and collaborate on ideas to advance fundamental physics.

Rajendran received the Moore Foundation's Convening Award to host a workshop dedicated to discussing emerging trends in theoretical particle physics relevant to understanding phenomena in our universe.

In addition, he received the Moore Foundation's Visitor Award to visit Peter Graham at Stanford, to develop new techniques for laboratory detection of dark energy and low-frequency gravitational waves.

NEWS BRIEFS

Jared Kaplan's Research Selected for Best Paper Award by Neural Information Processing Systems

A paper on research by Jared Kaplan and colleagues has been selected by the Neural Information Processing Systems for a Best Paper Award. This is one of the most prestigious awards a paper can win in the world of artificial intelligence.

The paper describes Generative Pre-trained Transformer 3, or GPT-3, the largest and most sophisticated language model ever constructed. It demonstrates that, if you make a language model accurate enough by using unprecedented amounts of data, it gains the ability to solve a wide variety of tasks without additional training, using only simple, natural language prompts.

Junjia Zhang Receives Provost's Undergraduate Research Award

Physics major Junjia Zhang has been selected to receive the Provost's Undergraduate Research Award for the current academic year. Junjia is working with Assistant Professor Yi Li in theoretical condensed matter physics.

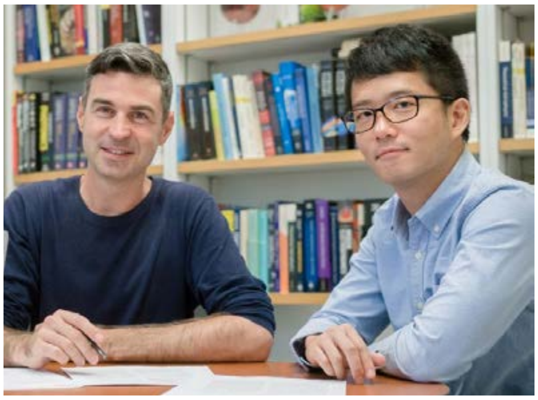
Provost Joseph Cooper (1991-1995) established the Provost's Undergraduate Research Award program in 1993 with a generous endowment by the Hodson Trust. The program was created to support and encourage Hopkins undergraduate students to engage in independent research, scholarly, and creative projects.

Brice Ménard and Yi-Kuan Chiang Measure the Global Warming of Galaxies

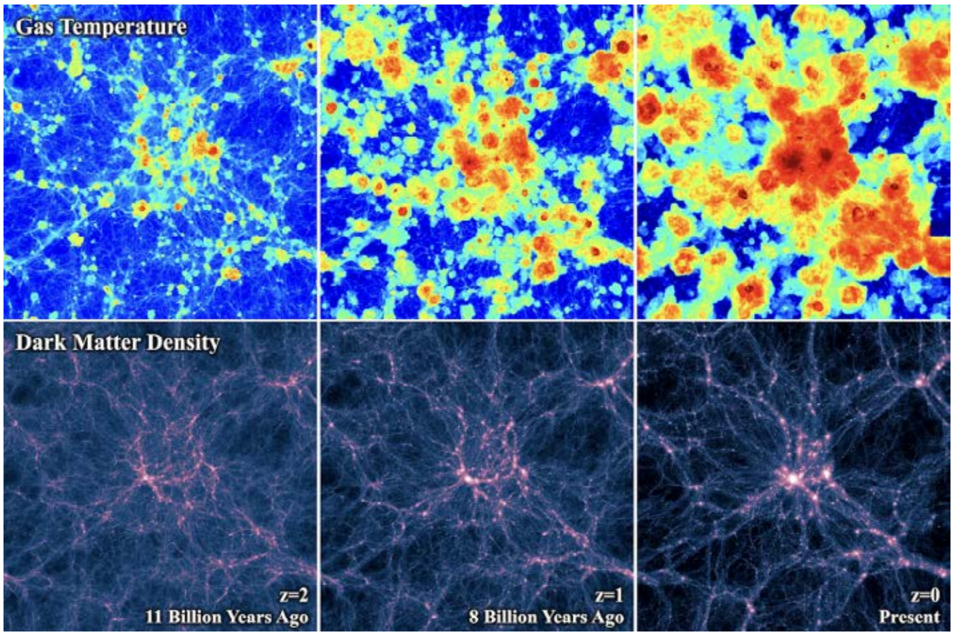
Associate Professor Brice Ménard and former postdoctoral fellow in the department, Yi-Kuan Chiang, have published research in *Astrophysical Journal* that demonstrates how the temperature of galaxy clusters today, on average, is 10 times hotter than 10 billion years ago.

"We have measured temperatures throughout the history of the universe," said Ménard, "As time has gone on, all those clusters of galaxies are getting hotter and hotter because their gravity pulls more and more gas toward them."

The research team used a novel tool that Ménard developed with Chiang. With it, they estimated the redshift of gas concentrations seen in images of microwave light going back in time all the way to 10 billion years ago. They call the new tool the Tomographer and it is able to explore the redshift distribution of any source catalog or sky map, using the a clustering-redshift technique.



Brice Ménard (left) and Yi-Kuan Chiang



As the universe evolves, matter concentrations are surrounded by gas halos getting hotter and bigger. (Credit: D. Nelson / Illustris Collaboration)

2020 Physics Major Katherine Xiang named Hertz Graduate Fellow

A lifelong artist who came to science through her design work, Katherine Xiang spent her Hopkins career leveraging her talents in the scientific world, curating gallery exhibitions with the TedX team, collaborating with a local Baltimore artist on a stage installation inspired by entropy, and designing graphics about GMO misinformation for the meal-replacement company Soylent.

After finishing her final semester at Hopkins, Xiang—a physics, biophysics, and mathematics major—was awarded the Hertz Graduate Fellowship, a prestigious award recognizing her contributions to physics.

The fellowship is granted to outstanding physical, biological, and engineering science students who demonstrate the potential to change the world for the better through their research. Xiang is one of 16 students selected to receive the award from a pool of more than 800 applicants. The award includes up to five years of funding, as well as professional support from a network of more than 1,200 fellows.

While Xiang may have originally felt her scientific and artistic leanings were at odds with each other, she realized their intrinsic link during the summer before college.

"One day I applied to a job at a science infographic startup on a hopeful whim. This led to a surprise—my first encounter with research," Xiang said. "One morning, I got a phone call from the CEO. He was delighted by my graphic design work and wanted me to work for them. However, I had never read a research paper before."

The intersection of science and design will play a major role in her career in physics, during which she hopes to leverage her artistic talents to merge her research with communication, delivering findings to the public with integrity.

"I am confident that scientific progress will better people's lives, and I strive toward inspiring this same belief in the public, by explaining science through an accessible medium," Xiang said. "The U.S. needs science communication now more than ever in this era of scientific distrust, such as toward climate change, immunology, GMOs, and other fields. Science communication will certainly not be enough, but it's a first step."

While at Hopkins, Xiang worked extensively with the research group of Professor Daniel Reich, who described Xiang as one of the best undergraduate research students he has ever worked with.

"She has outstanding experimental and mathematical skills, and has an overwhelming perseverance and commitment to get things done in the lab," Reich said. "She took our research on the dynamics of force fluctuations in the cellular cytoskeleton in a new direction, and her work forms a major component of two papers that we expect to publish this year."

With support from the fellowship, Xiang will pursue a PhD in physics at Harvard University in the fall. Although she is keeping her options open, her possible paths for research at Harvard are plentiful: quantum mechanics, magnetic field sensing in birds, and innovative treatments for metabolic diseases. She hopes to continue to hone her creative abilities through art classes and continue to merge the two in her career as a scientist to make the results of her work more accessible.

— Jacob Budenz

Sydney Timmerman and Katherine Xiang are Co-recipients of the 2020 Donald E. Kerr Memorial Award

Physics majors Sydney Timmerman and Katherine Xiang were named as co-recipients of the 2020 Donald E. Kerr Memorial Award. The Kerr Award, established in 1979, acknowledges outstanding graduating Physics majors who have distinguished themselves through their performance in the classroom, their accomplishments in research, and their other positive contributions to the department.

Turner Woody Receives Goldwater Scholarship

Junior physics major Turner Woody was awarded a 2020 Goldwater Scholarship. Woody's goal is to pursue a PhD studying the chemistry and kinematics of stars in our galaxy. His faculty mentor is Assistant Professor Kevin Schlaufman.

The Goldwater Scholarship Program, one of the oldest and most prestigious national scholarships in the natural sciences, engineering and mathematics in the United States, seeks to identify and support college sophomores and juniors who show exceptional promise of becoming this Nation's next generation of research leaders in these fields.

VIDEOS

The Wonders of Networks

In January Associate Professor Brice Ménard presented the President's Frontier Award Lecture on his research concerning networks and sequences all around us. Ménard was the recipient of the President's Frontier Award in 2019.

Women in Physics & Astronomy Spotlight

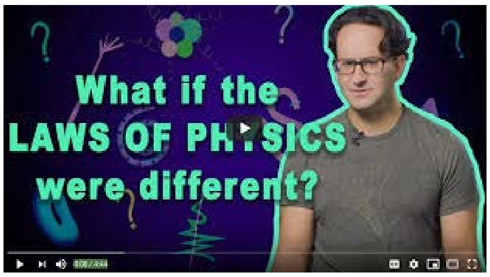
The JHU Physics and Astronomy Advisory Council welcomed three of the department's cutting-edge scientists to share their research via Zoom. This video allows viewers to learn first-hand about the exciting research being conducted by graduate student Melissa Diamond, postdoctoral fellow Yishu Wang and Associate Professor Nadia Zakamska.

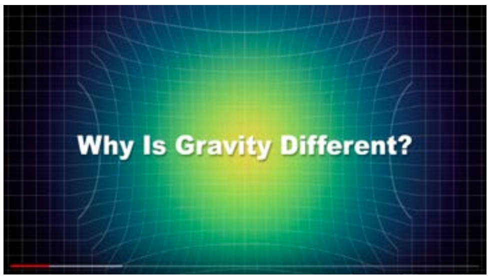
Space@Hopkins Virtual Symposium

Space@Hopkins, led by Bloomberg Distinguished Professor Chuck Bennett, connects the array of Johns Hopkins University divisions, departments, and collaborative institutions in their common pursuit of civilian space research. The Space@Hopkins 2020 Virtual Symposium video features astronaut Captain Reid Wiseman (JHU WSE '06) and five Space@Hopkins seed grant recipients.

Jared Kaplan Creates Video Series with Scientific American

Associate Professor Jared Kaplan created a new video series in conjunction with *Scientific American* in 2020 that focuses on physics, cosmology, and quantum gravity. The three short, whimsical videos were funded by Kaplan's National Science Foundation CAREER grant.





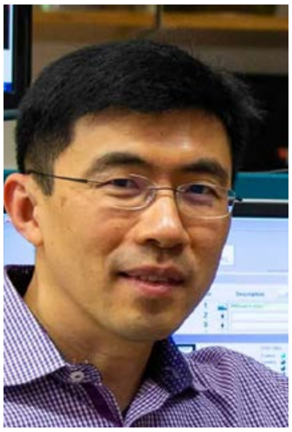
ALUMNI UPDATES

These five former department members achieved great things in 2020. We hope that you share your latest accomplishments with us by contacting Pam Carmen in the Chair's Office at pcarmen@jhu.edu.

Rob Semper Receives Joseph A. Burton Forum Award

Rob Semper (PhD 1973) has been awarded the 2021 Joseph A. Burton Forum Award from APS for his outstanding contributions to the public understanding or resolution of issues involving the interface of physics and society.

Kai Liu Named AAAS Fellow



Kai Liu (PhD 1998), McDevitt Chair in the Department of Physics at Georgetown University, has been elected Fellow of the American Association for the Advancement of Science (AAAS). Liu was recognized "for distinguished contributions to the field of nanomagnetism and spintronics, particularly for understanding of magnetic materials and nanostructures." He is one of 27 members elected from the AAAS Section on Physics in 2020.

Jami Valentine Miller Celebrates 165 African American Women Physicists

Jami Valentine Miller (PhD 2006), the first Black woman to graduate with a PhD in physics from Johns Hopkins University, has amassed a listing of 165 African American women who are currently working in, or retired from, the field of physics on the website she created, African American Women in Physics, AAWIP.com. Miller regularly engages in many outreach activities, including speaking to young physicists, future scientists and engineers, and those interested in non-academic physics careers, especially in intellectual property.

David Jones Named NASA Einstein Fellow

David Jones (PhD 2017) has been awarded a NASA Einstein Fellowship. The Einstein Fellowship enables outstanding postdoctoral scientists to pursue independent research across NASA Astrophysics, using theory, observation, experimentation, or instrument development. Each fellowship provides the awardee up to three years of support. Bloomberg Distinguished Professor Adam Riess was Jones' PhD advisor.

Jeffrey (Heshy) Roskes Receives Springer Award

Jeffrey (Heshy) Roskes (PhD 2019) has received the Springer Award for an outstanding PhD thesis. Roskes worked with Professor Andrei Gritsan as his PhD advisor. Together with his colleagues in the CMS group at JHU, Roskes developed a precise analysis of the properties of the Higgs boson. The Springer Award is composed of a monetary prize to the student, as well as publication of the work in the Springer collection of outstanding dissertations, *Springer Theses*.

Roskes is currently an Assistant Research Scientist in the Institute for Data Intensive Engineering and Science at JHU led by Bloomberg Distinguished Professor Alex Szalay.

Please keep in touch!

We would love to hear from you.

Contact Pam Carmen in the Chair's Office at pcarmen@jhu.edu

IN MEMORIAM

Mark O. Robbins, professor and renowned condensed matter and statistical physicist, died unexpectedly on Thursday, August 13, 2020. He was 64.

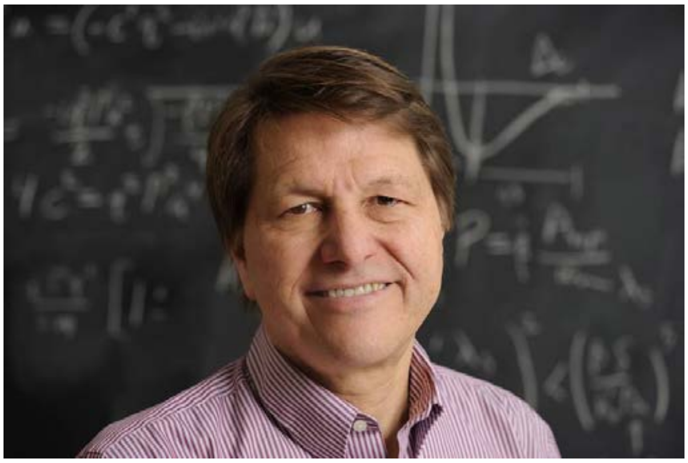
Robbins specialized in non-equilibrium processes like friction and adhesion, working to better understand the atomic origin of macroscopic phenomena such as earthquakes and avalanches. He also played a key role in supporting the development of computational facilities at Johns Hopkins, and was associate director of the Institute for Data Intensive Engineering and Science, coordinating the institute's computing efforts.

"Mark was a brilliant physicist," said Robert Leheny, also a professor in the department and a colleague who worked closely with Robbins. "What I admired most about Mark was his keen eye for interesting problems, which he combined with deep intuition, to make beautiful insights about the physical world that many would have overlooked."

Robbins also made an impact on his students. "[Mark] was greatly liked and admired by generations of graduate students and postdocs, and a large part of his legacy will be his many former group members who are now emerging as leaders in their own right," Leheny said. "Mark really set a positive tone in the department, and in the condensed matter group, that made it an enjoyable and invigorating place to work and study. On a personal level, Mark was a great friend and mentor to me. He made me feel at home and supported from the first day I arrived in Baltimore. I feel a terrible loss on his passing."

Robbins grew up in Newton, Massachusetts, and received his BA and MA degrees from Harvard University. He spent a year as a Churchill Fellow at Cambridge University before receiving his PhD from the University of California, Berkeley in 1983. Following a postdoctoral fellowship at Exxon's Corporate Research Science Laboratory in New Jersey, he joined the Department of Physics and Astronomy at Johns Hopkins in 1986.

According to Bloomberg Distinguished Professor Alex Szalay, Robbins was central to the grass-roots effort to build the first shared computing cluster at JHU and subsequent expansions of that system. His efforts were also critical to establishing the alliance that resulted in the Maryland Advanced Research Computing Center, the largest computing system at JHU, and he was part of the team to receive a multi-million dollar grant from the National Science Foundation to expand the MARCC.



Mark O. Robbins
1955 - 2020

"Mark was the driving force behind bringing modern, high-performance computing to Johns Hopkins," Szalay wrote. "The large computing systems he helped to create have changed the way we all do our research—he left indelible marks behind."

On a research trip to Brazil in 1987, Robbins picked up what he humorously described as a "dangerous habit" of collecting and crossbreeding orchids. He grew a diverse number of the species, from miniature species with blooms no larger than a watermelon seed, to upward twisting palm-sized sculptural flowers. After growing hundreds of orchids in the basement of his home and his office in Bloomberg Center, Robbins also developed new breeds of orchids through experimental crossbreeding techniques, earning him an Award of Merit from the American Orchid Society. He officially named two of his new orchids after his children, Thomas and Catherine.

"Mark had a wide range of interests in theoretical soft condensed matter physics, and his work always showed impeccable tastes," wrote Professor Chia-Ling Chien, "One of the first things to bring him fame while still an assistant professor was his research addressing the microscopic origin of friction, a phenomenon so ubiquitous yet poorly understood."

Added Tim Heckman, chair of the department: "Mark Robbins was a great colleague and true leader. His passing leaves a gaping hole in the fabric of our department. We will do all we can to support the research team he left behind."

Robbins was a member of the advisory board for the Kavli Institute of Theoretical Physics at the University of California, Santa Barbara and was also on the advisory board of the Boulder School for Condensed Matter and Materials Physics. He became a Fellow of the American Physical Society in 2000 and was awarded a Simons Fellowship in Physics in 2013. He served as chair of the American Physical Society Group on Statistical and Nonlinear Physics and organized symposia and workshops, such as "From the Atomic to the Tectonic: Friction Fracture and Earthquake Physics," for the Materials Research Society and the Aspen Center for Theoretical Physics.

He is survived by his wife, Patricia McGuiggan, an associate research professor in the Whiting School of Engineering's Department of Materials Science and Engineering, and his two children.

IN MEMORIAM

Ronald J. Allen, adjunct professor in the department and Space Telescope Science Institute (STScI) astronomer, passed away on August 8, 2020. Allen was a pioneer in the field of radio astronomy and the physics of the interstellar medium in galaxies from radio, optical, and far-ultraviolet observations. He inspired countless young astronomers to always "look at the physics first" and to seek answers to the universe's most interesting questions.

"He was very direct and always was able to cut out the surrounding noise to get to the most essential information within a complex idea," remembered longtime colleague and research scientist in the department, Anand Sivaramakrishnan. "Ron was able to ignore what was not important and focus on what would advance [STScI's] reputation and reach."

Allen played a key part in awarding funds to the team that led the development of Hubble's Wide Field Camera 3, which gave new life to Hubble and has subsequently ushered in countless scientific discoveries since its installation.

Born and raised in Prince Albert, Saskatchewan, Canada, Allen took up skiing and fishing, although he enjoyed the former more than the latter. He graduated with a bachelor's degree in physics from the University of Saskatchewan in 1961 and a doctorate in physics from the Massachusetts Institute of Technology in 1967. Allen chaired the astronomy department at the University of Illinois for four years starting in 1985. He then joined the Space Telescope Science Institute in 1989, when he also became an adjunct professor in the department.

Allen was graduate lecturer on "Fourier Optics and Interferometry in Astronomy" in the department Sivaramakrishnan, who co-taught the course with Allen for many years, remembers him as a highly approachable and nurturing mentor that motivated his students to always seek answers to the interesting, important questions.

"He was always finding ways to challenge people to do their utmost, by saying, 'What more can you get out of this, how much more can you do?'" Sivaramakrishnan said. "And the way he did it was very nonthreatening and brought out people to do extremely good work."

Ronald J. Allen
1940 - 2020

Allen was a respected researcher published in 18 invited review papers (16 as the first author), more than 100 papers in refereed journals (33 as the first author), and more than 66 papers in conferences and media (24 as the first author).

According to Professor Colin Norman, a longtime colleague, Allen was particularly proud of the four *Nature* covers, and their associated ground-breaking studies, framed on his office wall. Allen's research over the years focused on spiral galaxies and he's specifically remembered for his work on neutral hydrogen gas in the Andromeda galaxy.

Michael Busch, a graduate student in the department, spent the summer of 2017 working with Allen as part of a research rotation.

"Allen was a very easy guy to work with," said Mr. Busch, who wrote a tribute to Allen on Facebook. "You could ask him a dumb question, and he would say, 'That's a great question,' and then explain why that happened. He knew where to start you off and then lead you along. Every week, he would check in with you and explain physics in a way where it wasn't like a classroom instruction, but an appreciation for physics. Through that sort of perspective, he would excite his students into doing research, and I really appreciated that perspective."

One year after Allen moved his family to Phoenix in Baltimore County, his wife, Janice R. Allen, surprised him with two breeding ewes for his 51st birthday in 1991 and fenced off one acre of land for the sheep. Two acres of their five-acre property is now home to nine ewes, four rams and five lambs.

"It doesn't go with him when you picture an astrophysicist, but he found the fact that the sheep had a life that depended on the seasons and knew what they needed, he just loved it," she said, adding that her husband was an active member of the Maryland Sheep Breeders Association and participated several times in the annual Maryland Sheep and Wool Festival. "I think it grounded him somehow."

In addition to his wife, Allen is survived by a daughter, Melanie McConkey of Arlington, Massachusetts; two sons, Matthew Allen of Jarrettsville and Stefan Allen of Catonsville; one brother, Anthony Allen of Saskatoon, Saskatchewan, Canada; and seven grandchildren.

JOHNS HOPKINS
KRIEGER SCHOOL
of ARTS & SCIENCES

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Celebrating the 30th Anniversary of Astro-1

December 2-10, 2020, marked the 30th anniversary of the Astro-1 space shuttle mission aboard the orbiter Columbia. This mission carried the Astro Observatory into space for a dedicated ultraviolet astronomy mission, including the Hopkins Ultraviolet Telescope (HUT) for which Professor Arthur F. Davidsen was the Principal Investigator. HUT was a 0.9 m telescope with a prime focus far ultraviolet spectrograph. The spectrograph itself is on display in the Bloomberg Center second floor lobby, but HUT is on display in the Smithsonian Air & Space Museum. Many of the scientists and engineers who "cut their teeth" on the HUT project at JHU have gone on to become key players in many other missions and space instruments, including the Hubble Space Telescope and the upcoming James Webb Space Telescope. Congratulations to all who participated in this landmark mission.