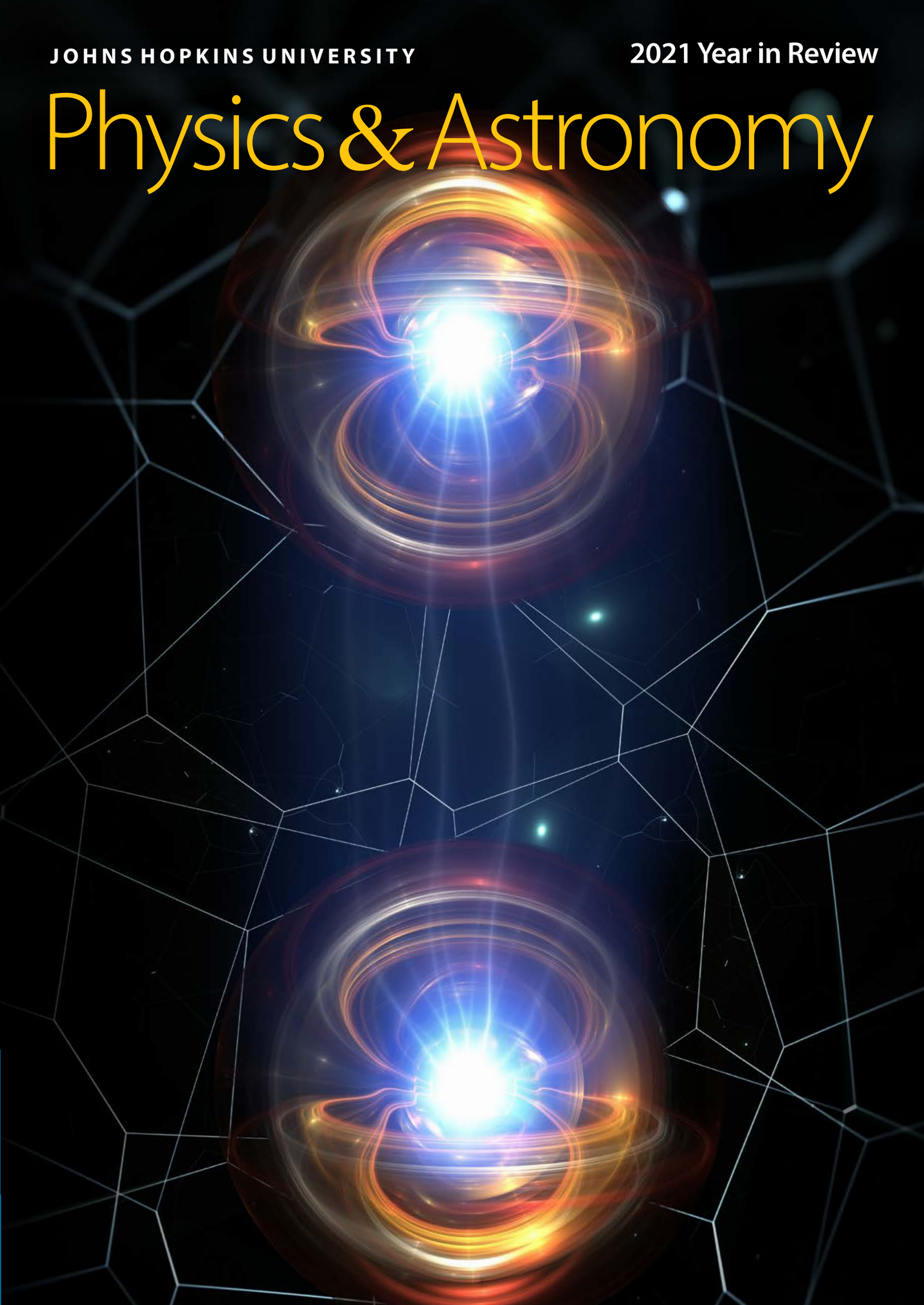
JOHNS HOPKINS UNIVERSITY

2021 Year in Review

Physics & Astronomy



JOHNS HOPKINS
KRIEGER SCHOOL
of ARTS & SCIENCES

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Physics and Astronomy is an annual publication of the Johns Hopkins University Zanvyl Krieger School of Arts and Sciences and the William H. Miller III Department of Physics and Astronomy. Send correspondence to:
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Front cover: Researchers in the Institute for Quantum Matter, housed in the department, study the quantum mechanics of materials. According to these quantum equations, particles can possess multiple characteristics until they are observed; and they can affect each other s states across vast distances instantaneously, seemingly defying the universal speed limit, the speed of light. These perplexing properties are examined in ***The Institute for Quantum Matter: Discovering the Materials of the Future*** on page 3.

Credit: Peter Jurik, Quantum Entanglement Illustration

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Letter from the Chair

Dear alumni, colleagues, and friends,

If you have not heard already, I want to pass along some incredible news. In December the department received a gift of $75M. Of this, $50M is from philanthropist William H. Miller III and $25M is from other anonymous donors. To our knowledge, this is the largest gift ever made to a physics department. This unmatched gift will be used to build upon the extraordinary strengths of the department to take us to a new level of excellence. In recognition of this gift, the department has been renamed the William H. Miller III Department of Physics & Astronomy. The faculty have plans to continue to honor the legacy of Henry Rowland as we enter a new age for the department.

When added to additional investments to made by the university, the department will be transformed over a five-year period. The size of the faculty will increase by 13 new positions, enabling us to establish an outstanding new group in Atomic, Molecular, and Optical (AMO) physics and attain a "critical mass" in the most exciting and rapidly developing areas in physics and astronomy. We will be launching new programs of William H. Miller III postdoctoral fellows and graduate research assistants. These programs will bring the brightest and most promising young scientists into the department. This will make the department an even more vibrant place, and enable us to train, and mentor the scientific leaders of tomorrow.

On top of all this good news, I am also very pleased to welcome three new faculty members into the department as of January 1, 2022. These are Assistant Professors Dan Beller (theoretical Biological and Condensed Matter Physics), Yahui Zhang (theoretical Condensed Matter Physics), and Yaojun Zhang (theoretical Biological Physics, in a joint position with the Department of Biophysics). This not only greatly strengthens Condensed Matter Physics, but puts us in a strong position to build a world-class group in Biological Physics.

As a final bit of good news, the James Webb Space Telescope (JWST) was successfully launched on Christmas morning and is on its way to its eventual orbit a million miles from Earth, where it will look back over 13 billion years to study the first stars and galaxies, and (much closer to home) will seek possible chemical signatures of life on planets orbiting other stars. If Hubble is any guide, JWST's most remarkable discoveries will be the unanticipated ones. JWST will be operated on behalf of the scientific community at the Space Telescope Science Institute (STScI), just across San Martin Drive from our department. We look forward to working with our STScI colleagues to make the most of this incredible tool for discovery. We won't be out of the woods in terms of full verification of JWST's performance for about six months. Everything is great so far, but we have a long way to go. Fingers crossed!

Here's wishing that we can finally emerge from the COVID-19 pandemic and spend more time celebrating and planning face-to-face in the months ahead. Best wishes to you all, and thanks for your continuing interest in, and support of, the department.

Best regards,

Tim Heckman

INVESTOR BILL MILLER GIVES $50M TO JOHNS HOPKINS DEPARTMENT OF PHYSICS AND ASTRONOMY

Legendary investor and philanthropist William H. "Bill" Miller III has made a lead gift of $50 million in a combined $75 million philanthropic effort to support Johns Hopkins University's Department of Physics and Astronomy.

Miller's $50 million commitment will fund endowed professorships, postdoctoral fellowships, and graduate research, and will provide ongoing support for research infrastructure. His gift also served as the impetus for two anonymous donors to support the department as well, expanding to $75 million the funding to advance key areas of physics research.

William H. "Bill" Miller III

The gift will propel one of the nation's most storied departments of physics to new heights—expanding research into emerging subfields of study and attracting promising young researchers, Johns Hopkins University President Ron Daniels said.

"The support Bill Miller has shown Johns Hopkins is historic," Daniels said. "Four years ago, Mr. Miller committed what is believed to be the largest ever gift to a university philosophy program, and now he has made an equally impressive gift to the study of physics and astronomy. We are endlessly grateful for his generosity that is driving our scholars to explore everything from the human condition to our understanding of the universe and our place in it. A philanthropic investment of this magnitude will be a standard-bearer for how a robust physics and astronomy department can broaden its research, engage in collaborative exploration, and advance to the front lines of emerging areas."

Said Miller: "Physics seeks to understand reality at its most fundamental level. It is the bedrock on which the other sciences rest. I am delighted to be able to make a gift to Johns Hopkins physics that will enable it to add new resources and continue to build on its distinguished history."

At the center of Miller's gift is funding for young scientists. Support for these future leaders in physics and astronomy includes the creation of 10 prize postdoctoral fellowships and 10 endowed graduate research fellowships. The gift will also support the establishment of three endowed professorships, a cohort of senior and junior level faculty lines, and funding for research infrastructure such as laboratory equipment and instrumentation. In all, this new philanthropic support will enable the department to grow from its current 33 faculty to 46 over the next five years.

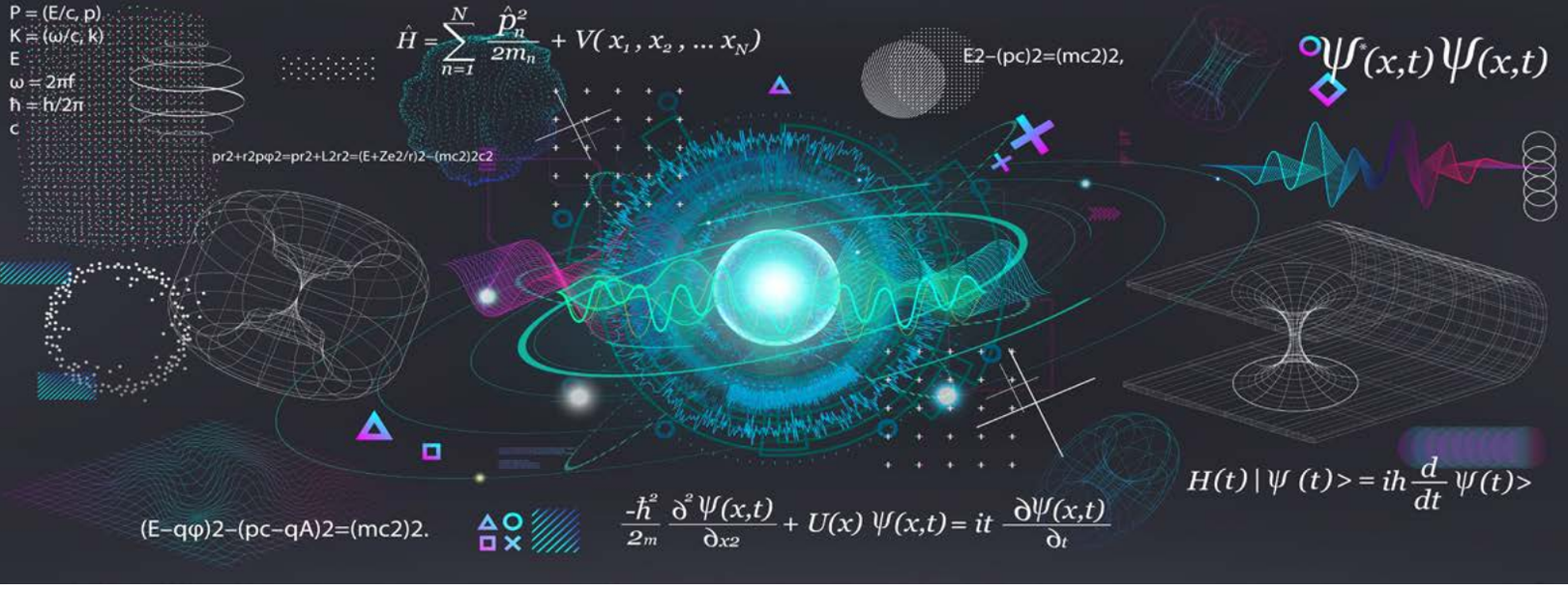
"The visionary research currently underway in our physics and astronomy department will be enhanced by this gift in vital ways that could potentially change our view of the universe," said Chris Celenza, dean of the university's Krieger School of Arts and Sciences, of which the Department of Physics and Astronomy is a part. "Mr. Miller's extraordinary gift will enrich the scholarly and collaborative pursuits of our faculty and students for decades to come."

Today, the department's expertise is distributed in three primary areas: astronomy, condensed matter physics, and particle physics. Its experimental and theoretical faculty members are renowned for their work in areas such as astrophysics, cosmology, extra-galactic astronomy, big data, quantum materials, particle-theory model building, dark matter detection, and studies of new particles and their interactions.

"Because of Mr. Miller's gift, Johns Hopkins will be an even more enticing place for young physics students and scholars to learn from our preeminent physicists," said Timothy Heckman, professor and department chair. "Our faculty, in turn, will have the privilege of preparing the next generation of brilliant physicists. Such a financial venture will have an astounding impact on discovery that could potentially reveal new truths about some of the deep mysteries of the universe and how we live in it."

In recognition of Miller's gift, the department has been renamed the William H. Miller III Department of Physics and Astronomy. The department formally carried an honorific naming in recognition of the department's first chair, Henry A. Rowland, who was known as one of the most significant physicists of the 19th century for his work in electricity, heat, and astronomical spectroscopy. The department chair's position will now be named for Dr. Rowland, and the university will seek additional opportunities to honor his legacy.

Miller is the founder and chairman of Miller Value Partners and formerly the longtime manager of the Legg Mason Capital Management Value Trust. Miller serves on the Johns Hopkins University board of trustees. He majored in economics and European History at Washington and Lee University, graduating with honors in 1972. He later served as a military intelligence officer overseas and studied philosophy at Johns Hopkins before turning to his career in investments. In 2018, he made a $75 million gift to Johns Hopkins' Department of Philosophy, believed to be by far the largest gift ever to a university philosophy program.



THE INSTITUTE FOR QUANTUM MATTER:

DISCOVERING THE MATERIALS OF THE FUTURE

BY ANNIE PRUD'HOMME-GENEREUX

"Materials are so important for society that we name whole eras after them," notes Brad Ramshaw, a principal investigator in the Institute for Quantum Matter.

Stone Age, Bronze Age, Iron Age. The structural properties of these materials define their era. For example, "iron holds an edge better on a sword than bronze, and you can build bigger things because it's not as soft," explains Ramshaw.

Which material defines our age? Many would argue that computer chips shape every aspect of our lives, from opening a car door at a distance to video conferencing across continents. This capability depends on the semiconductor properties of silicon. "You couldn't do that with glass or iron; it just doesn't work. You need silicon. Silicon is special," asserts Ramshaw. Or, put another way, we live in the Silicon Age.

The researchers at the Institute for Quantum Matter (IQM), an Energy Frontier Research Center funded by the Department of Energy, seek to uncover what materials come next. The IQM connects 13 principal investigators spread across five universities; nine are at Hopkins, with others at Princeton, Rutgers, Penn State, and Cornell. These physicists and chemists are theorizing, creating, and then studying the properties of new materials, elements of the periodic table put together in new combinations that may unlock new properties of matter, new technological capabilities, and propel our society into a new era.

As the name of the institute suggests, researchers at the IQM are betting that "quantum materials" are the gateway to the next age. But, what exactly is a quantum material?

"Pretty much all of the materials are quantum," chuckles Oleg Tchernyshyov, a principal investigator at IQM. "The underlying equations that govern me throwing my wallet, or anything – it is ultimately quantum mechanisms," agrees Ramshaw.

"But," Ramshaw adds, "for a lot of problems that we are interested in – humans are usually interested in problems that they can see, that are at the human scale – you can ignore quantum mechanics. You can use Newton's laws and statistical mechanics and thermodynamics, and for most things, the fact that there is quantum and atoms down at some tiny level… You don't have to worry about that. You can figure out how to hit a baseball and figure out the equations for putting a rocket up in space without knowing anything about quantum mechanics."

The problem with continuing with this strategy is that "we have already harnessed the classical properties of materials," says Ramshaw. To develop new technologies, we must discover new materials with properties that can only be explained by quantum – not classical – physics. Ramshaw hints that discovering these materials "would allow us to do things we can't currently do."

Quantum mechanics takes place at tiny scales and extreme energies. It describes phenomenon that are challenging to grasp based on our everyday experiences. According to these equations, particles behave as waves and interfere with one another like colliding ripples on a pond; they can possess multiple characteristics until they are observed; and they can affect each other's states across vast distances

instantaneously, seemingly defying the universal speed limit, the speed of light.

Crucially, these properties emerge from the collective action of electrons. "You can learn everything there is to know about one electron," says Ramshaw, "but when you put [many] electrons together, they do completely different things like superconductivity that you would never, in a million years, predict from studying a single electron."

"For information technology systems there are opportunities to reduce consumption while continuing to enhance the performance."

—Collin Broholm,
Director of the Institute for Quantum Matter

Superconductivity is the poster child for an emergent quantum property. It is "something unexpected which appears because of the way that the electrons in the system interact with each other," says IQM investigator David Vanderbilt. It occurs under certain conditions, where "all of the sudden, all of the electrons just – whoop! – and flop into a completely different state of matter with completely different properties," explains Collin Broholm, the Director of the IQM. It's like when water freezes, transitioning from a liquid state to a solid state. Chemically, it's still water – H_2O – but coordination between molecules brought about by their interactions yield a material with completely different properties. In quantum matter, it is changes in the coordinated motion of *electrons* that precipitates a different state of matter. Below a threshold temperature in a superconducting material, the electrons rearrange to form a collective matter wave that can carry an electrical current without any resistance. This has myriad applications, including in the workings of MRI machines. You can't explain any of it with classical physics.

IQM postdoctoral fellow Yishu Wang says that "this is very similar to how human beings interact with each other to form a society. It's not really about how an individual is behaving but about the interactions between human beings." The whole is greater than the sum of its parts.

Wang predicts that this is where "there are new fundamental physical laws to be discovered." Laws that can be controlled to create the materials of tomorrow.

"The idea behind researching quantum materials is that materials with new properties can really change the way you do absolutely everything," says Ramshaw. "But," he cautions, "we are at the start of that pipeline. Quantum materials will allow you to do… well we don't even know. That's the thing. If you asked people in 1920 'what's the point of studying silicon?' They wouldn't talk to you about iPhones. They would just tell you it's interesting."

Many IQM researchers echo this weariness of speculating about the potential applications of their work. "Thankfully, some agencies, and the Department of Energy is one of them, have people in charge who care about funding basic science because they see a connection between basic science and technology of the future," says Robert Cava, one of the founders of IQM. "We are not mortgaging our future for the present."

Perhaps because Broholm trained as an electrical engineer, he is predisposed to spotting potential applications. He points to a material made by colleague Satoru Nakatsuji in which electrons exhibit unusual magnetic properties because of their geometrical arrangement and interactions. Researchers can manipulate their magnetic state into one of two ways, and by passing a current through the material, read which of the state the electrons settled into. If this sounds like a computer system, with bits of 0s and 1s encoded at the subatomic level, it is because that's what it could become.

"This kind of information storage system has the ability to become much more compact and much more energy efficient," asserts Broholm. He adds that "as a society, more and more of our energy is expended in information technology. If you extrapolate 10 or 20 years into the future, it begins to rival what we use for transportation. For information technology systems there opportunities to reduce consumption while continuing to enhance the performance." This explains the Department of Energy's involvement in this work. Broholm remarks that "various companies are already interested in working on this [material]" and

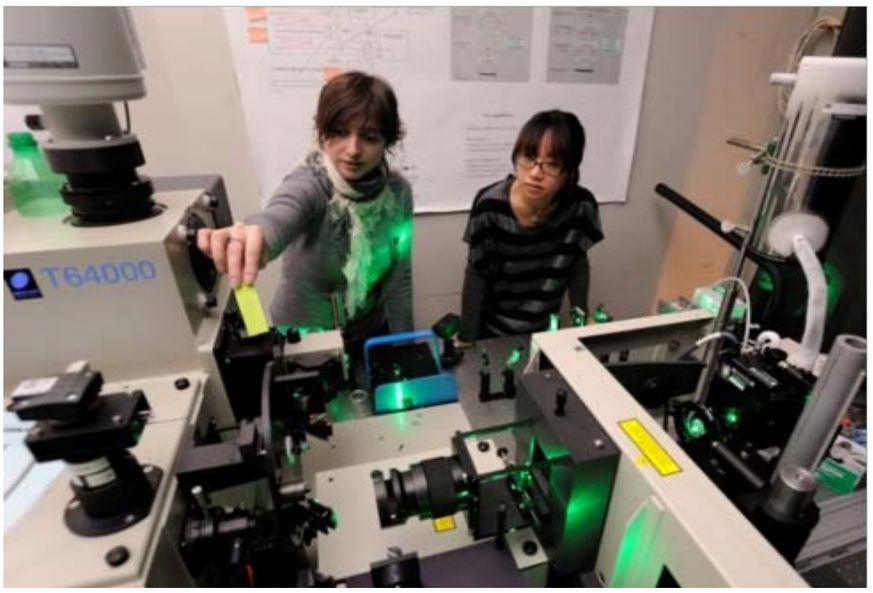
that "I wouldn't be at all surprised if in the next 5 to 10 years, we find devices and electronics based on this [material]."

Broholm came up with the idea for the IQM after participating on a National Research Council committee charged with examining where promising new materials were coming from. "It turned out that less and less was coming from efforts of scientists in the US, and more and more we were eclipsed by developments in other countries, including Europe, and Japan, and China," recalls Broholm.

The reason for this is that by the late 20th century, the field was in transition. "There were these big conglomerates – IBM and Bell Labs were the leading institutions – and they had been doing very fundamental research but could do less and less of that for various business reasons," explains Broholm. "People were moving from those types of labs into academia." In academia, researchers tend to work in isolation. That caused a problem because progress in quantum materials discovery relies on the integration of different technical and knowledge expertise. IQM proposed to remedy this, by forming a collaborative network.

Theorists at IQM use quantum mechanics to predict the emergent properties of new materials when specific elements of the periodic table are placed side by side in arrangements that have hitherto never existed before. "Theorists can run through a lot of possibilities, run calculations, and see which ones appear to be most promising," explains Vanderbilt, a theorist himself. Tchernyshyov, another theorist, captures the uniqueness of each challenge with a nod to Anna Karenina: "Happy electrons are all alike; every frustrated electron is frustrated in its own way."

Chemists put these predictions to the test by synthesizing the materials in large furnaces utilizing heats that rival the Sun's. Cava and Nakatsuji grow pure crystals of these materials in which the atoms combine in specific arrangements. Throughout, the theorists and crystal growers collaborate. "You might find out that they weren't able to grow the materials; it's not a thermodynamically stable material," says Vanderbilt. "Ok, so throw that one out."



Associate Research Professor Natalia Drichko (left) and former postdoc Sunghee Kim use Raman scattering of green laser light to reveal the inner workings of quantum materials at the Institute for Quantum Matter.

Once a material is synthesized, IQM experimentalists such as Broholm, Ramshaw, and Wang subject the crystals to tests to uncover their workings. "You bombard [the crystal] with X-rays or neutrons, or various types of spectroscopies with light, and characterize what is going on," describes Vanderbilt. The experimentalists relay their findings back to the theorists. "It might be that the theory says X, but we find Y," explains Vanderbilt. "Then you go back to the theory to figure out: 'why did it say Y instead of X' and try again."

"None of us have a complete view of the material, but each of us have a certain window as to what is happening," describes Broholm. "And what is 'happening' has to be discovered by combining all of these perspectives, then gradually piecing together the story."

The IQM is, in many respects, a legacy of the famed Bell Labs. Two of its founders, Broholm and Cava are alumni and they sought to recreate its culture. "[At Bell Labs] we were encouraged to go talk to people all of the time, which we did," recalls Cava. "People write stories about the cafeteria at Bell Lab, and it's true. You would sit down at a random table, and you would have cross-fertilization of ideas. I think that's kind of what IQM is about."

"Individually, they are all just amazing," comments Alannah Hallas, a materials scientist at the University of British Columbia who sometimes collaborates with researchers at the IQM. "And then the fact that they are all in the same institute just amplifies the creativity and unique approach."

Like the electrons they study, something emerges from the collaboration of the individual researchers that the IQM makes possible.

"You have mixtures of people who are experts in different things," reflects Cava, "and when you put them together, you get something that is bigger than the sum of the parts."

Chuck Bennett Earns Prestigious Rumford Prize

The American Academy of Arts & Sciences has awarded Bloomberg Distinguished Professor Charles L. Bennett one of the oldest and most celebrated awards in science, the Rumford Prize, an honor Bennett now shares with Thomas Edison, Enrico Fermi, and Henry A. Rowland.

In nominating Bennett for the award, theoretical physicist Marc Kamionkowski, credited him with "the single most significant experiment" in humankind's understanding of the universe, writing that the Wilkinson Microwave Anisotropy Probe led by Chuck Bennett "transformed our view of the universe from a rough sketch to a remarkably precise picture."

Chuck Bennett, Bloomberg Distinguished Professor

"Before WMAP," continued Kamionkowski, a professor of physics and astronomy at Johns Hopkins, "cosmology was something pursued at the fringes of physics and astronomy. After WMAP, cosmology became a central component in our pursuit of the fundamental laws of physics, and WMAP's measurements became an essential ingredient in all subsequent studies of galactic and extragalactic astronomy."

"I am honored to receive the Rumford Prize and to join the distinguished group of scientists who received this prize before me," Bennett said. "There has never been a guarantee that cosmologists or astrophysicists would come to understand the universe, but we have collectively made incredible discoveries in recent decades. I am thankful that I was able to contribute to this progress, grateful to my collaborators, and ever excited to see what mysteries of the universe we might unveil next."

Founded in 1796 but first awarded in 1839, the Rumford Prize recognizes distinguished contributions to the fields of heat and light and is one of the oldest scientific prizes in the United States. It was last awarded in 2019 to six scientists for their contributions to the invention and refinement of optogenetics. Previous recipients include Thomas Edison in 1895, Edwin Land in 1945, and Enrico Fermi in 1953. At least a dozen scientists who have received the Rumford Prize have also won the Nobel Prize.

"Professor Bennett's spectacular work helped transform cosmology into an integral component in the quest for the fundamental laws of physics," said David W. Oxtoby, president of the American Academy. "His trailblazing work gives us an unprecedented, precise view of the universe, and more importantly, reminds us of the joys and possibilities of scientific discovery."

Bennett is a Bloomberg Distinguished Professor, Alumni Centennial Professor, and a Johns Hopkins University Gilman Scholar in the department with a joint appointment at the Johns Hopkins Applied Physics Laboratory. His efforts have helped establish a standard model of cosmology. He led NASA's Wilkinson Microwave Anisotropy Probe mission from 1996 to 2013.

"In his fearless pursuit of questions and ideas that challenged convention, Chuck stands alongside a select few investigators who have truly transformed our understanding of our universe," said Johns Hopkins University President Ron Daniels. "We are thrilled at the prospect of the discoveries he will continue to make and the pathways of inquiry he has opened for future generations of physicists."

Bennett is now testing the standard model of cosmology he helped establish while addressing outstanding cosmological mysteries. Such as: Did the universe begin with inflation, and if so, which kind? What is dark matter? What is dark energy? Why are some current measurements in conflict with the standard model of cosmology?

Rumford Medal of the American Academy of Arts and Sciences

Also, as a member of the Euclid and the Cosmology Large Angular Scale Surveyor, or CLASS, projects, Bennett continues to work to improve cosmological measurements and to improve the analysis of the microwave signals from our Milky Way galaxy that contaminate measurements of the cosmic microwave background.

Rumford Prize recipients from Johns Hopkins include Henry A. Rowland (1883), the first chair of the physics department from 1876 until his death in 1901; Robert W. Wood (1909), professor of optical physics from 1901 until his death in 1955; William D. McElroy (1965) a Biology Department chair who discovered the enzyme that makes firefly bioluminescence.

Bennett, who has taught at Johns Hopkins since 2005, received his PhD in Physics from MIT in 1984 and joined the scientific staff of the NASA Goddard Space Flight Center the same year. He served as the Infrared Astrophysics Branch head, a senior scientist for experimental cosmology, and a Goddard senior fellow. Prior to WMAP, Bennett was a leader of the Differential Microwave Radiometers instrument and the Cosmic Background Explorer, or COBE, mission which resulted in the first detection of variations of the temperature of cosmic microwave background radiation.

"This is a remarkable achievement for Professor Bennett," said Christopher Celenza, dean of the Krieger School of Arts and Sciences. "His transformational work in the field of cosmology has unlocked mysteries about the universe for all of humankind."

— Jill Rosen

Alex Szalay Receives Life Sciences Award for AstroPath Cancer Mapping Technology

Janis Taube and Alexander Szalay.

Credit: Johns Hopkins Kimmel Cancer Center

Bloomberg Distinguished Professor Alex Szalay and Kimmel Comprehensive Cancer Center pathologist Janis Taube, M.D., M.Sc., received a Life Sciences 2021 award for AstroPath at the Falling Walls Science Summit, an international event honoring research breakthroughs from across the globe.

The Johns Hopkins submission titled "Breaking the Wall to Mapping Cancer Using Multispectral Microscopy" was selected from hundreds of entries for the AstroPath platform design. AstroPath is a new, comprehensive platform for imaging and mapping microscopic sections of tumors to identify and validate predictive biomarkers to guide precision immunotherapies for cancer.

"It's a convergence of scientific technology, big data and astronomy — aimed at curing cancer," says Szalay, Bloomberg Distinguished Professor of Physics and Astronomy and Computer Science, and director of the Institute for Data Intensive Engineering and Science (IDIES) at JHU.

"Biomarkers are essential to understanding individual cancer signatures. Using this spatial mapping approach, we can better determine which patients will or will not respond to a cancer therapy. Our long-term goal is to match individual patients with personalized therapies," says Taube, professor of Dermatology and director of the Division of Dermatopathology at the Johns Hopkins University School of Medicine.

The foundation of the AstroPath platform is the database for the Sloan Digital Sky Survey, a 3D digital map of the universe architected by Szalay. "In astronomy we often ask, What is the probability that galaxies are near each other? We apply the same approach to cancer — looking at spatial relations in the tumor microenvironment. It is the same problem on a vastly different scale," he says.

Just as the Sloan Survey maps the cosmos on an astronomical scale, AstroPath maps tumor cells on a microscopic scale.

"Who would have thought techniques from astronomy would end up saving lives?" Szalay concluded.

"Who would have thought techniques from astronomy would end up saving lives?"

— Alex Szalay, Bloomberg Distinguished Professor

AstroPath was developed with support from the Mark Foundation for Cancer Research; the Melanoma Research Alliance; the Johns Hopkins Bloomberg Kimmel Institute for Cancer Immunotherapy; the Harry J. Lloyd Charitable Trust; the Emerson Collective; Moving for Melanoma of Delaware; the Barney Family Foundation; the Laverna Hahn Charitable Trust; Bristol Myers Squibb; Sidney Kimmel Comprehensive Cancer Center Core Grant P30 CA006973; National Cancer Institute R01 CA142779; and technology from Akoya Biosciences.

The Falling Walls conference is held each year in Berlin, Germany, and is named in recognition of the fall of the Berlin Wall in 1989.

— Amy Mone

NEWS BRIEFS

Marc Kamionkowski Receives 2021 Gruber Cosmology Prize

William R. Kenan, Jr. Professor Marc Kamionkowski has been awarded the 2021 Gruber Cosmology Prize, along with Uroš Seljak of the University of California at Berkeley and Lawrence Berkeley National Laboratory, and Matias Zaldarriaga of the Institute for Advanced Studies, for their contributions to methods essential for studying the early universe through analysis of the polarization of the cosmic microwave background. The award is given through the Gruber Foundation, which was established at Yale to honor and encourage excellence in the fields of cosmology, genetics, neuroscience, justice, and women's rights.

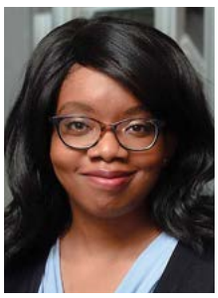
Kamionkowski joins previous JHU Gruber prize-winners Bloomberg Distinguished Professor Adam Riess (2007), Bloomberg Distinguished Professor Chuck Bennett (2012), and Homewood Professor Joe Silk (2019).

Ibou Bah Selected as Principal Investigator of Simons Foundation Grant to Establish a New Collaboration on Global Categorical Symmetries

Assistant Professor Ibrahima Bah has been selected as a Principal Investigator of the Simons Collaboration on Global Categorical Symmetries. The collaboration brings together a group of physicists and mathematicians, working across disciplinary boundaries, to unlock the power of symmetry in its broadest, most general form. Symmetry is a powerful tool for organizing physical phenomena and anchors our understanding of the laws of nature.

Bah works on holography, supergravity, and string theory. He has developed novel methods and techniques for studying anomalies of continuous as well as discrete symmetries for quantum field theories constructed within string theory.

Danielle Speller Receives the 2021 Stuart Jay Freedman Award in Experimental Nuclear Physics from APS



The American Physical Society has awarded Assistant Professor Danielle Speller the 2021 Stuart Jay Freedman Award in Experimental Nuclear Physics, which recognizes an outstanding early career experimentalist in nuclear physics. Speller's citation reads,"For excellence in experimental research into the fundamental nature of matter and mass based on low-energy cryogenic detection techniques, in particular neutrinoless double beta decay and dark matter searches."

Speller works with two top experimental nuclear and particle physics projects. The Haloscope at Yale Sensitive to Axion Cold Dark Matter (HAYSTAC) is a cutting-edge experiment looking for axions. The Cryogenic Underground Observatory for Rare Events (CUORE) in Assergi, Italy, is one of the leading searches for neutrinoless double-beta decay.

Surjeet Rajendran Receives Simons Investigator Award

Associate Professor Surjeet Rajendran was selected as one of the sixteen scientists in the US, Canada, the UK, and Ireland to win a Simons Investigator award in 2021. Simons Investigators are outstanding theoretical scientists who receive a stable base of research support from the foundation, enabling them to undertake the long-term study of fundamental questions.

Rajendran has invented new experimental methods to detect gravitational waves, dark matter and dark energy. These methods are being implemented by many laboratories around the world. He has also developed theoretical tools to solve outstanding problems of particle physics such as the hierarchy and vacuum energy problems via cosmological evolution. His recent theoretical interests have been in identifying novel gravitational phenomena within general relativity, permitting new experimentally testable approaches to resolving cosmological singularities and solutions to the black hole information problem.

NEWS BRIEFS

Nadia Zakamska Receives Krieger School's Excellence in Teaching Award

Professor Nadia Zakamska has received the Krieger School of Arts and Sciences 2020-21 Excellence in Teaching Award. The award was based on nominations from students, alumni, faculty, and staff who highlighted Dr. Zakamska's continued ability to engage and inspire students, build community, and foster relationships outside of the classroom. Below are two quotes from the many students who nominated Zakamska for the award.

"I've only known Dr. Zakamska through Zoom. About a year ago, she took me on to her undergraduate research team to look into young stars, and in that one, remote year, she has made more of an impact on me than any teacher I've ever had. She helps her students grow by providing the perfect balance of appreciation, constructive criticism, encouragement, and excitement."

"Dr. Zakamska has been a light in the darkness for the entire year I've known her. She has unwavering positivity, unparalleled patience, and a contagious love for her field. From the way she calls a complex special relativity problem 'cute' to the beaming smile she gives when someone shares a physics result, she never fails to draw my admiration."

Carrie Filion and Cicero Lu Receive NASA FINESST Graduate Fellowships

Graduate students Carrie Filion and Cicero Lu have been selected by NASA to receive Future Investigators in NASA Earth and Space Science and Technology (FINESST) graduate fellowships. The FINESST fellowships will cover funding for three years of research for Carrie and Cicero.

Carrie will use the funds to carry out her project titled, "The Low-Mass Stellar Initial Mass Function in the Earliest Galaxies," she will use Hubble Space Telescope imaging of nearby, ultra-faint dwarf galaxies to constrain the mass distribution of the long-lived, low-mass stars in these dark-matter-dominated systems.

Cicero will apply the funding to her project titled "Sequencing Dusty Disk Spectra: A Non-Parametric, Systematic Analysis Revealing the Relationships Between Disks and their Host Stars." Cicero will use SpitzerSpace Telescope Infrared Spectrograph observations of dusty disks around nearby, young stars to investigate the commonality of crust-mantle formation in extrasolar, Earth-like planets, and relationships between disk architectures and their host star properties.

Sihao Cheng Receives International Astrostatistics Association Award for Outstanding Publication

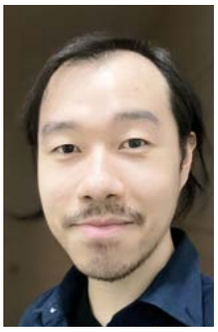
Sihao Cheng, a graduate student in the department working with Associate Professor Brice Ménard, received the International Astrostatistics Association award for Outstanding Publication in Astrostatistics led by a graduate student. Only one student is selected for this honor every two years. The publication that earned Cheng this recognition is titled "A new approach to observational cosmology using the scattering transform," and appeared in Monthly Notices of the Royal Astronomical Society. The publication introduces a novel statistical tool for parameter estimation with non-Gaussian stochastic fields.

Bingjie Wang Receives American Astronomical Society's Roger Doxsey Travel Prize

Graduate student Bingjie Wang has received the Roger Doxsey Travel Prize from the American Astronomical Society (AAS) in recognition of her presentation of her thesis research at the annual winter meeting of the Society. The Roger Doxsey Prize will award Wang with complimentary registration for an upcoming AAS meeting. In addition, she will receive a stipend to reimburse her travel expenses to the next in-person AAS meeting.

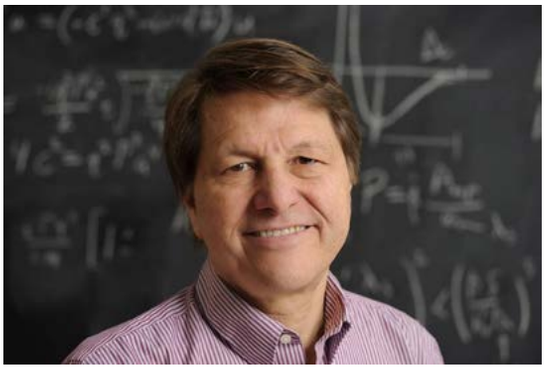
NEWS BRIEFS

Erwin Tanin Receives 2021 International Student Prize Fellowship



Second year graduate student Erwin Tanin has been awarded an International Student Prize Fellowship by the department. Tanin is working in Theoretical Particle Physics and Cosmology with David Kaplan and Surjeet Rajendran, and has published two papers during his time at JHU. Currently, Tanin is focusing on theoretical ideas for dark energy. Tanin has also been one of the top-ranked teaching assistants in the department and has served as a head teaching assistant.

Inaugural Mark O. Robbins Prize in High Performance Computing Awarded



In recognition of a cherished friend and contributor to the department and the Institute of Data Intensive Engineering and Science, the Robbins Prize was awarded in 2021 to recognize three outstandingly talented PhD students who reflect Dr. Mark O. Robbins' contributions to computational science and engineering.

Mark O. Robbins Prize
in High Performance Computing

The inaugural winners of the Mark O. Robbins Prize in High Performance Computing are Dr. Sai Pooja Mahajan, Postdoctoral Fellow in JHU's Department of Chemical & Biomolecular Engineering; Dr. Karthik Menon, Postdoctoral Fellow in Stanford University's Department of Cardiovascular Biomechanics Computation; and Dr. Andrew Ruttinger, Policy Analyst with Natural Resources Canada.

The Robbins Prize is made possible thanks to generous donations from the Department of Chemical and Biomolecular Engineering, the Hopkins Extreme Materials Institute, the Institute of Data Intensive Engineering and Science, the Department of Mechanical Engineering, and the Department of Physics and Astronomy.

Vedant Chandra Receives American Astronomical Society's Chambliss Student Poster Award

Undergraduate Vedant Chandra has received the Chambliss Student Poster Award from the American Astronomical Society for his digital iPoster on star formation in nearby dwarf galaxies using color-magnitude diagrams. Chandra conducted the research outlined in the iPoster with Dr. Mario Gennaro at the Space Telescope Science Institute. In the iPoster, Chandra demonstrated how the novel techniques and tools he developed with Gennaro are an improvement over past methods by using mock James Webb Space Telescope data.

Justin Otter, Bastian Pradenas, Isu Ravi, Sanjana Sekhar, and Nicholas Speeney Receive Graduate Teaching Awards

The department's Graduate Program Committee announced their 2021 selection of the most outstanding graduate student Teaching Assistants in the department with their annual graduate teaching awards.

Justin Otter was awarded the Agnew Prize for Excellence in Teaching for his fall 2020 performance in introductory physics, where he prioritizes students' success and clear communication, and has received outstanding evaluations.

Bastian Pradenas was awarded the E.J.Rhee Prize for Flair in Teaching for his fall 2020 performance in introductory physics, where he provides personalized assistance, is generous with his time, and has received outstanding evaluations.

Isu Ravi was awarded the Tatum Prize for Excellence in Teaching for her fall 2020 performance in "Introduction to Space Science and Technology", where she went above and beyond the call of duty, ensuring a positive educational experience, and has received outstanding evaluations.

Sanjana Sekhar was awarded the Rowland Prize for Innovation in Teaching for her spring 2021 performance in "Practical Data Science", where she has demonstrated remarkable flexibility and communication skills, and provided extensive personalized support to students.

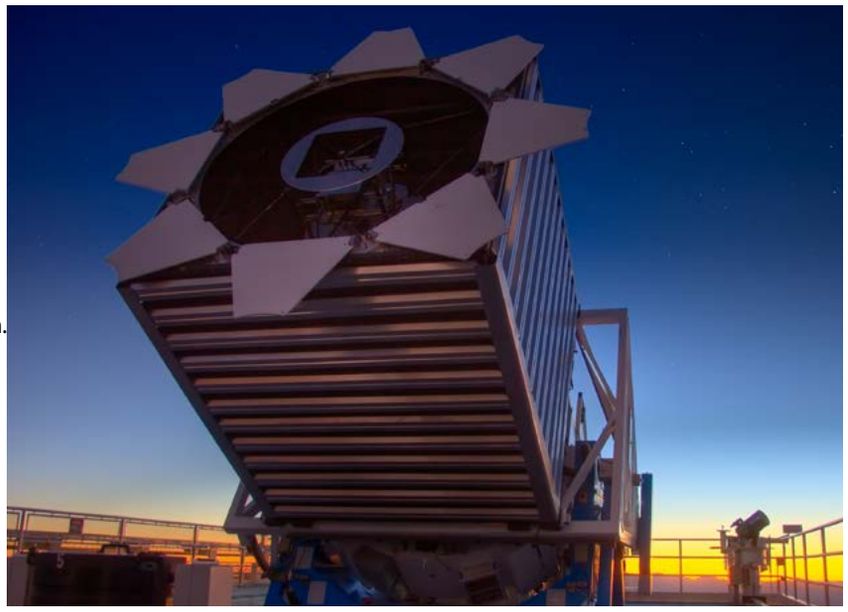
Nicholas Speeney was awarded the Kilby Prize for Excellence in Teaching for his fall 2020 performance in introductory physics, where he provides timely and helpful feedback, and has received outstanding evaluations.

NEWS BRIEFS

Sloan Digital Sky Survey Given the 2021 SIGMOD Systems Award

The Association for Computing Machinery has named a team of Sloan Digital Sky Survey members the recipients of the 2021 Special Interest Group on Management of Data (SIGMOD) Systems Award. Twenty members of the team of awardees are current or past members of the department.

The citation for the award reads, "…Sloan Digital Sky Survey, an early and influential demonstration of the power of data science to transform a scientific domain. Not only has this system shown off the value of data management technology, it has also influenced data management by publishing real analytic workloads that have been used for testing, comparing, and advancing data management systems."



Sloan Digital Sky Survey Telescope, Apache Point Observatory, Sunspot, New Mexico
Credit: David Kirkby

Awardees from the department include: **Robert Brunner, Tamas Budavari, Sam Carliles, Peter Kunszt, Gerard Lemson, Nolan Li, Dmitry Medvedev, Deoyani Nandrekar-Heinis, Maria Nieto-Santisteban, Wil O'Mullane, Victor Paul, Alex Szalay, Gyula Szokoly, Manu Taghizadeh-Popp, Jordan Raddick, Bonnie Souter, Ani Thakar, Jan Vandenberg,** and **Sue Werner.**

The Association for Computing Machinery is a non-profit professional membership group and the world's largest scientific and educational computing society; it was founded in 1947.

Lucas Mandacaru Guerra, Rongrong Liu, and Shreya Sriramineni Receive Provost's Undergraduate Research Awards

Three physics majors, Lucas Mandacaru Guerra, Rongrong Liu, and Shreya Sriramineni, have received Provost's Undergraduate Research Awards (PURA). The PURA program was created to support and encourage Hopkins undergraduate students to engage in independent research, and to participate in scholarly and creative projects. Their winning research projects are listed below.

• **Lucas Mandacaru Guerra**, "Shining light on the Higgs: Study of the Higgs boson couplings to photons at the Large Hadron Collider, " mentored by Andrei Gritsan

• **Rongrong Liu**, "Developing an Automated Algorithm to Solve the Pentagon and Hexagon Polynomial Equations in Topological Quantum Computing," mentored by Yi Li

• **Shreya Sriramineni**, "Computationally modeling the edge evolution of 2D transition metal dichalcogenide nanocrystals," mentored by Thomas Kempa and Reynolds Dziobek-Garrett

Turner Woody Receives 2021 Donald E. Kerr Memorial Award

The department announced physics major Turner Woody as recipient of the 2021 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.

IN MEMORIAM

William B. Gardner
1939 - 2021

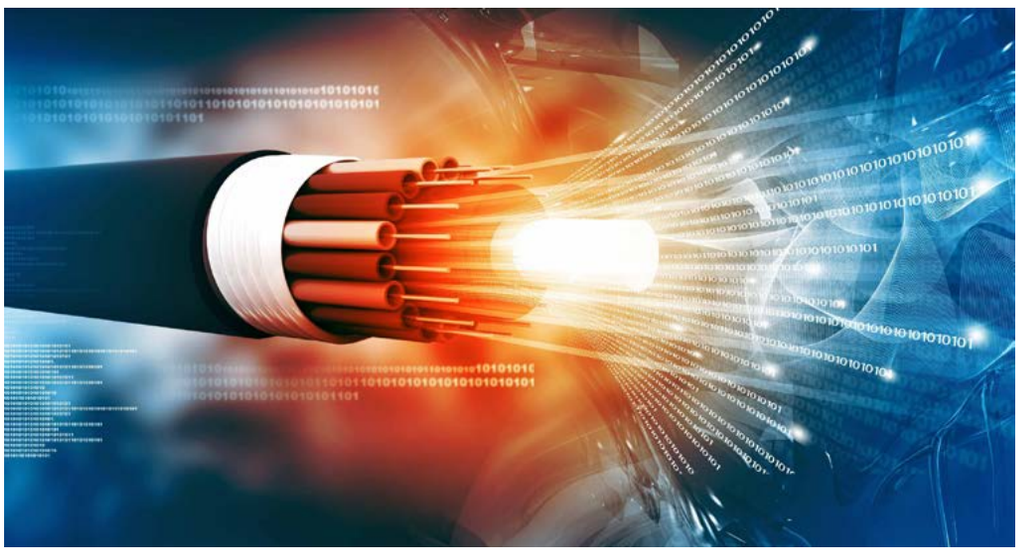
William "Bill" Bentley Gardner passed away peacefully on January 29, 2021, after an advanced cancer diagnosis. Dr. Gardner received his PhD in the department in 1968 working with Professor Warren Moos. He had a highly successful career at Bell Labs, and always maintained an interest in the department. He was one of the founding members of the department's Advisory Council Board and has provided generous support over the years.

In 1972, he was transferred to a new location of Bell Laboratories in Atlanta, GA, whose mission was to develop a manufacturing facility for optical fibers for AT&T. He became part of the research and development management team that established optical fibers as a practical communications medium to compete with copper cables. This is the technology that makes our global broadband communications possible today. He was the recipient of a half dozen patents, and served as a columnist for the trade journal ***Lightwave***.

In March 1977, he helped install AT&T's first optical fiber cable under the streets of Chicago. During the decade of the 1990s, he chaired the International Telecommunication Union's subcommittee in Geneva, Switzerland, that established standards for optical fibers worldwide.

As a retiree in the 2010s, he established the William Gardner Graduate Fellowship in the department—enabling outstanding graduate students to start their doctoral research as early as possible.

Gardner was a pilot, an avid reader, a devoted Alabama football fan, and a runner, still winning races at age 80. He could talk knowledgeably about a multitude of subjects and explain technical topics in a way that almost everybody could understand. He loved to hike, travel, and sing with a local choral group. Gardner's many favorite weekends were spent flying somewhere in the Southeast for a race and concerts, as well as a good dinner. Over the last 40-plus years he hiked many times in the Alps. He summited Mont Blanc in France, Mt. Kilimanjaro in Tanzania, and several 14,000' peaks in Colorado. Other travels took him to the Galapagos, Europe, China, the Rockies, Alaska, and his favorite, Dog Island, Florida.



Bill Gardner was an essential part of the research and development team that established optical fibers as a practical communications medium
Credit: Shutterstock

IN MEMORIAM

Jan Vincent Vandenberg, a computer scientist and systems architect who was connected to Johns Hopkins University for 30 years, passed away on May 13 after an eight-year battle with colon cancer. He was 48.

Vandenberg is known for helping propel citizen science forward as a key collaborator of Galaxy Zoo, an online project offering unprecedented public access to astronomy images, and as a core member of the Sloan Digital Sky Survey team, working on the world's most ambitious and detailed astronomical survey to date.

"The cosmos has lost a brilliant mind and a kind soul," Vandenberg's longtime friend Phil Tang, a former vice provost for academic services at Johns Hopkins.

Born and raised in Cumberland, Maryland, Vandenberg joined Johns Hopkins University as an undergraduate in 1991, majoring in philosophy before switching to computer science, then—sans degree—starting work as a systems administrator in the department.

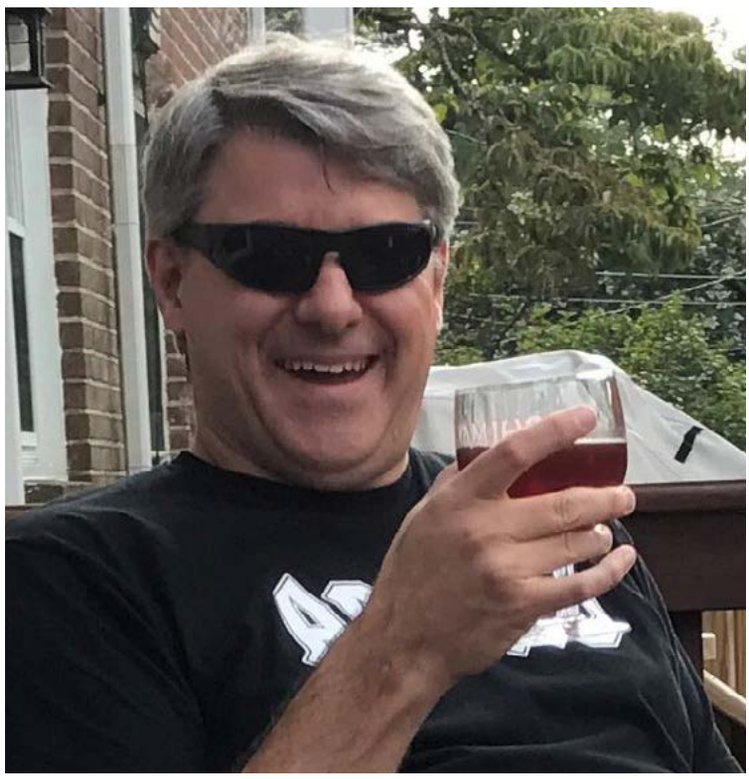
Later, Vandenberg worked as chief systems architect for the Institute for Data Intensive Engineering and Science, building "ground breaking computer systems ... on par with the world's most advanced supercomputers, including the award-winning GrayWulf cluster."

"Jan really was the very embodiment of Hopkins," Tang said. "He was extremely highly regarded in various circles and certainly in his profession. He wasn't motivated by titles or superficial milestones. He liked the work and its intellectual stimulation."

Vandenberg was instrumental to the Galaxy Zoo, through which volunteer users in 2009 helped discover a cluster of small, compact galaxies known as "the Green Peas," known for forming stars at an extremely high rate. For his work with the Sloan Digital Sky Survey—where more than 230,000 volunteer users have classified 1 million images of galaxies—Vandenberg and his colleagues received an Association for Computing Machinery SIGMOD Award in 2021.

"I have known him for 30 years, when he was an undergraduate at Hopkins, and then he grew up in our department and group. He was our key person and knew how to make things work," said Bloomberg Distinguished Professor Alex Szalay, a cosmologist and director of the Institute for Data Intensive Science at Hopkins.

"Jan was an amazingly smart guy whose research was always pushing the edge," he said. "He built custom systems and we exploited technology so we could advance science. He had ideas on how to build systems because you couldn't buy them off the shelf. He made sure there were no bottlenecks. He was an artist and was an essential part of our effort."



Jan V. Vandenberg
1973 - 2021

Dr. Tamas Budavari, associate professor in JHU's Department of Applied Mathematics and Statistics, is both a colleague and close friend for more than 20 years.

"Jan was a computer scientist and always on the cutting edge in regards to hard and software that handled huge amounts of data," Dr. Budavari said. "He was able to build computers from the ground up, and was extremely knowledgeable."

The two men also shared a passion for brewing beer and driving high-performance automobiles, and at his death Mr. Vandenberg was under the guidance of Dr. Budavari, a certified BMW, Porsche and Audi instructor.

"He owned a vintage BMW and was taking lessons but did not participate in races," Dr. Budavari said. "He was learning how to become a certified high-performance driver and participated on weekends at racetracks. It's one of the things we did together, and we had a lot of wonderful memories."

Mr. Vandenberg is survived by his wife of 19 years, the former Jennifer Strauss; his father, his mother, Mimi Kendall Vandenberg; three sons, Charles Garrett Vandenberg, William Everest Vandenberg, Lincoln River Vandenberg, and a sister, Abby Vandenberg of Jericho, Vermont.

Jan Vandenberg with an SDSS fiber optic plug plate

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James Webb Space Telescope Begins Journey of Discovery

Our neighbors across San Martin Drive at the Space Telescope Science Institute successfully supported the launch of the James Webb Space Telescope on Christmas morning. The Space Telescope Science Institute will conduct the science and mission operations for Webb just as it has for the Hubble Space Telescope since its launch. Webb will function at only 40 degrees above absolute zero, and its mirror array will operate at about 100 times the sensitivity of Hubble s as it explores the universe s first galaxies and the origins of life. In essence, Webb will cover a scientific blind spot, the light too old, too faint, and too distant for Hubble to observe. Professor Nadia Zakamska will head one of the first research teams to utilize the Webb telescope once it begins transmitting scientific data in the second half of 2022.