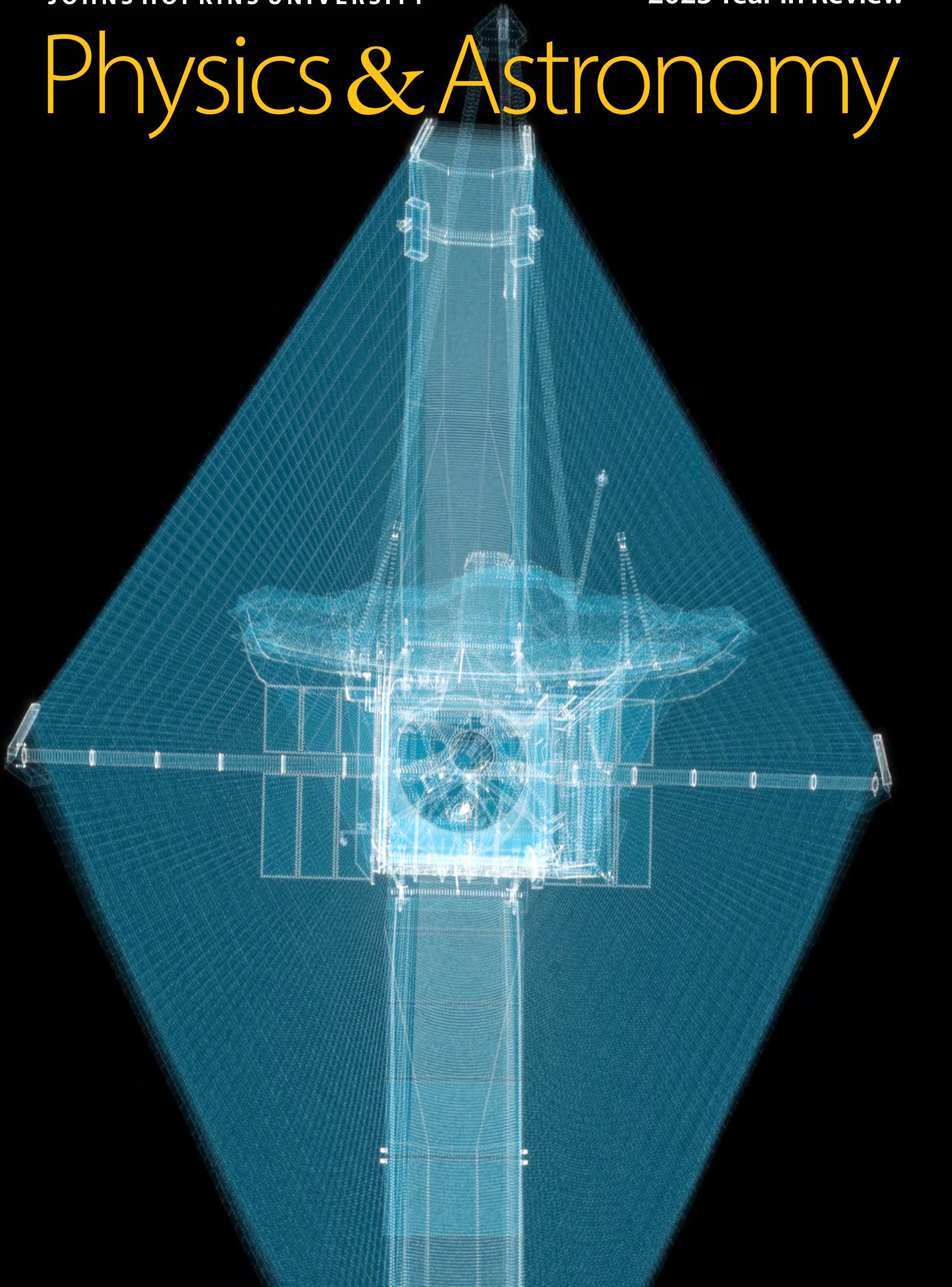
JOHNS HOPKINS UNIVERSITY

2023 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: jon.schroeder@jhu.edu.

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Front cover: Go inside the varying research conducted utilizing the James Webb Space Telecope within the department in "Seeing Further by Standing on the Shoulders of Giants" on page 4.

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Letter from the Chair

Dear alumni, colleagues, and friends,

I am pleased to be writing to you at the end of an exciting year here in the Department of Physics & Astronomy at Johns Hopkins. We have been very busy these past twelve months as we embark on the major expansion of the department enabled by the generous and visionary endowment provided by JHU alumnus William H. Miller. We are thrilled to be realizing the transformative potential of the Miller gift, which is enabling us to attract incredible young scholars to the department and is fueling important innovations and discoveries.

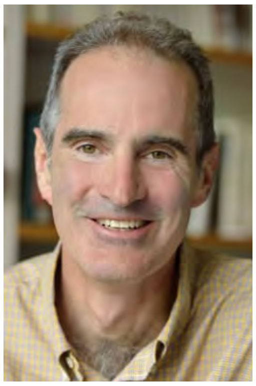
A central component of the expansion is growth of the faculty, and we have welcomed several new faculty members in the past year. Assistant Professor **Christopher Overstreet** joins us following a postdoctoral position at Stanford. Chris is the founding member of our department's new program in atomic, molecular, and optical (AMO) physics, a signature initiative in the department's expansion. Chris is building a laboratory in which his group will harnesses advanced technologies to cool atomic gases and control the atoms' quantum states to make precision measurements to detect the elusive particles that comprise dark matter. Chris is joined by fellow new arrival, astronomer **Meredith MacGregor**, who comes to Hopkins from the University of Colorado Boulder. Meredith's work explores the formation and properties of extra-solar planets, with an emphasis on assessing the potential habitability of planetary systems. Also joining us as an Assistant Professor in July will be **Danielle Norcini**, who is wrapping up a postdoctoral appointment at the University of Chicago. An experimental particle physicist, Danielle will build a major new laboratory in the department where she will develop a program focused on searching for dark matter and investigating the physics of neutrinos. Astrophysicist **Floor Broekgaarden**, who received her PhD from Harvard last year, will join the faculty in 2025 after completed a postdoctoral fellowship at Columbia University and the Flatiron Institute in New York. Floor's research program will focus on "gravitational-wave paleontology," in which she will analyze the signals from black hole and neutron star mergers to learn about massive stars through cosmic history. Finally, we are joined by astronomer **Ray Jayawardhana**. As I am sure many of you know, Ray recently arrived at Hopkins to serve as the university's 16th Provost, coming from Cornell where he was dean. While pursuing these administrative roles, Ray has maintained a vibrant research program on the origins and evolution of planetary systems and stars. We are delighted to be welcoming these new colleagues to our community, and we look forward to working with them during this pivotal time in the department's history.

I hope you enjoy this year's edition of the newsletter. In the pages that follow, you will find news of many other developments in the department over the past year, including descriptions on research highlights and reports on the impressive set of awards and accolades garnered by department members. Of these, let me highlight just one. In May, we gathered to celebrate Alex Szalay's election to the National Academy of Sciences, an honor recognizing Alex's seminal contributions to statistical cosmology and to the development of data intensive computing to address a range of interdisciplinary problems.

In closing, let me thank you again for your continued interest and support in physics and astronomy at Johns Hopkins. Our department has an exciting future ahead, and I am pleased that you are a part of it.

Best regards,

Bob Leheny



Renowned Astrophysicist Ray Jayawardhana Becomes 16th Provost of Johns Hopkins University

Ray Jayawardhana, an accomplished academic leader, renowned and widely published astrophysicist, and award-winning author who precioiusly served as dean of Cornell University's College of Arts and Sciences, was selected as Johns Hopkins University's 16th provost in July 2023.

Jayawardhana led Cornell's largest and most academically diverse college since 2018, overseeing enhancements to the student experience and the recruitment of 130 new faculty members. He stood out among a strong group of candidates identified during a comprehensive national search.

"Dr. Jayawardhana is a visionary and collaborative leader who is driven by the same passionate pursuit of excellence and discovery that has been the hallmark of our institution since its founding," JHU President Ron Daniels wrote in a message to the Hopkins community announcing Jayawardhana's appointment.

As provost at Johns Hopkins, he serves as the university's chief academic officer, working closely with President Daniels and with leaders from across JHU on interdisciplinary initiatives, academic policies and procedures, and key priorities that support the university's research and education missions.

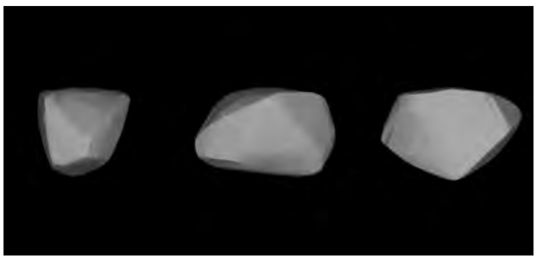
"Johns Hopkins is on a remarkable trajectory, with bold ambitions and tremendous momentum," Jayawardhana said. "I am excited to join this exceptionally dynamic community, and partner with President Daniels and others to help advance the university's excellence and impact."

Prior to joining Cornell's faculty, Jayawardhana served as Dean of Science and Professor of Physics and Astronomy at York University in Canada. This followed a decade on the faculty at the University of Toronto, where he served as a Canada Research Chair, Professor of Astronomy and Astrophysics, and Senior Advisor to the President for Science Engagement.

A native of Sri Lanka, Jayawardhana earned a bachelor of science degree in astronomy and physics from Yale University and a PhD in astronomy from Harvard. He is the winner of numerous awards and accolades, including a Guggenheim Fellowship, a Rutherford Medal in Physics from the Royal Society of Canada, and a Carl Sagan Medal from the American Astronomical Society's Division of Planetary Sciences. Asteroid (4668) "Rayjay" is named after him.

His research focuses on the diversity, origins, and evolution of planetary systems. His group uses large telescopes on the ground and in space to characterize planets outside our solar system, with an eye toward investigating the prospects for life elsewhere in the universe. He is a core science team member for the Near Infrared Imager and Slitless Spectrograph (NIRISS) instrument on the James Webb Space Telescope, and has authored more than 150 refereed papers in scientific journals.

Jayawardhana is also an acclaimed writer whose articles have appeared in *The Economist, The New York Times,* and *The Wall Street Journal*, among other publications. He is the author of four books, including *Strange New Worlds*, an insider's account of the search for life on other planets; *Neutrino Hunters*, a tale of the chase for the so-called ghost particle that won the Canadian Science Writers Association's Book Award in 2014; and *Child of the Universe*, a children's book published in 2020 meant to spark the same fascination with our universe that inspired him as a child.



Main-belt Orbit Asteroid 4668, A.K.A. "Rayjay"
Credit: Database of Asteroid Models from Inversion Techniques

The book aims to convey "the deep and enduring links—both physical and poetic—between the universe and us, and to nurture a sense of wonder about the great beyond," Jayawardhana wrote in his author's note.

An avid traveler, Jayawardhana has visited more than 55 countries and all seven continents. His travels, for research and writing, have included visits to mountaintop observatories in Chile and Hawaii, a meteorite collecting expedition in Antarctica, a parabolic flight with the European Space Agency, a solar eclipse chase in western Mongolia, and a descent into a South African mine with geobiologists. *Wired* magazine may have put it best: "As astronomers go, RayJay is a rock star."

Ray Jayawardhana aboard a parabolic flight with the European Space Agency. Credit: ESA

He succeeded Sunil Kumar, who served as JHU's provost from September 2016 through April 2023 and recently became the president of Tufts University.

WELCOME NEW FACULTY MEMBERS

Floor Broekgaarden joined the department in 2023 as an assistant research professor and will start full time by July 2025 as an assistant professor. She is currently working at the Flatiron Institute and Columbia University. She plans to build a program focused on "Gravitational-Wave Paleontology" which will involve analyzing the signals from black hole and neutron star mergers to learn about massive stars through cosmic history. The goal of her research is to answer some of the biggest questions in astrophysics today including: "How do gravitational-wave sources form? What can we learn from them about the formation, lives, and explosive deaths of massive stars across cosmic time? How do these sources help enrich the universe with heavy metals?" She is also active in outreach and enjoys sharing presentations with the public, which have included talks for the North Shore Amateur Astronomy Club, Podcast Astrophiz 150, the Astronomical Society of Palm Beachers, and Gloucester Area Astronomy Club, to name just a few.

Christopher Overstreet joined the department in July 2023 as Assistant Professor and became the department's first scholar in the field of atomic, molecular, and optical (AMO) physics. AMO physics is the study of how small numbers of atoms or molecules interact with one another and with the electromagnetic field. Overstreet employs atoms and molecules cooled to a temperature just above absolute zero as "test particles" because their degrees of freedom can be optically controlled and precisely measured. The particles can then be used to create exceptionally accurate clocks and inertial sensors, among other applications. Overstreet's research interests are centered on using these AMO methods to shed light on some of the most challenging problems in fundamental physics, including baryon asymmetry, the nature of dark matter, and the relationship between gravity and quantum mechanics. Prior to joining JHU, Overstreet was a Bloch Postdoctoral Fellow at Stanford University from 2021 to 2023. He received his PhD in Physics from Stanford University in 2020 and his bachelor's degree in Physics and Mathematics from Harvard University in 2013.

Meredith MacGregor joined the department in August 2023 as Assistant Professor. MacGregor's research group uses multi-wavelength astronomical observations to explore the formation and potential habitability of planetary systems. Her research utilizes state-of-the-art facilities like the Atacama Large Millimeter/submillimeter Array, the James Webb Space Telescope, the Hubble Space Telescope, and the Transiting Exoplanet Survey Satellite. MacGregor is also actively involved in building the next generation of observatories. She is the Deputy Principal Investigator for the Far-Infrared Spectroscopic Space Telescope (FIRSST) and Principal Investigator for the Early Star and Planet Evolution Explorer (ESPEX). Currently, she is also the Co-Chair of the NASA Infrared Science and Technology Integration Group and the Next Generation Great Observatories Science Analysis Group. MacGregor completed her PhD in Astrophysics at Harvard University in 2017 before joining the Carnegie Institution for Science, Earth and Planets Laboratory as a National Science Foundation Astronomy and Astrophysics Postdoctoral Fellow. Starting in 2020, she was as an assistant professor at the University of Colorado Boulder.

Danielle Norcini is a KICP & Grainger fellow at The University of Chicago and will be joining the department as an assistant professor in July 2024. An experimental particle physicist, she will build a major new laboratory at Hopkins to develop a program focused on searching for dark matter and investigating the nature of neutrinos. Currently, her group is advancing experiments that use low energy-threshold, single-quanta skipper CCDs to directly detect dark matter. Hopkins will be a leading institution on the construction and physics analyses of DAMIC-M, a low-background, underground experiment that will observe light dark matter-electron scattering for the first time or set world-leading limits in the sub-GeV mass regime. In parallel, the team will also lead sensor R&D for the larger, lower background OSCURA experiment to be constructed in 2028 at SNOLAB. Norcini received her PhD from the Wright Laboratory at Yale University, where she helped lead the R&D, construction, and first analyses of the PROSPECT reactor neutrino experiment. Her thesis detailed the search for short-baseline, eV-scale sterile neutrino oscillations and the world-leading measurement of the uranium-235 antineutrino energy spectrum from the High Flux Isotope Reactor at ORNL. Originally from Philadelphia, she earned both a BS in Physics and BA in Philosophy from Penn State University.

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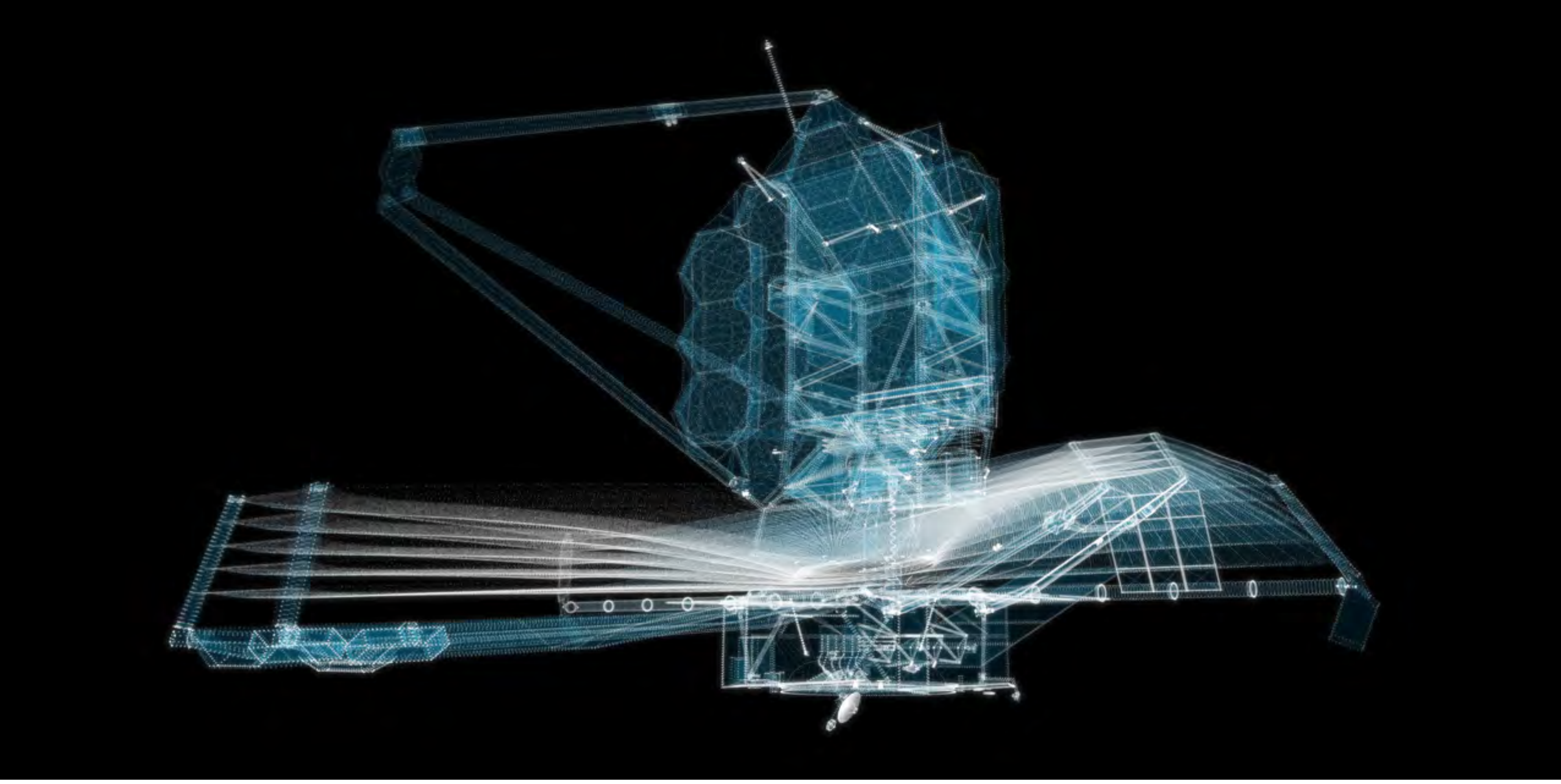


SEEING FURTHER BY STANDING ON THE SHOULDERS OF GIANTS:

INSIDE JHU OBSERVATIONS WITH THE JAMES WEBB SPACE TELESCOPE

BY ANNIE PRUD'HOMME-GENEREUX

The James Webb Space Telescope (JWST) is the largest telescope ever launched into space. Its 6.5-meter mirror size dwarfs Hubble's 2.4-meter. For a telescope, size matters; the larger the mirror, the more light it collects, and therefore the more it can resolve faint objects. "It's an enormous leap forward," says Bloomberg Distinguished Professor David Sing.

Adam Riess

Unlike Hubble, its predecessor, JWST can peer into the infrared and dissect its wavelengths, making it ideal to see through dusty regions where stars are forming, detect the presence of molecules such as water and carbon dioxide that absorb infrared light, and peer back in time to the early universe shortly after the Big Bang.

JHU researchers in the Department of Physics & Astronomy have been impressively successful in requesting telescope time on this new observatory. A double-blind peer review process evaluates proposals and allocates telescope time using JWST.

Proposals from Johns Hopkins, sometimes with scientific collaborators from the Space Telescope Science Institute (STScI), the organization that operates JWST, were clearly deemed to be superior.

In 1979, Hopkins won an unlikely bid to locate the STScI on the Homewood campus. History credits the efforts of Arthur Davidsen, a Physics & Astronomy (P&A) faculty who rallied support for the project and used clever tactics to woo NASA officials when they came to visit campus. The gamble paid off.

"Every time you sit in a [STScI] talk and you hear people talk about data they're getting from JWST or how they're using it or what it can do," says Bloomberg Distinguished Professor Adam Riess, "You think, 'oh, what can that do for my science, for my area'?"

P&A researchers use JWST to examine our galactic neighbors, look further at nearby galaxies, and further still to witness phenomenon that happened during the early formation of the universe.

IN OUR OWN GALAXY

Investigating Alien Planets

David Sing points JWST towards extrasolar planets that are our neighbours in the Milky Way. "There's a small percentage of stars out there where the alignment is just right," he explains. "The orbiting planets pass right in front of their star as viewed from the Earth, and when that happens, you can learn an incredible amount about the planet."

Sing looks at the atmosphere of a planet to determine its composition, temperature, cloud coverage, and even wind speeds. That's an amazing feat for planets that are hundreds of light years away.

David Sing

His favorite planet is WASP-121b, recently nicknamed Tylos. "It's not just hot," he asserts, "it's ultra hot." He continues, "The planet is tidally locked so that the same face is always facing its star, being blasted up to nearly 3,000 degrees Kelvin (5,000°F). That sets up these huge equatorial winds from the day to the night side that are thousands of kilometers per second." Sing adds that "this planet is so close to its star that it is deformed and football shaped, and pretty soon, it'll be torn apart by the gravity of the star."

Why study such an extreme environment? "There are a lot of types of planets out there that we don't have in our own solar system," says Sing, "We have no idea what their overall composition is, how they work, how they got there, or how they formed.

It's completely uncharted territory. These exoplanets represent natural laboratories where we can figure out how these complex atmospheres behave in these different conditions."

NEARBY GALAXIES

Solving a Puzzle

Riess is motivated the solve "the crisis in cosmology," a mystery that has puzzled physicists for over a decade. In 2011, he discovered that the rate at which the universe expands is accelerating – an insight that earned him the Nobel Prize. The next step was to calculate the current rate of that acceleration – a value called the Hubble Constant.

Riess measures this value through observations of exploding stars in nearby galaxies. He measures the distance to each star and how fast they are moving away.

Another group uses light emitted 380,000 years after the Big Bang. They evolve this starting state of the universe to what we see today using the known laws of physics. This gives them a different value for the Hubble Constant.

In trying to explain this discrepancy, Riess identified a potential source of bias in his results. "It can be difficult to isolate one individual star from other stars around it. It's sort of like hearing one voice in the crowd. There are other ones overlapping."

Riess put in a proposal to redo his Hubble observations. "With JWST, our resolution is so good that we can see the individual stars without the overlaps."

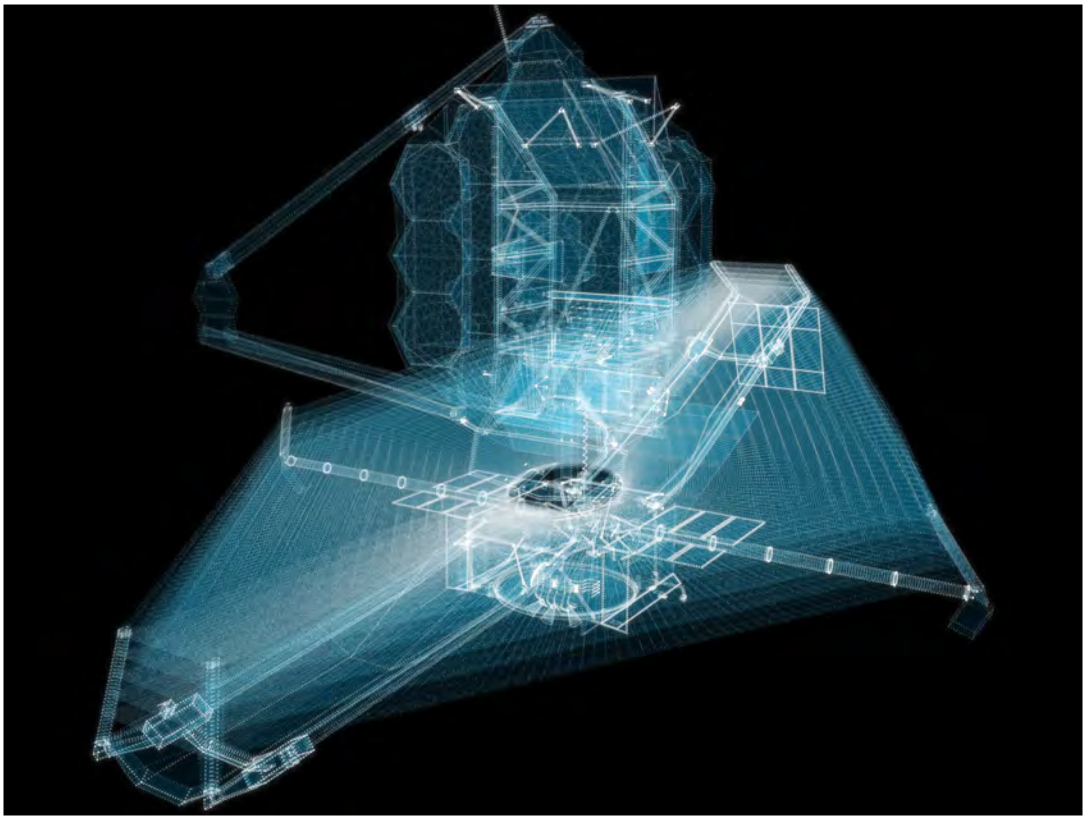
It was approved. But, "Through the vagaries of the scheduling process, our data wasn't going to start until the following year," recalls Riess. "I was like, I can't wait six months!"

Riess searched the archive of data collected by JWST. He found that another researcher examined an area of the sky that he had previously inspected with the Hubble. "The data wasn't perfect for our needs," says Riess, but the data would be sufficient for a quick test of his hypothesis that the telescope was capturing the light of more than one star, biasing his results. "We analyzed it and we saw the same results," shrugs Riess.

Riess waited a few more months to collect his data using the perfect settings of the JWST. "It's extremely razor-sharp data, but we see the same thing that we saw with the Hubble. This discrepancy looks real." The puzzle remains unsolved, for now.

"I don't personally care how fast the universe is expanding," says Riess. "But when something doesn't fit, usually that's an opportunity to learn something new about the universe."

Rosemary Wyse



Is the Milky Way Special?

"[After] the universe was born, it was largely hydrogen, some helium, and maybe 0.1% of other stuff," says Associate Research Scientist David Nataf. "Yet," he adds, "people are made of carbon and oxygen and if you look on a multivitamin, there's virtually the entire periodic table. These elements had to have been created at some point in our galaxy's evolution."

David Nataf

"How did our galaxy, as a whole, change the chemical mix, both in the interstellar medium and in the stars out of which it formed?," asks Alumni Centennial Professor Rosemary Wyse, who collaborates with Nataf.

Wyse's studies have shown that, "the Milky Way is unusual." She adds, "We don't want to say we're special, because it's drummed into us since Copernicus that we are just an ordinary part of the universe." And yet, her work shows that the Milky Way may have had an unusual history.

To confirm this, they need data from other galaxies. The Andromeda Galaxy "is like the Milky Way in its overall large-scale properties," explains Wyse, "and we're trying to find out whether the star formation history in its disk, and possibly the rate at which it assimilated and merged with companions, is similar or different from the Milky Way."

"It's very difficult to study stars in Andromeda," explains Nataf. "The typical star is 100 times farther away than the typical star in the Milky Way, and that means it's 10,000 times fainter, so you need a really big telescope, like JWST."

The data from JWST was days from being collected when Nataf and Wyse spoke about their work. "With this project, we're learning how to use JWST better," says Nataf, "so that once we go to more distant galaxies, we know exactly how to do it."

DISTANT GALAXIES

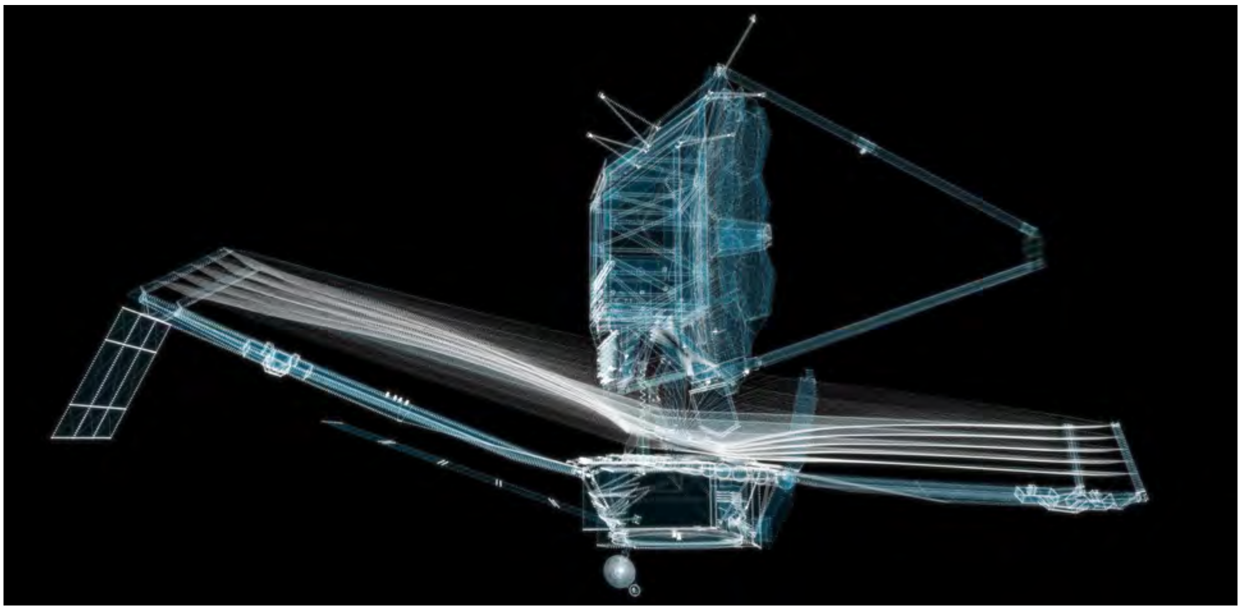
Shortly after the Big Bang, stars and galaxies began to form, but they were different from the ones we see today. Filled predominantly with hydrogen and helium, early galaxies lacked the richer assortment of elements found in later ones, because these elements had yet to be forged in the furnaces of stars and dispersed by supernovae explosions.

These nascent galaxies were small and simple, lacking the intricate spiral and elliptical structures seen in their modern counterparts. They had not yet encountered and merged with many neighbors, a process essential for combining stars and gas and growing in size and complexity.

Unraveling the mysteries of these primordial galaxies requires a journey back in time, a feat made possible by JWST. The observatory's ability to see in the infrared allows it to peer into the past. That's because the light from those early galaxies has been traveling for a very long time, across vast distances. During this time, the universe has expanded, stretching the light and effectively shifting it to longer wavelengths, into the infrared range.

Additional P&A groups have peered into the past, using JWST as a time machine. One team is pioneering a comprehensive map of early galaxies, helping to fill the blanks of our understanding of galaxy formation and evolution. Another group employs an ingenious method to observe one of the oldest known galaxies, a feat challenging even for JWST's advanced capabilities. Yet another team delves into the intricate process of galactic mergers, shedding light on how early galaxies evolved into the complex ones of the present universe.

Through these groundbreaking studies, JWST offers an unprecedented glimpse into the dawn of the universe.



Mapping Galaxies in the Early Universe

"Before launch, we didn't know what to expect with respect to JWST's performance," says Susan Kassin, an Associate Research Scientist in the department and Associate Astronomer with tenure at STScI. "We didn't know how its instruments would behave after launch or how they would degrade with time." Therefore, her approach was to "go big or go home," and push the observatory's capabilities as far as they would go.

Kassin works with JHU PhD students Celia Mulcahey and Ezra Sukay, and other collaborators, to map in exquisite details a small region of the sky containing a few dozen galaxies.

"We went crazy deep," says Kassin, "I think we went the deepest of anyone requesting telescope time."

Mulcahey explains that, "'deep' means letting the telescope collect light for a long time." This technique reveals the details of faint objects that were previously invisible.

Susan Kassin

The team focused their attention on galaxies that existed in the early universe, when it was 1.4 to 5.8 billion years old.

JWST's unmatched resolution allows the team to examine different regions of these ancient galaxies and study their composition, their mass, the motion of gases and stars inside of them, patterns of star formation, and other parameters.

Since receiving the data last September, the team has analyzed, "five galaxies that we call poster children," says Kassin.

Sharing a map of the motions of the gas inside a galaxy he investigated, Sukay points to one side of the galaxy shaded in red, and the other side in blue. These colors indicate whether the stars in each region are moving toward us or away from us – details that can be picked up by JWST. "We can see that this galaxy is rotating like this," says Sukay making a rotating motion with his hand, "with the bottom part coming towards the observer and this top part going away."

Ezra explains how studying deep spectra from galaxies provides information about the mass of stars and dark matter, the influence of black holes, and the outflowing of gas produced by supernovae. Mulcahey chimes in: "With our data we can see how these quantities vary by location within a galaxy."

JWST makes this possible because of its superb spatial resolution and its ability to collect and distinguish infrared light of different wavelengths. "Different wavelengths tell us a different part of the story," says Mulcahey, "We look at our objects in different wavelengths to get a more complete picture." She adds, "These objects are incredibly complex and stunning."

"There are no spectral studies of galaxies at these epochs with such exquisite spatial resolution," says Sukay, "People don't even know what we expect to see and we're trying to piece together a story of what galaxies are doing at this epoch. It's terra incognita."

The Oldest Known Galaxy Comes into Focus

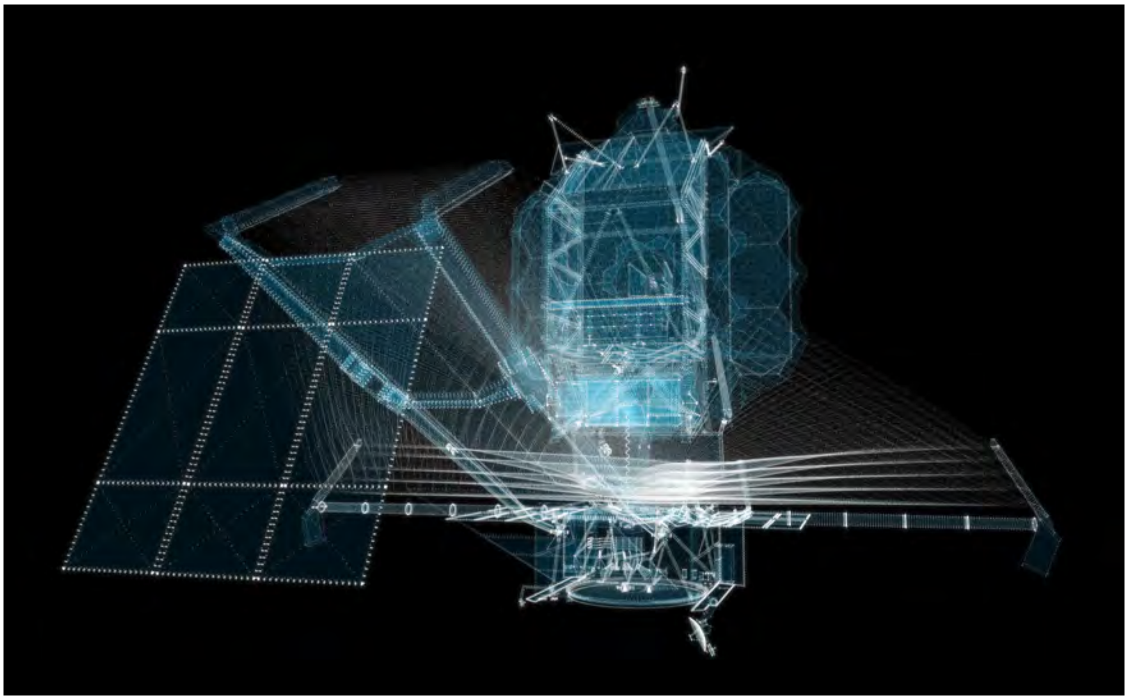
MACS0647-JD, a contender for one of the oldest known galaxies, is believed to have formed just 460 million years after the Big Bang, a mere blink in the universe's 13.8-billion-year history.

Initially detected by the Hubble Space Telescope as a measly dot, MACS0647-JD lay beyond Hubble's resolving power. While JWST has greater resolution, there is a limit to what it can detect, and this distant galaxy was beyond its capabilities. But there's a twist.

"This galaxy gets magnified around 10 times," explains post-doctoral researcher Abdurro'uf who is studying this celestial body.

When telescopes take snapshots of MACS0647-JD, the galaxy appears in three different images. This is because its light is being bent and magnified by the gravity of a cluster of galaxies that lies between the Earth and MACS0647-JD. This effect is known as gravitational lensing, and it's like having a natural cosmic telescope that helps us see faraway objects more clearly.

"Finding such a lensed galaxy from such an early time in the universe's history is extremely rare," Abdurro'uf notes.



Using JWST, Abdurro'uf and his colleagues have analyzed MACS0647-JD's light, akin to a prism separating sunlight into various colors. They have confirmed the galaxy's age with greater accuracy, placing it in its proper place in the cosmic timeline. They have observed rapid star formation. They also found that the galaxy's elemental composition is low in heavier atoms like oxygen and neon compared to our Sun, aligning with theories about early galaxies.

There was another surprise. MACS0647-JD might actually be two merging galaxies," Abdurro'uf reveals.

Upon closer examination, what appeared as a single "dot" turned out to be two galaxies engaged in a gravitational dance. The larger one shows signs of active star formation, while the smaller seems older, with traces of dust.

Abdurro'uf

"The early universe likely had a higher galaxy merger rate due to shorter distances between galaxies," Abdurro'uf suggests.

However, Abdurro'uf cautions, "We don't really know whether these galaxies are merging. This is to be confirmed with our future observations."

His upcoming research will look for signs of the galaxies spiraling towards each other, among other signatures of galaxy merger.

Abdurro'uf concludes, "If they are merging, it would be the earliest observed galaxy merger, occurring just 460 million years after the Big Bang."

Watching Distant Galaxies Collide

Professor Nadia Zakamska, post-doctoral fellow Yu-Ching (Tony) Chen, and PhD candidate Yuzo Ishikawa are galaxy merger specialists. They are interested in what happens to the super massive black hole (SMBH) at the core of every galaxy and its surrounding environment during the melding process.

"Merging galaxies are very well known in the local universe," says Zakamska, "They look super messy."

The team found two galaxies where "the separation of the two SMBH is four kiloparsec," says Chen. To put that in perspective, the size of our Milky Way is 20 kiloparsec, so these two galaxies are in each other's space.

Yu-Ching (Tony) Chen

The hitch is that these galaxies are not in the local universe. Rather, they existed 10-11 billion years ago, and that's where the JWST's infrared sensitivity can help.

"We expected to see two nuclei of two galaxies, one very disturbed, and another one showing tidal tails which get ripped off when the galaxies merge," says Zakamska. In other words, they expected to see a galaxy merger as it occurs in the local universe.

"Instead, we see a very well-organized single galaxy, with two black holes on either end of it," says Zakamska.

"This is very puzzling for us," comments Chen, "we don't know what's going on here."

"Is this a plausible merger stage?," asks Zakamska, "Or, is this a single galaxy that contains two black holes?" No such examples are known.

Nadia Zakamska

"There are no good theories," says Zakamska, "There are crazy ones, but we did not expect to go into the crazy regime with our first target observed with JWST."

To further the mystery, the two black holes look like twins in terms of how massive they are and how much surrounding gas they are consuming. "You are what you eat," says Ishikawa, "so maybe the galactic merging process fuels black holes equally."

The team continues to explore the data, testing "crazy theories" that could explain the observations. "If we can answer that," says Ishikawa, "that will be when our paper is done."

JWST's 20-Year Mission

"Originally, JWST was slated for a five-year mission," reflects Sing, "But the launch went so well that the European Space Agency didn't have to spend a lot of propellant course correcting. Because of that, the telescope is now up there with 20 years' worth of fuel."

He adds, "My own mindset went from, this is going to be exciting few years, to we're going to be able to have this telescope more or less the rest of my career, and that's a complete game changer for the field."

A CELESTIAL BODY THAT BEHAVES LIKE A STAR AND A BLACKHOLE SIMULTANEOUSLY

ROBERTO MOLAR CANDANOSA

It looks like a black hole and bends light like a black hole, but it could actually be a new type of star.

Though the mysterious object is a hypothetical mathematical construction, new simulations by Postdoctoral Fellow Pierre Heidmann, Associate Professor Ibrahima Bah, and Professor Emanuele Berti, suggest there could be other celestial bodies in space hiding from even the best telescopes on Earth. The findings are set to publish in *Physical Review D.*

"We were very surprised," said Pierre Heidmann, who led the study. "The object looks identical to a black hole, but there's light coming out from its dark spot."

The detection of gravitational waves in 2015 rocked the world of astrophysics because it confirmed the existence of black holes. Inspired by those findings, the Johns Hopkins team set out to explore the possibility of other objects that could produce similar gravitational effects but that could be passing as black holes when observed with ultraprecise sensors on Earth, said co-author associate professor Ibrahima Bah.

"How would you tell when you don't have a black hole? We don't have a good way to test that," Bah said. "Studying hypothetical objects like topological solitons will help us figure that out as well."

The new simulations realistically depict an object the Johns Hopkins team calls a topological soliton. The simulations show an object looking like a blurry photo of a black hole from afar but like something else entirely up close.

The object is hypothetical at this stage. But the fact that the team could construct it using mathematical equations and show what it looks like with simulations suggests there could be other types of celestial bodies in space hiding from even the best telescopes on Earth.

The findings show how the topological soliton distorts space exactly as a black hole does—but behaves unlike a black hole as

This image depicts the gravitational lensing effects caused by no object in an observer's line of sight, a black hole, and the topological soliton

Credit: Pierre Heidmann

it scrambles and releases weak light rays that would not escape the strong gravitational force of a true hole.

"Light is strongly bent, but instead of being absorbed like it would in a black hole, it scatters in funky motions until at one point it comes back to you in a chaotic manner," Heidmann said. "You don't see a dark spot. You see a lot of blur, which means light is orbiting like crazy around this weird object."

A black hole's gravitational field is so intense that light can orbit around it at a certain distance from its center, in the same way that Earth orbits the sun. This distance determines the edge of the hole's "shadow," so that any incoming light will fatally hit the region that scientists call the "event horizon." There, nothing can escape—not even light.

The Hopkins team simulated several scenarios using pictures of outer space as if they had been captured with a camera, placing a black hole and the topological soliton in front of the lens. The results produced distorted pictures because of the gravitational effects of the massive bodies.

"These are the first simulations of astrophysically relevant string theory objects, since we can actually characterize the differences between a topological soliton and a black hole as if an observer was seeing them in the sky," Heidmann said.

Motivated by various results from string theory, Bah and Heidmann discovered ways to construct topological solitons using Einstein's theory of general relativity in 2021. While the solitons are not predictions of new objects, they serve as the best models of what new quantum gravity objects could look like compared to black holes.

Scientists have previously created models of boson stars, gravastars, and other hypothetical objects that could exert similar gravitational effects with exotic forms of matter. But the new research accounts for pillar theories of the inner workings of the universe that other models don't. It uses string theory that reconciles quantum mechanics and Einstein's theory of gravity, the researchers said.

Pierre Heidmann

"It's the start of a wonderful research program," Bah said. "We hope in the future to be able to genuinely propose new types of ultracompact stars consisting of new kinds of matter from quantum gravity."

The topological soliton in the simulations was first constructed in research published in 2022 by Bah's group.

EUCLID MISSION BEGINS

The Euclid space telescope successfully launched atop a SpaceX Falcon 9 rocket on July 1, 2023 and is now beginning to collect data about millions of galaxies across one-third of the sky, part of a quest to better understand the so-called dark universe.

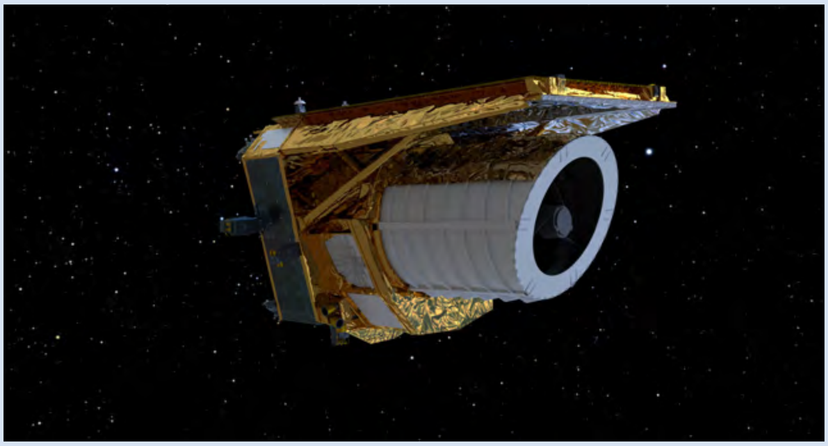
Three scientists in the department—Bloomberg Distinguished Professor Chuck Bennett, Professor Brice Ménard, and Associate Research Scientist Graeme Addison—are part of the Euclid's science team and have begun taking part in the analysis of the mission's data.

After a one-month journey to the second Lagrange point of the Earth-sun system, where the combined gravity of the sun and Earth balances the centrifugal force of the orbit, Euclid began to survey millions of galaxies to determine the nature of the dark universe. This includes dark energy, which appears to accelerate the expansion of the universe, and dark matter, which is not made of atoms and does not interact with light.

The telescope is collecting data to create a three-dimensional map of the distribution of dark matter in space whose geometry contains key cosmological information. The mission's namesake, the Greek mathematician Euclid, is known as the father of geometry.

Liftoff of the Euclid Space Telescope Mission, July 1, 2023

Credit: ESA



A rendering of the Euclid Space Teslescope at the second Lagrange point *Credit: ESA*

Spiral galaxy IC 342, one of the first images captured by Euclid in November 2023.

Credit: ESA

Euclid is a European Space Agency mission with important contributions from NASA, including infrared detectors and data analysis. Bennett, Ménard, and Addison, as well as members of their respective research groups in the department, have access to the data stream from the telescope.

Bennett and Addison serve on the Galaxy Clustering Science Working Group, which uses Euclid's data from a very large number of galaxies as a "standard ruler" to gain insights into the evolution of the universe, and in particular the nature of the dark energy that currently dominates the universe.

Ménard's group focuses on novel data analysis techniques to create maps of dark matter and extract astrophysical information from the stream of images that the Euclid mission produces.

The $1.6 billion spacecraft's payload includes a 1.2-m-diameter telescope and two scientific instruments: a visible-wavelength camera and a near-infrared camera/spectrometer. With more than 11 years of preparation building up to launch, the Euclid team consists of more than 2,000 scientists from 300 institutes in 13 European countries, the U.S, Canada, and Japan. Euclid is slated to operate for six years, with an option to extend the mission until it runs out of propellant.

NEWS BRIEFS

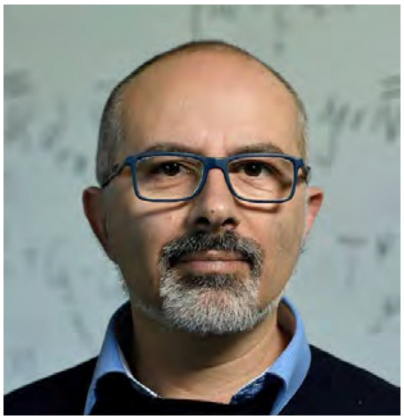
Peter Armitage Receives 2023 Brown Investigator Award

Professor Peter Armitage received a 2023 Brown Investigator Award from the Brown Science Foundation. The elite award recognized curiosity-driven research in chemistry and physics and supports research with up to $2 million over five years. Armitage was one of only seven recipients in 2023. The Brown Science Foundation, a Science Philanthropy Alliance member, is dedicated to the belief that scientific discovery is a driving force in the improvement of the human condition.

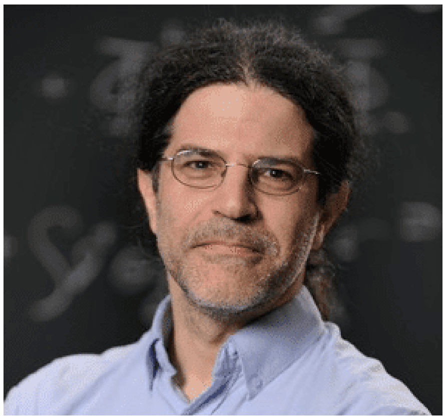
Ethan Vishniac Named Fellow of the American Association for the Advancement of Science

Research professor Ethan Vishniac was among the newest class of fellows of the American Association for the Advancement of Science, or AAAS, in 2023. The AAAS is the world's largest general scientific society. He was recognized by the AAAS for advancing our understanding of magnetic fields that shaped the cosmos on multiple scales, and for his distinguished service to the scientific community as the Editor in Chief of the American Astronomical Society journals, including *The Astrophysical Journal*.

Emanuele Berti and David Kaplan Named Simons Investigators in Physics



Emanuele Berti



David Kaplan

Professor Emanuele Berti and Professor David Kaplan were both named Simons Investigators in Physics by the Simons Foundation in 2023. 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. Professor Berti was selected by Simons Foundation in recognition of his work on various topics in gravitational-wave science, including black hole quasinormal modes, higher multipole radiation and spin precession in binary systems, astrophysical scenarios for the formation and evolution of compact binaries, and modified theories of gravity. Professor Kaplan was chosen in recognition of his proposed extensions to the standard models of particle physics and cosmology and for finding new ways to test them experimentally. He has discovered models of a naturally small cosmological constant and Higgs mass, classical solutions for firewalls in general relativity, and causal modifications of quantum mechanics. Kaplan has also developed testable models of dark matter, dark energy, and dark radiation. Each Investigator receives research support of $150,000 per year for a period of five years. Also, an additional $10,000 per year is provided to the department for each Investigator.

NEWS BRIEFS

Alex Szalay Elected Member of the National Academy of Sciences

Bloomberg Distinguished Professor and Director of the Institute for Data Intensive Engineering and Science, Alex Szalay, was elected as a member of the National Academy of Sciences (NAS) in 2023. Szalay was among 143 members who were elected to the NAS in 2023 in recognition of their distinguished and continuing achievements in original research.

Yahui Zhang Receives National Science Foundation CAREER Award

Assistant Professor Yahui Zhang received a National Science Foundation (NSF) CAREER Award in 2023 for his proposal titled "Superconductivity, fractionalization and quantum criticality in multilayer quantum simulator." The NSF CAREER Awards are awarded to support junior faculty who exemplified the role of teacher-scholars through research and education, and the integration of these endeavors in the context of their organizations' missions. The awards, presented once each year, include a federal grant for research and education activities for five consecutive years.

Adam Riess Receives 2023 H0 Award From The Chalonge – de Vega International School of Astrophysics

Bloomberg Distinguished Professor Adam Riess has received the H0 Award from The Chalonge - de Vega International School of Astrophysics in Paris. Riess received the award for "his relentless clever work and deep discoveries regarding the expansion rate of the Universe, a puzzle at the center of Cosmology and LambdaCDM showing the Model is currently challenged to connect the early to the present Universe." After accepting the H0 Award, Riess gave the Closing Lecture of the Year 2023 in December at The Daniel Chalonge – Hector de Vega International School of Astrophysics, which took place in Paris, France.

Nadia Zakamska Named President's Frontier Award Finalist

Professor Nadia Zakamska was named a President's Frontier Award Finalist by President Ron Daniels in February 2023. The President's Frontier Award Program, created to support and celebrate mid-career faculty at JHU, awarded Zakamska with $80,000 to support her ongoing research efforts. Zakamska was among only three other awardees in 2023. The awards were generously funded by donations from trustee Louis J. Forster and alumnus David Smilow.

Zakamska primarily studies extragalactic astrophysics and galactic astrophysics. Her lab discovered the existence of the quasar winds of supermassive black holes and has turned their attention to extreme quasar winds. With the James Webb Space Telescope, Zakamska researches the co-evolution of black holes and their host galaxies. Additionally, Dr. Zakamska is focused on discovering and characterizing white dwarfs in compact binaries which will merge due to the emission of gravitational waves – a quest that could solve the origin story of type Ia supernovae.

NEWS BRIEFS

Emanuele Berti and Adam Riess Included in the 2023 Clarivate Highly Cited Researchers List

Clarivate, a leading global information services provider, included Professor Emanuele Berti and Bloomberg Distinguished Professor Adam Riess in their 2023 Highly Cited Researchers List. Each researcher selected has authored multiple papers which rank in the top 1% by citations for their fields and publication year over the past decade. The evaluation and selection process draws on data from the Web of Science citation index, together with analysis performed by bibliometric experts and data scientists at Clarivate. In 2023, 6,849 researchers were on the list from more than 1,300 institutions in 67 nations and regions around the world.

Bar Veinstein, President of Academia & Government at Clarivate said, "We celebrate the Highly Cited Researchers whose contributions transform our world by helping to make it healthier, more sustainable and more secure. Recognition of Highly Cited Researchers not only validates research excellence but also enhances reputation, fosters collaboration, and informs resource allocation, acting as a beacon for academic institutions and commercial organizations."

Jennifer Lotz Appointed as Director of the Space Telescope Science Institute

Jennifer Lotz, who earned her PhD in astrophysics from the department in 2003, was appointed as the next Director of the Space Telescope Science Institute (STScI) in November of 2023. Dr. Lotz, who's research specializes in galaxy evolution and morphology, the high-redshift universe, and gravitational lensing, will begin her five-year appointment as STScI Director starting February 12, 2024. Previously, Dr. Lotz was the Director of the International Gemini Observatory. Before her appointment as Gemini Director, she was a tenured associate astronomer at STScI with a joint appointment as a research scientist in the department. She was also a Leo Goldberg Fellow at the National Optical Astronomy Observatory, and a postdoctoral fellow at the University of California Santa Cruz.

"Dr. Lotz is a science driven, accomplished leader," said Dr. Matt Mountain, President of the Association of Universities for Research in Astronomy, which manages STScI on behalf of NASA. "Jen's passion for the Institute's mission, to enable the science community in its exploration of the ground-breaking science coming from both JWST and Hubble, and her compelling vision, will ensure an exciting future as she leads STScI into a new era of space science."

"I am honored to be rejoining STScI as its next Director. The Institute's work on Hubble and JWST has been an inspiration for the world," commented Jen Lotz. "I am also excited to partner with NASA to drive forward a new era of scientific discovery with the new generation of space telescopes — JWST, Roman, and the Habitable Worlds Observatory."

Julian Muñoz Named One of *Science News'* 10 Scientists to Watch

Credit: Nolan Zunk

Theoretical physicist Julian Muñoz, who earned his PhD from the department in 2017, has been named to the SN 10: Scientists to Watch list from *Science News*. Dr. Muñoz studies the universe's early years, when the first stars began to shine and galaxies began to light up. He has developed a way to measure distances in that era, called a standard ruler.

NEWS BRIEFS

WiP@JHU Hosts Inaugural Women in Physics Summit

In September 2023, the Women in Physics group at Johns Hopkins University (WiP@JHU) hosted their first annual Women in Physics Summit. The event was crafted to celebrate and foster connections among women in physics across various career stages within the Maryland/DC region. WiP@JHU's objective was to create a vibrant forum to highlight the significant research carried out by women in physics and related disciplines, along with enabling networking and collaborative opportunities.

The Summit had over a hundred attendees and was held in the Bloomberg Center for Physics & Astronomy and was funded in part by the American Physical Society. Speakers and panelists from JHU included Alice Cocoros, Roshni Rao, Rosemary Wyse, and Yaojun Zhang, while speakers and discussion leaders from outside the university hailed from NASA, The European Space Agency, The Space Telescope Science Institute, and Maryvale Preparatory School. The event helped to build connections with nearby universities and spurred an initiative to host collaborative events with Morgan State in 2024 and beyond.

Credit: Arshia Maria Jacob

Chris Anto, Stefan Arseneau, Keyi Ding, Le "Chris" Wang, and Jintong "Alice" Li Receive Summer Provost's Undergraduate Research Awards

The Summer Provost's Undergraduate Research Awards (PURA) were awarded to five undergraduates in the department who would had the opportunity to work closely with JHU research advisors over the summer of 2023. PURA was created to assist and encourage Hopkins undergraduate students to continue or begin independent research projects with university advisors over the summer and without curricular obligations inhibiting full-time effort. Below are the awardees in the department along with their advisors and research titles.

- **Chris Anto**, advised by Natalia Drichko, "Developing methods of Raman scattering thin film measurement and applications to Quantum Spin Liquid candidate TbInO3"
- **Stefan Arseneau**, advised by Nadia Zakamska, "Probing The Mass-Radius Relation of White Dwarfs Using Wide Binaries"
- **Keyi Ding**, advised by Rosemary Wyse and Carrie Fillion, "Development of Machine Learning Techniques to Distinguish Giant Stars from Dwarf Stars and Application to the Andromeda Galaxy and the Milky Way"
- **Le "Chris" Wang**, advised by Kevin Schlaufman, "Is The Formation Of Terrestrial Planets The Cause of Solar Atypical Abundance Pattern?"
- **Jintong "Alice" Li**, advised by Amanda Lauer (School of Medicine), "Mechanisms of Hearing Loss in Sickle Cell Disease"

NEWS BRIEFS

Nicole Crumpler Receives National Science Foundation Graduate Research Fellowship

Graduate student Nicole Crumpler received a Graduate Research Fellowship from the National Science Foundation (NSF) in 2023. Crumpler was recognized for her research in theoretical astrophysics. The NSF Graduate Research Fellowship Program recognizes and supports outstanding graduate students who demonstrated the potential to make significant contributions in STEM. The program also seeks to broaden participation in science and engineering of underrepresented groups, including women, minorities, persons with disabilities, and veterans. The three-year fellowship will provide three years of financial support inclusive of an annual stipend of $37,000.

Thomas Edwards Receives 2023 Mark O. Robbins Future Faculty Prize in High-performance Computing

Thomas Edwards, a postdoctoral fellow working with Marc Kamionkowski and Emanuele Berti, received the 2023 Mark O. Robbins Future Faculty Prize in high-performance computing in July. The award recognizes work by Edwards and his collaborators in which they used automatic differentiation and AI-assisted techniques to produce a code that analyzes gravitational waveforms from the Laser Interferometer Gravitational-Wave Observatory (LIGO) with far less computational time than the standard LIGO analysis pipeline.

The Mark O. Robbins Future Faculty Prize is awarded under the auspices of the Advanced Research Computing at Hopkins (ARCH), the high-performance computing facility at the Johns Hopkins University. Edwards will receive a monetary award of $3,000 as well as 800,000 CPU-hours on ARCH for his own self-directed research project.

Izze Hedricks, Grace Luettgen, Daniel Naiman, and Xin "Jason" Zhang Each Receive Undergraduate Research Recognition

Izze Hedricks received the Materials Science & Engineering Nanomaterials Senior Design Award for her work on nanoscale superconducting devices from novel materials. She was also part of the team that received the 2023 REDDx award at the Applied Physics Laboratory for her contributions to "Closed-loop machine learning for discovery of novel superconductors"
Grace Luettgen received an ASPIRE (Arts and Sciences Projects, Investigations, and Research Endeavors) grant from the Dean's Undergraduate Research Program to work with Prof. Brian Camley on cells that exhibit both chemoattraction and chemorepulsion.

Xin "Jason" Zhang, in Professor Tyrel McQueen's group, received a National Science Foundation Graduate Research Fellowship. Daniel Naiman, also part of the McQueen group, became part of the Chem-E-Car team that qualified for the 2023 national competition. The competition challenged teams to design and construct a car powered by a new chemical energy source.

NEWS BRIEFS

Ryan Freund and Shrutina Shrestha Receive Provost's Undergraduate Research Award

Physics majors Ryan Freund and Shrutina Shrestha each received the Provost's Undergraduate Research Award from The Hopkins Office for Undergraduate Research in 2023. Freund and Shrestha each received a monetary award of $3,000 to aid their outstanding independent research. The award was designed to support and encourage Hopkins undergraduate students to engage in independent research, scholarly and creative projects. It was created in 1993 with a generous endowment by the Hodson Trust.

Ziwei "Peter" Hu and Yiqi "Andrew" Liu Receive 2023 Donald E. Kerr Memorial Awards

The department announced in May that undergraduates Ziwei "Peter" Hu (pictured left) and Yiqi "Andrew" Liu (right) are the joint recipients of the 2023 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..

Ziwei "Peter" Hu

Yiqi "Andrew" Liu

JHU Society of Physics Students Named Distinguished Chapter

In December, The Society of Physics Students (SPS), an organization of the American Institute of Physics, named the Johns Hopkins University SPS Chapter as a 2022-23 Distinguished Chapter. The recognition applauded the JHU SPS Chapter's outstanding participation from the department to help build professional skills for students as well as the Chapter's impressive social events.

Ali Ghasemi, Neha Anil Kumar, Chris Lygouras, Bastian Pradenas, and Vladimir Strokov Receive Graduate Teaching Awards

In May, the Graduate Program Committee announced their selection of the most outstanding graduate student Teaching Assistants in the department with their annual graduate teaching awards.

Excellence in Teaching: Ali Ghasemi (AS.171.104), Neha Anil Kumar (AS.171.104), and Chris Lygouras (AS.171.106)

Rowland Teaching Award for Innovation: Bastian Pradenas (AS.171.201)

EJ Rhee Flair in Teaching: Vladimir Strokov (AS.171.603 & AS.171.605)

IN MEMORIAM

Brian R. Judd, Gerhard H. Dieke Professor Emeritus, passed away on April 8, 2023. This remembrance was written by Professor Chia-Ling Chien.

I was saddened to hear that Brian Judd had passed away.

Long before I met Brian Judd, he was already famous during my thesis research in the 1970's. I studied his theoretical papers on angular momentum and hyperfine interactions. To many physicists Brian Judd has been known as the "Angular Momentum Judd" in part because of his book Angular Momentum Theory for Diatomic Molecules.

After I came to Hopkins, I made an appointment to see him in Rowland Hall, now Krieger Hall. I had no idea how intimating the revered physicist might be. To my relieve, Brian was mild manner, tall and handsome, soft-spoken, in jacket and tie, a true English Gentleman. His office was spotlessly clean. Only a few things were displayed neatly on his meticulously organized desk. For all the years I have known him, Brian has always been this way. I have seen him without a tie only twice; once during the physics picnic, the other on Saturday. On both occasions, the jacket was still there.

In his office Brian had a few dozen notebooks on his bookshelves, all purchased from the same stationary store in London. The research results of his entire professional life were handwritten into these notebooks. I once had a question about his theoretical results. In some publications in that era, the forward slash "/" means division. I wondered whether the several factors to the right of the slash "/" were all in the denominator in one formula. Brian thought for a moment and took out one notebook from the bookshelves. In a few minutes, he found the formulae and clarified the ambiguities.

When the physics department moved from Rowland to Bloomberg in the 1990's Brian's office was on the 5thfloor. Once he told me that the custodian had smoked in his office and used his phone. I could understand the smoking part because of the tobacco smell, but using his phone? Brian explained that the cord of his telephone was always looped in a particular way when he used the phone.

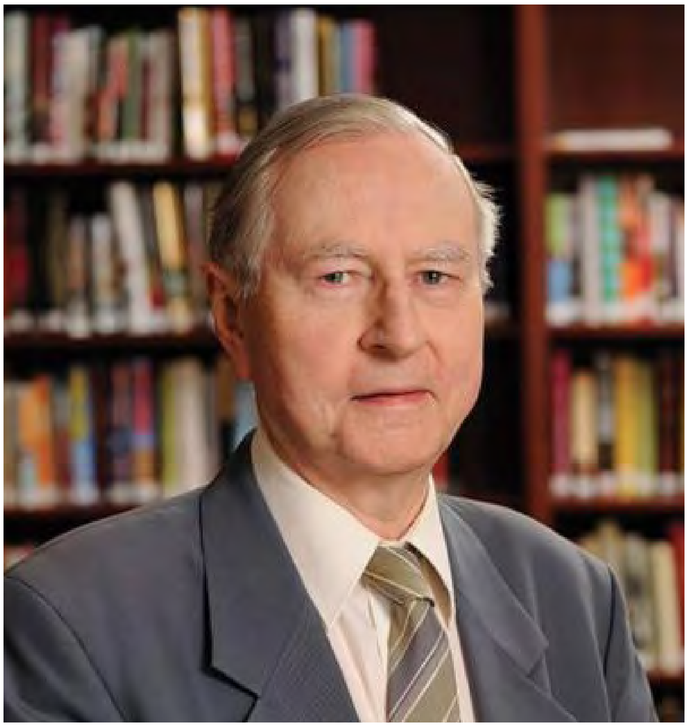
Brian came to Hopkins from Oxford via Berkley. He came as a bachelor and lived in the nearby Hopkins House apartment, at the corner of University Parkway and 39th street for many years. In addition to being conveniently located, he also met Josephine also living at the Hopkins House. They later moved to the house on Malvern Ave in the county, where we played piano four-hand and chamber music with other members in the physics department.

Brian was an accomplished pianist. Through Brian I learned that the British had strange names for music terms, such as quaver and crochet, for the eighth and quarter notes respectively. Brian is an excellent sight reader of music, probably due to years of training looking at the 3-j and 6-j symbols in angular momentum. Brian had a vast collection of music scores, literally a roomful in the Malvern Ave house, including some very rare pieces. Before the internet, one's first encounter with a piece of music was either through a music score or by a live performance or recording. I encountered some rarely heard pieces of music at Brian Judd house, such as Cantabile and Contradance by Chopin, and the piano transcriptions of Beethoven's Nine Symphonies by Liszt. That room was full of treasures.

The Grove Dictionary of Music and Musicians is the most authoritative publication in music, with 20 plus volumes in each edition, occupying more than 8 feet of shelve space. It teaches everything one ever wants to know about music except how to play it. After the first Grove edition published in 1840, a new edition appeared every two decades or so. The mighty JHU Milton Eisenhower Library had only two different editions of Grove, Brian had three.

The best story related to Brian was when he first came to Hopkins in the 1960's. He went into a classroom for his lecture, and the blackboard was fully covered with notes from an earlier class. He proceeded to wipe clean the blackboard and announced to the class that he expected a clean blackboard in his class. The American students did not take seriously the demand of the British professor. On the next day, the blackboard was again full of formulae from the earlier class. Brian cleaned the board again and made the same announcement again. On the third day, the blackboard was still not cleaned. This time Brian did not clean the blackboard. He started his lecture and proceeded to write formulae and notes in the small spaces between the lines. He soon filled up all the small spaces. Now he must clean the board as the class thought. He did but only his own notes in the small spaces between the lines. Henceforth, Brian always had a clean blackboard when he entered the classroom.

The last time I saw Brian and Josephine was in 2018 or 2019 in the Wilmer Institute in Greenspring Station while we were waiting for our eye exam. They were already in wheelchairs. Brian was still, as always, mild manner, soft-spoken, and in jacket and tie of course. To my newer colleagues, I wish you could have met him.



Brian R. Judd
1931 - 2023

IN MEMORIAM

Samuel Thornton Durrance, an astronomer who flew on two NASA space shuttle missions as a payload specialist, and who was a principal research scientist in the William H. Miller III Department of Physics and Astronomy from 1980 to 1997, died on May 5, 2023 at the age of 79.

Dr. Durrance came to JHU in 1980, as one of the first team members on the Hopkins Ultraviolet Telescope (HUT) project led by Prof. Arthur Davidsen. HUT had been selected for development by NASA in 1978, with the intent of making multiple flights on the space shuttle. Durrance was a key player in the construction and testing of HUT and in 1984 was selected as one of two payload specialists to fly with the telescope. Preparations and training took Durrance away from JHU for long periods, but his returns were always exciting times for his JHU colleagues to get caught up on the latest of his activities and to provide status of the HUT's instrumentation, most of which were developed on the first floor of Bloomberg Center for Physics and Astronomy.

"I remember one trip back where Sam had a cutting edge NASA `laptop' in tow, only available to astronauts. It was about 14×18 inches, 2 inches thick and weighed about 10 pounds! It was the first time any of us had seen a `portable' computer!" said research professor Bill Blair who was also part of the HUT team.

Originally slated to launch in March 1986 to view Halley's comet, the mission was scrubbed when the previous flight in January 1986, involving the space shuttle Challenger, exploded shortly after liftoff. The Challenger tragedy put future shuttle flights on indefinite delay and caused real concern about whether HUT would ever fly.

In the down time after Challenger, Durrance and his JHU colleagues turned their attention to a new technology known as adaptive optics that was being developed for ground-based telescopes. Their Adaptive Optics Coronagraph (AOC) aimed to image faint companions and diffuse features around bright nearby stars by using the stars' light to dynamically sense and correct for the blurring effects caused by the earth's atmosphere. This work involved a detailed understanding of atmospheric behavior as well as the development of an adaptive mirror system that could measure and correct image distortions up to 100 times per second. It was ground-breaking work that began an era of significant advances in ground-based astronomical observing. Together with colleagues from JHU and other universities, Durrance operated the AOC on telescopes at Las Campanas, Kitt Peak, Mt. Palomar, and the European Southern Observatories, making several seminal discoveries in the fields of exoplanet formation, very low-mass stars, and brown dwarfs.

Samuel T. Durrance
1943 - 2023

David Golimowski, now a staff scientist at the Space Telescope Science Institute and a graduate student with Durrance at the time, stated, "Although the Astro missions were the indisputable highlights of Sam's professional life, the AOC project that he led was, in my opinion, a close runner-up."

Durrance continued working on improvements to the AOC during the remainder of his time at JHU, even while training for and after flying the Astro missions.

Eventually NASA scheduled the Astro Observatory payload for flight, and after an agonizing series of launch delays in 1990, Durrance, along with HUT and the other telescopes of the Astro Observatory, launched on the 10-day Astro-1 shuttle mission on Columbia (STS-35) in December 1990, as well as the 16-day Astro-2 mission in March 1995 aboard space shuttle Endeavour (STS-67). During both missions, a cadre of 30 support scientists, engineers, and support staff from JHU Physics and Astronomy and from the JHU Applied Physics Laboratory were resident at NASA-Marshall Space Flight Center in Huntsville, Alabama, to support Durrance's real-time mission operations.

Hundreds of astronomical targets were observed with HUT, including everything from solar system objects to nearby galaxies to distant quasars. While every data set obtained was truly unique, "One of the key observations made with HUT was a measurement of the partially-ionized intergalactic medium in absorption using the ultraviolet light from a distant quasar as a background source," explained Blair. "This measurement was one of the primary scientific goals set forth in the original HUT proposal to NASA in 1978." Because of the importance of this result, the Smithsonian Institution requested that HUT be enshrined in the National Air and Space Museum in Washington, D.C., where it still resides today.

After leaving JHU in 1997, Durrance was a professor of physics and space sciences at Florida Institute of Technology and starting in 2001 served as the executive director of the Florida Space Research Institute, located at NASA's Kennedy Space Center. Durrance was a member of several scientific societies, including the American Astronomical Society and Association of Space Explorers. He born on September 17, 1943, in Tallahassee, Florida, and grew up in Tampa, Florida. Durrance earned Bachelor of Science and a Master of Science degrees in physics from California State University, Los Angeles, in 1972 and 1974, respectively. In 1980, he received a PhD in astro-geophysics from the University of Colorado at Boulder before coming to JHU.

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Dr. Jami Valentine Miller Named American Physical Society Fellow

Jami Valentine Miller, who earned her PhD in the department in 2007 working with Professor Chia Ling Chien, was named American Physical Society Fellow in 2023. Her citation from APS reads: "For extraordinary contributions to diversity and inclusion in physics, both in the United States and internationally, and for essential contributions to the history and promotion of Black women in American physics, through the founding of African-American Women in Physics, Inc. " Dr. Valentine Miller is the first Black woman to earn a PhD in physics at Johns Hopkins. For more incormation on African-American Women in Physics, visit AAWiP.com.