

Spring 2024

# NEWS FROM THE DEPARTMENT OF PHYSICS

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RESEARCH FEATURE

## Ohio State High Energy Nuclear Physics Group

Researchers probe the fundamental  
forces of Nature with high-energy  
heavy-ion collisions



THE OHIO STATE UNIVERSITY  
COLLEGE OF ARTS AND SCIENCES

# The Annual Alpheus W. Smith Lecture



Photo credit: ©Nobel Prize Outreach, Nanaka Adachi

This year's Alpheus Smith Lecture will feature **Anne L'Huillier**. L'Huillier, a French native and researcher at Lund University in Sweden, was one of the three winners of the 2023 Nobel Prize in Physics. L'Huillier, along with Pierre Agostini of The Ohio State University and Ferenc Krausz of the Max Planck Institute of Quantum Optics in Germany, were awarded the prize for their work on attosecond light pulses.

Dr. L'Huillier's work using lasers to study electrons helped enable this study of high-speed electrons, which was previously thought impossible. This 2023 Nobel Laureate's work will have applications across disciplines, from physics to electronics and even in medicine.

From her time as a student in France, to her work in Sweden and the United States, she has achieved much in her career, culminating in becoming a Nobel Laureate. L'Huillier is a well-decorated and respected physicist and we are thrilled to have her at Ohio State.

**The 61st Alpheus Smith Lecture will take place at the Fawcett Center on Friday, August 16, 2024 at 7:30 p.m. Free and open to the public, we invite you to join us in kicking off the fall semester with this once-in-a-lifetime experience.**



For more information, scan the code to the left or visit: [go.osu.edu/smithlecture](https://go.osu.edu/smithlecture)

■ *The Alpheus Smith Lecture has been bringing cutting-edge work of Nobel Laureates and other prominent physicists to the community since 1960. The free, public lecture series is endowed by Robert Smith to honor his father, Professor Alpheus W. Smith.*

# Letter from the Chair



I am delighted to start off the latest edition of the Physics Newsletter. It continues to be an honor to have the opportunity to serve as chair of this amazing department. The past couple of years have been great, with numerous accomplishments by our students, staff and faculty, which gives all of us pride. The stories in this edition provide a sense of these achievements, which I hope you will enjoy.

One of our most important accomplishments in the past two years is that six spectacular faculty have joined our department: Prof. Daniel Brandenburg, Prof. Jackie Chini, Prof. Mike Chini, Prof. Geraldine Cochran, Prof. Pierre Heidmann, and Prof. Kaeli Hughes. It was truly a pleasure to help recruit these amazing scholars to our community. There is a feature on each of them in this magazine. Please read about their backgrounds and their plans as they are getting started here in the department.

In addition, many of our established faculty continue to be highly successful with their scholarship and instruction. This includes many newly awarded federal research grants. The department's research programs are currently supported by 108 active grants and had nearly \$19M in research expenditures in 2023. The faculty's successes have been recognized by several university, national and international awards. Among these is the pinnacle award in physics, the Nobel Prize, awarded to Professor Emeritus Pierre Agostini in 2023! We are so proud of Prof. Agostini

and honored that he joined the department back in 2005 to continue his work in attosecond science, which he does in close collaboration with Prof. Lou DiMauro. An article featuring the Nobel Prize award ceremony and the science behind this award is in this magazine, which I encourage you to read.

Our undergraduate and graduate student programs remain strong and impactful with just under 400 undergraduate majors and just over 200 graduate students. We graduated 84 undergraduates and 30 graduate students this past year. We remain one of the top producers of graduates with physics undergraduate and graduate degrees. In fact, in 2021-2022 we had 100 undergraduate students receive their degrees, which put our department at the second highest producer of physics undergraduate degrees in the country that academic year. Many of these students have earned awards and scholarships, and then go on to great careers in industry and academia. Some of these successes are highlighted in the newsletter.

An essential part of our department is the outstanding staff, who provide key support for the research and teaching missions of the department. The department currently has 18 administrative staff, 20 research staff and 20 instructional staff. During my time as chair, I am very happy to report that the department has hired 34 outstanding staff. Both the new and veteran staff members work great together supporting each other and the department. They are wonderful to work with and I am grateful for all that they do.

To maximize the success and impact of our department, it is critical that our community be welcoming and supportive of all members. Furthermore, our department is constantly working in teams to solve problems and answer important questions in a wide range of research areas, in our instruction and even in our administration. The most effective teams have members with diverse backgrounds and skill sets. I am proud that our department continues to work on these goals. We are part of the Howard Hughes Medical Institute Driving Change project that "aims to effect lasting culture change on research university campuses by

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creating a more inclusive learning environment for all." The department is also participating in a National Science Foundation pilot project to create inclusive graduate programs. Our APS-funded Bridge Program continues to bring in 2-3 excellent students annually, who in 1-2 years become prepared for physics graduate school. We have spectacular student-led programs such as the Polaris mentoring program, which connects first-year physics and astronomy majors with a physics or astronomy graduate student mentor. Please have a look at the article on the success and impact of this outstanding student-run program.

I am so grateful to everyone in our physics community for their commitment, effort and support of the department. I feel fortunate and blessed to be a member of our wonderfully impactful and successful department.

Sincerely,  
**Michael Poirier**

## ON THE COVER

Photo credit: ©Nobel Prize Outreach, Nanaka Adachi

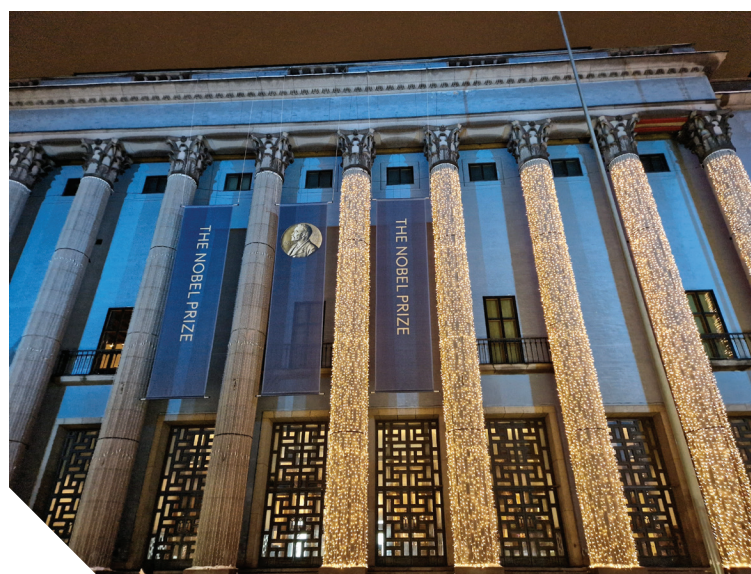
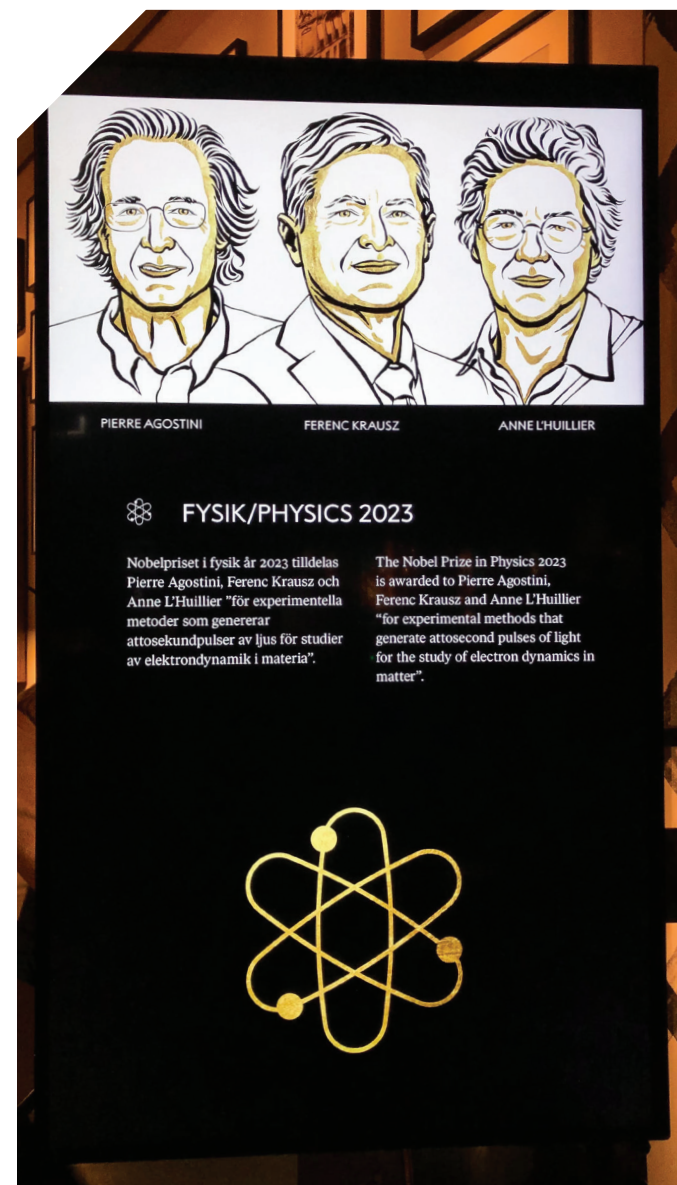
# Pierre Agostini honored with Nobel Prize in Physics

**Pierre Agostini**, Emeritus Professor in the Department of Physics, received the 2023 Nobel Prize in Physics at a ceremony in Stockholm on Dec. 10. Colleagues, former students and family members joined him in Sweden to celebrate a lifetime of accomplishments.



*Pictured are Professors Lou DiMauro and Pierre Agostini in their lab. Lou DiMauro is a professor in the Department of Physics and the director of the Institute for Optical Science. DiMauro is a long-time colleague of Nobel Laureate Agostini and is largely responsible for bringing Agostini to Ohio State. It is in Lou DiMauro and Pierre Agostini's lab where the work with lasers and attosecond pulses has continued.*

*Photo credit: Jodi Miller*



*“Being awarded the Nobel Prize is the pinnacle for a researcher’s career. Ohio State is so proud of Prof. Agostini and his achievements, and we look forward to seeing his lab and the Department of Physics continue to expand on his groundbreaking work.”*

**– Peter Mohler,**  
Executive Vice President for  
Research, Innovation and Knowledge,  
The Ohio State University

*Thanks to Jessi Middleton and  
Daniel Gauthier for photos of their  
time in Stockholm, Sweden for Nobel Week!*

*“This is the great recognition of the groundbreaking work of Dr. Agostini, and also the worldwide recognition of the new era he unveiled — attosecond science.”*

**– Xu Junliang**  
former Ohio State postdoc,  
Assistant Professor,  
Department of Radiation Oncology,  
University of Maryland School of Medicine



*“The Nobel Prize weekend events are special because it honors the scientific achievements of the laureates...It was so heartwarming to see all the families of the laureates gathering in the lobby of the hotel. Everyone was so happy and excited!”*

**– Daniel Gauthier**  
Professor, Department of Physics,  
The Ohio State University



*“For those of us who could not attend the Award Ceremony and Banquet, Ohio State hosted a private watch party. It made the evening special and we were able to celebrate together with applause and excitement.”*

**– Jessica Middleton**  
Office Administrator,  
Institute for Optical Science,  
The Ohio State University



► Read more about Dr. Agostini’s impact at Ohio State at [news.osu.edu/agostini-is-awarded-nobel-prize-while-ohio-state-cheers](https://news.osu.edu/agostini-is-awarded-nobel-prize-while-ohio-state-cheers)



► Watch a celebratory video at [youtu.be/7TJAL0KjVnU](https://youtu.be/7TJAL0KjVnU)

## Ohio State High Energy Nuclear Physics Group

Physicists tend to figure out how a system works by breaking it into smaller components. Usually, the apparent complexity of a large system can be understood in terms of simpler interactions between these more fundamental building blocks. Think of the amazingly complex and varied interactions between protein molecules, which arise from much simpler interactions of just a few types of atoms.

Indeed, each atom itself exhibits highly nontrivial properties, which can be studied and understood in terms of its fundamental components: the electrons and the nucleus. By separating these elements, we find a fundamental force at play – Coulomb’s Law of attraction and repulsion – that combines with quantum mechanics to explain the atom’s properties.

We can delve further...The atomic nucleus itself is hugely complex, but can be understood in terms of only two components – the protons and the neutrons – and the forces between them. We can understand a lot by systematically taking the nucleus apart.

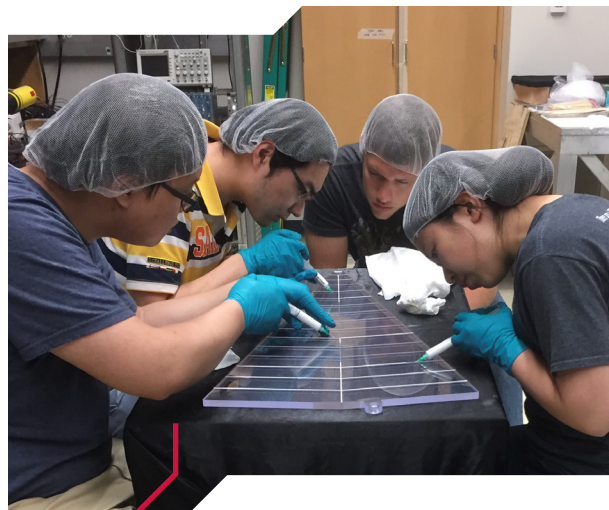
“Our group uses the world’s largest machines to probe the Universe’s smallest systems and most intense forces through ultrarelativistic, violent collisions of atomic nuclei. The breadth of our expertise — in detector construction, experimental operations, data analysis and phenomenology — allows us to play leading roles in several experiments.”

– **Mike Lisa**  
College of Arts and Sciences  
Distinguished Professor,  
Department of Physics

But we’re not done yet. It turns out that protons and neutrons are complex, and part of a much larger and fascinating subatomic “zoo” of particles which are – you guessed it – composed of what we believe are truly fundamental particles, quarks and gluons. However, here the physicist’s game of separating the constituents to study them individually ends. Due to a fascinating feature of the Strong Force, a quark cannot exist in isolation. If we try to remove a quark from a proton, new quarks pop into existence from the vacuum (and Einstein’s famous  $E = mc^2$ ) and immediately recombine with the original.

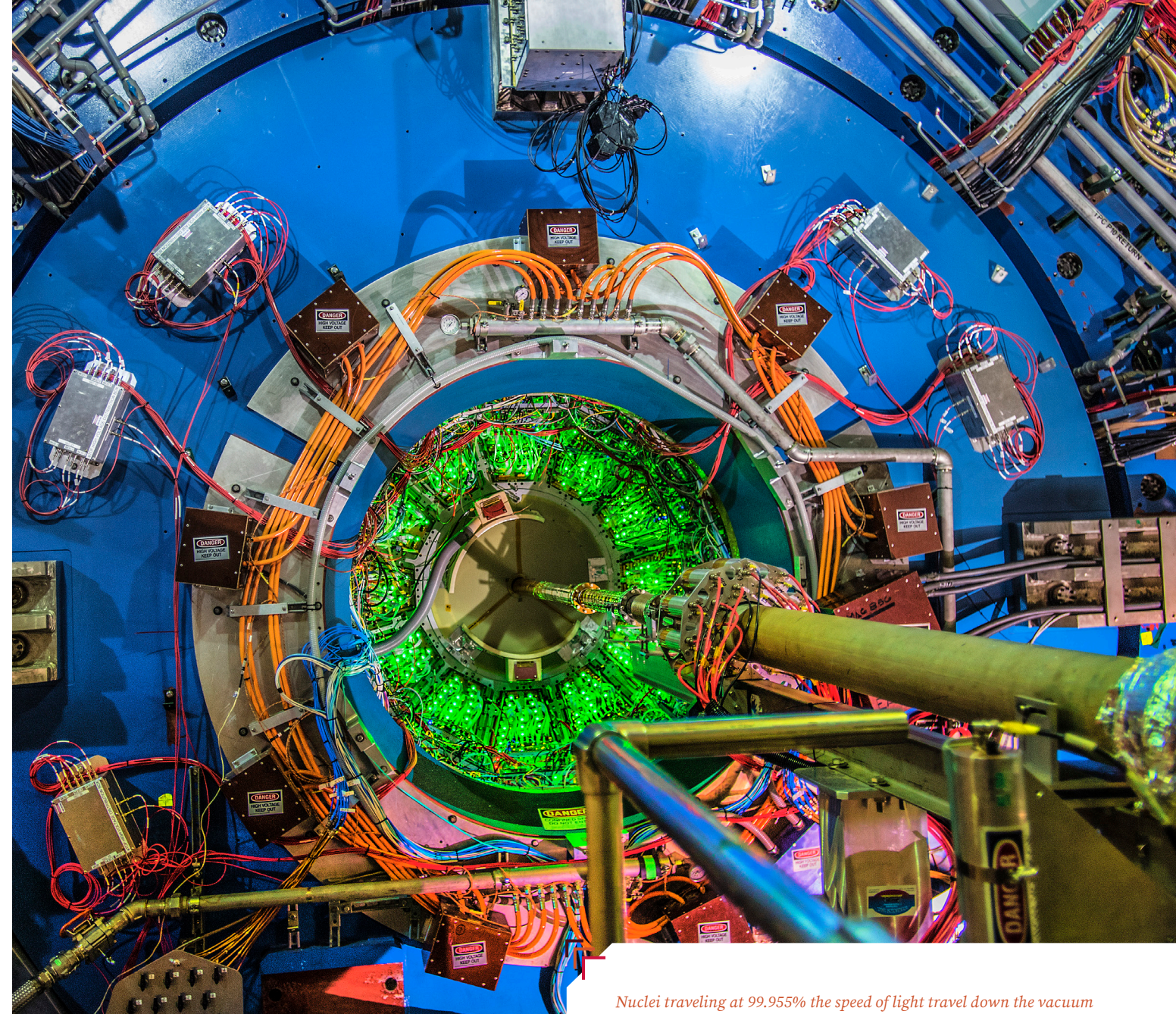
The Strong Force is the most complicated and – well – the strongest of Nature’s fundamental forces. It is the special properties of the Strong Force – not the Higgs boson! – that give rise to more than 90% of the mass in the visible universe. It is also by far the least-understood force in Nature.

Professors Daniel Brandenburg, Tom Humanic and Mike Lisa lead Ohio State’s experimental high energy nuclear physics (HENP) group. Supported by grants from the Department of Energy, they perform experiments at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory in New York and the Large Hadron Collider (LHC) at CERN in Europe. The experiments themselves are huge, resembling particle physics experiments in size and complexity. However, the focus is quite different; rather than discovering new particles, the HENP group probes unique properties of the Strong Force itself.



Students building the STAR Event Plane Detector. Ohio State is the lead institution on this detector: constructing, maintaining and operating it during RHIC beamtime. The EPD is crucial to measurements that connect the initial state geometry of the collision to the reaction of the quark-gluon plasma.

These experiments are huge in terms of the number of people involved, too. The HENP group actively collaborates with hundreds of physicists around the world and are prominent leaders in the community, with members regularly holding leadership positions such as physics analysis coordinator, physics working group convener and project leader for experimental systems. The group’s reputation gives Ohio State students increased visibility and opportunities; young HENP members regularly travel to international workshops to present their new results. Students learn how to effectively work in large, distributed scientific teams.



Nuclei traveling at 99.955% the speed of light travel down the vacuum tube entering the STAR experiment. They collide at the center of the massive detector, producing thousands of particles that physicists analyze offline.

Photo courtesy of: Brookhaven National Laboratory, CC BY-NC-ND 2.0, flickr.com/photos/brookhavenlab

Students work on a wide array of analyses, including femtoscopy, the use of quantum correlations to measure spacetime features of subatomic collisions; momentum flow; searches for novel quark-gluonic states; novel physics in ultraperipheral collisions; and polarization measurements. These require extensive computational and analytic skills, as well as intimate knowledge of detector operation.

Members of the group have made several high-profile discoveries in the past few years. Humanic’s team published the first compelling evidence of tetraquark formation in collisions at the LHC. Lisa’s team published the discovery of “vorticity” (rotational flow substructure) in the quark-gluon plasma, which is – amazingly – a fluid 10,000 times smaller than a single atom! Brandenburg uncovered evidence of light-on-light scattering and vacuum birefringence in the interaction between intense electromagnetic fields of nuclei traveling at 99.995% the speed of light. In addition to experimental measurements, group members regularly perform and publish theoretical studies of these phenomena.

While continuing with RHIC and LHC physics, the group is actively involved in preparations for experiments at the next large nuclear facility, the Electron-Ion Collider (EIC) at Brookhaven Lab. The group is leading the project for a hadronic calorimeter. Students will be heavily involved in detector construction and testing in the lab, as well as software infrastructure for the project. The broad variety of projects in the HENP group provide students with strong computing, analysis and hardware skills that will serve them well in science or industry.

# NSF Awards \$780K Grants to Ohio State's Andrew Heckler for STEM Fluency App

BY MALIK PERKINS

Andrew Heckler, well-known specialist in physics education research at The Ohio State University was awarded two grants from The National Science Foundation (NSF) totaling \$780,000 to enhance the STEM Fluency Learning Application.

STEM Fluency is an online tool which aims to sharpen accuracy and speed in foundational STEM skills. By simplifying practice, the app empowers students to tackle intricate STEM problems at their own pace.

"The idea is to not only build up a student's accuracy when solving these problems, but also increase their speed," said Heckler, professor of physics at Ohio State. "STEM Fluency uses mastery-based learning. The students have to answer three to five questions in a row correctly, but they get as many tries as they want."

STEM Fluency is utilized by more than 30,000 students from 15 institutions, who have collectively answered 12 million questions. The app covers 10,000 questions across 200 STEM skill categories, including introductory physics, second-year physics, upper-level quantum mechanics, introductory chemistry and intermediate astrophysics. Data gathered from the app shows the gap between students' skills in STEM subjects significantly narrows or closes completely the more they practice.

"I felt strong, but not confident," said Mia Marcellana, a third-year student studying neuroscience. "It helped me feel stronger with fundamentals like basic algebra and skill sets I hadn't pulled from since high school."

Madalyn Long, also in her third year at Ohio State studying radiologic science, likened the academic challenge to running around a track five times, equating its difficulty to a rigorous workout that ultimately enhances one's abilities.

"It is challenging, but it makes you a better athlete," Long said. "These problems can take quite some time to do, but it makes me a better student"

Following the grant achievements, Heckler spearheaded the creation of STEM Fluency Inc. in summer 2023. The nonprofit now possesses ownership of the question bank and software licenses from Ohio State, and their primary objective revolves around widespread distribution to educational institutions, with a continual focus on enhancing features and functionalities. This expansion includes Columbus State Community College alongside two Historically Black Universities, Hampton University and South Carolina State University, broadening its access across diverse educational institutions.

■ Reposted from [oied.osu.edu](https://oied.osu.edu)



Photo credit: Getty Images

## Physicists demonstrate powerful physics phenomenon

BY TATYANA WOODALL

In a new breakthrough, researchers have used a novel technique to confirm a previously undetected physics phenomenon that could be used to improve data storage in the next generation of computer devices.

Spintronic memories, like those used in some high-tech computers and satellites, use magnetic states generated by an electron's intrinsic angular momentum to store and read information. Depending on its physical motion, an electron's spin produces a magnetic current. Known as the "spin Hall effect," this has key applications for magnetic materials across many different fields, ranging from low power electronics to fundamental quantum mechanics.

More recently, scientists have found that electrons are also capable of generating electricity through a second kind of movement: orbital angular momentum, similar to how Earth revolves around the sun. This is known as the "orbital Hall effect," said Roland Kawakami, co-author of the study and a professor in physics at The Ohio State University.

Theorists predicted that by using light transition metals – materials that have weak spin Hall currents – magnetic currents generated by the orbital Hall effect would be easier to spot flowing alongside them. Until now, directly detecting such a thing has been a challenge, but the study, led by Igor Lyalin, a graduate student in physics, and published today in the journal *Physical Review Letters*, showed a method...



► Read the full story at: [news.osu.edu/physicists-demonstrate-powerful-physics-phenomenon/](https://news.osu.edu/physicists-demonstrate-powerful-physics-phenomenon/)

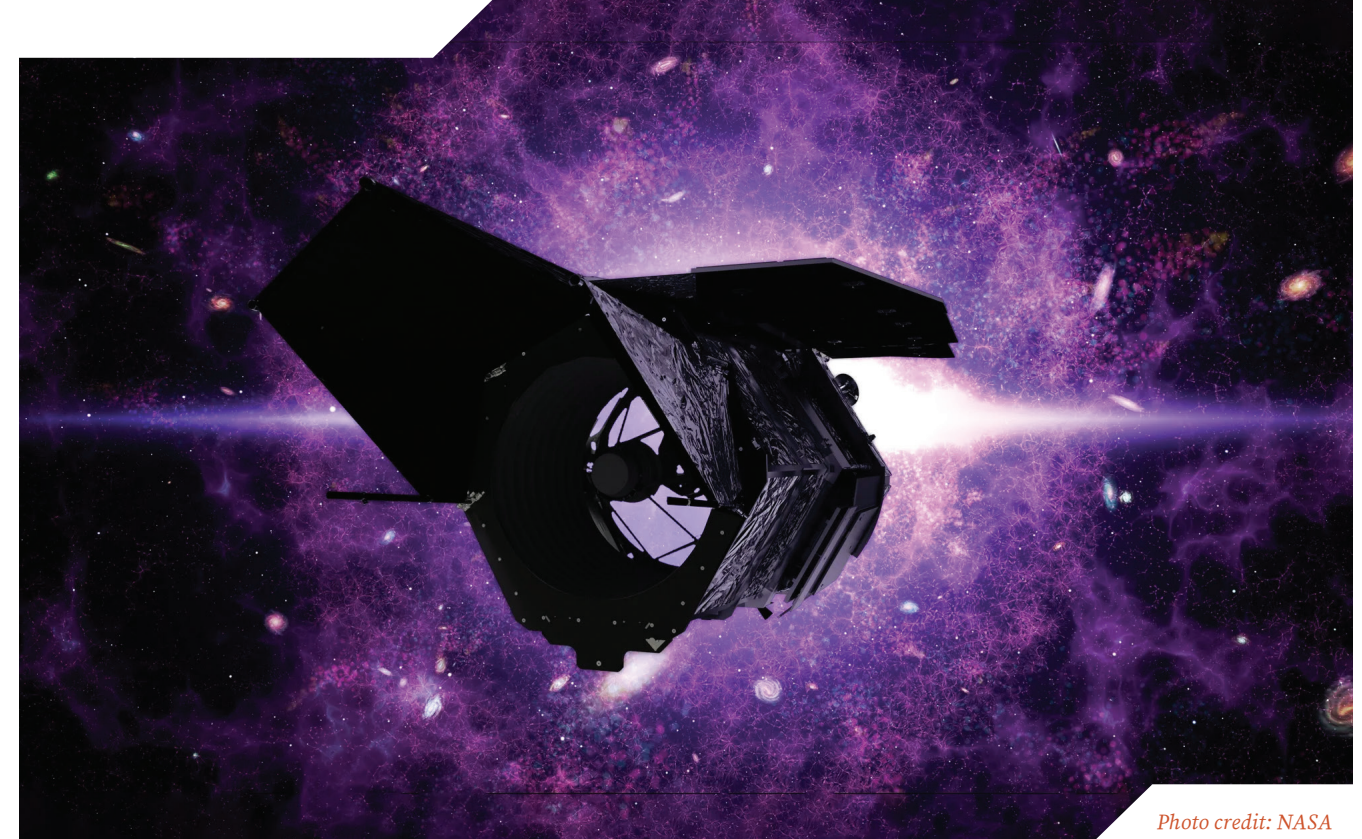


Photo credit: NASA

## Departments of Astronomy and Physics receive NASA grants to join Nancy Grace Roman Space Telescope Mission

BY CHRISTINA DIERKES

Faculty, staff and students in the Departments of Astronomy and Physics will play a large part in NASA's next large astrophysics mission, the Nancy Grace Roman Space Telescope (Roman), expected to launch in late 2026 or early 2027. The selected science teams are charged with developing a variety of strategies and software for the mission's largest surveys, with research goals ranging from the discovery of planets orbiting other stars to mapping the expansion of the universe through cosmic time.

"The success of these proposals is a testament to the key role that Ohio State has had in the development of Roman since its inception," said Scott Gaudi, Thomas Jefferson Professor for Discovery and Space Exploration and University Distinguished Scholar in the Department of Astronomy. "Several of us have devoted a significant fraction of our careers to Roman. We led Science Investigation Teams with similar composition over the past five years, and this allowed us to assemble teams with so much expertise and experience that it would be hard to imagine NASA executing the mission without them. These grants solidify Ohio State's major footprint in Roman."

The Roman mission will focus on dark energy and dark matter, exoplanets, stars, and a wide range of infrared astrophysics and planetary science topics. Ohio State scientists involved in the funded projects include Gaudi; Marc Pinsonneault, University Distinguished Scholar and professor of astronomy; David Weinberg, Distinguished University Professor and astronomy department chair; Ashley Ross, research scientist in the Center for Cosmology and Astroparticle Physics; and Christopher Hirata, professor in the Department of Physics.

Overall, the selected grants will bring about five million dollars' worth of funding to Ohio State over the course of five years, with opportunities for extensions for another five years. Six of the selected projects, including three of the five major project infrastructure teams, include Ohio State representation. Other notable institutions on the science teams include NASA's Goddard Space Flight Center and Jet Propulsion Laboratory.

“The success of these proposals is a testament to the key role that Ohio State has had in the development of Roman since its inception.”

– Scott Gaudi

*Thomas Jefferson Professor for Discovery and Space Exploration and University Distinguished Scholar*

The Roman Space Telescope is a NASA observatory designed to settle essential questions in the areas of dark energy, exoplanets and infrared astrophysics. The telescope has a primary mirror that is 2.4 meters in diameter (7.9 feet) and is the same size as the Hubble Space Telescope's primary mirror. The Roman Space Telescope will have two instruments, the Wide Field Instrument and the Coronagraph Instrument technology demonstration. The telescope will have a primary mission lifetime of five years, with a potential five-year extended mission.

# Ohio State to launch quantum MS/PhD program with funding from the National Science Foundation

BY CHRISTINA DIERKES

An interdisciplinary team at The Ohio State University has received \$3M from the National Science Foundation to support the launch of a new graduate program in quantum information science and engineering (QISE). Faculty leaders from the College of Arts and Sciences and the College of Engineering are involved in the program, which is one of a few in the U.S. that is not housed in a single academic department.

The program, funded by NSF's Research Traineeship (NRT), will include core new graduate-level courses, experiential learning such as graduate research and industry internships, and professional training in communication and ethics. Students will have access to faculty members and courses in the Departments of Physics, Math and Chemistry and Biochemistry in the College of Arts and Sciences, as well as the Departments of Electrical and Computer Engineering, Computer Science and Engineering, and Materials Science Engineering.

"The 2018 U.S. National Quantum Initiative Act has spurred a remarkable acceleration of progress in quantum information science and technology in just the past few years," said Jay Gupta, professor of physics and the program's principal investigator. "What's exciting about the program we're launching at Ohio State is that it provides us an opportunity to design an innovative graduate curriculum from scratch, using evidence-based methods for instruction, and prioritizing multi-disciplinary research and education from the outset. The program also leverages the investments Ohio State has made recently in the Center for Quantum Information Science and Engineering and in faculty hiring."

Traditional graduate programs can lack the funding and industry engagement needed to develop a diverse workforce that can solve grand challenges in quantum information sciences and engineering (QISE) and translate fundamental research to commercial applications. In addition to courses, NRT trainees will be engaged in QISE research and industry internships from the start, and will develop professional skills in ethics, technical writing and communication...



► Read the full story at:  
[artsandsciences.osu.edu/news/ohio-state-launch-quantum-ms-phd-program-funding-national-science-foundation](https://artsandsciences.osu.edu/news/ohio-state-launch-quantum-ms-phd-program-funding-national-science-foundation)

## How an essential class of proteins can access blocked genes

BY EMILY CALDWELL

Genetic information contained within DNA has to be read by specific proteins that enable the process of gene activation to begin – but in many cases, these proteins can't access their targets because DNA strands are bundled up to control what genes are used in the wide range of different cell types.

New research led by scientists at The Ohio State University shows how one of these proteins, known as a transcription factor, functions as a special "pioneer factor" by managing to bind to a blocked segment of DNA to begin the process of opening up and activating a gene.

The research was conducted in budding yeast, a single-cell organism, but the transcription factor studied, called Cbf1, is among a family of proteins with a long evolutionary history that have a basic helix-loop-helix configuration – a structural feature similar to about 100 transcription factors known to exist in humans.

"In humans, mutations in this class of transcription factors play central roles in cancer," said Michael Poirier, lead corresponding author of the study and professor and chair of the Department of Physics at The Ohio State University.

"This work tells us one of the main ways genes are activated," Poirier said. "We're trying to understand, at a fundamental level, how cells work with the idea that this ultimately provides the information one needs to understand disease and develop therapies."

Benjamin Donovan, a biophysics graduate student in Poirier's lab, is first author of the study. Song Tan and Lu Bai, professors in Penn State University's Department of Biochemistry and Molecular Biology, were co-corresponding authors of the paper, which was recently published in *Molecular Cell*.

In plants, animals and other organisms whose cells have a nucleus, sections of DNA spool around a collection of histone proteins to form nucleosomes, similarly to how a watering hose might be organized in a backyard. Once locked into a nucleosome spool, portions of those DNA segments can't be accessed by most transcription factors.

But a special class of these binding proteins found in humans and recently discovered in plants, called pioneer factors, "can access sites that are not accessible," Poirier said. "How they do that has been a complete mystery."

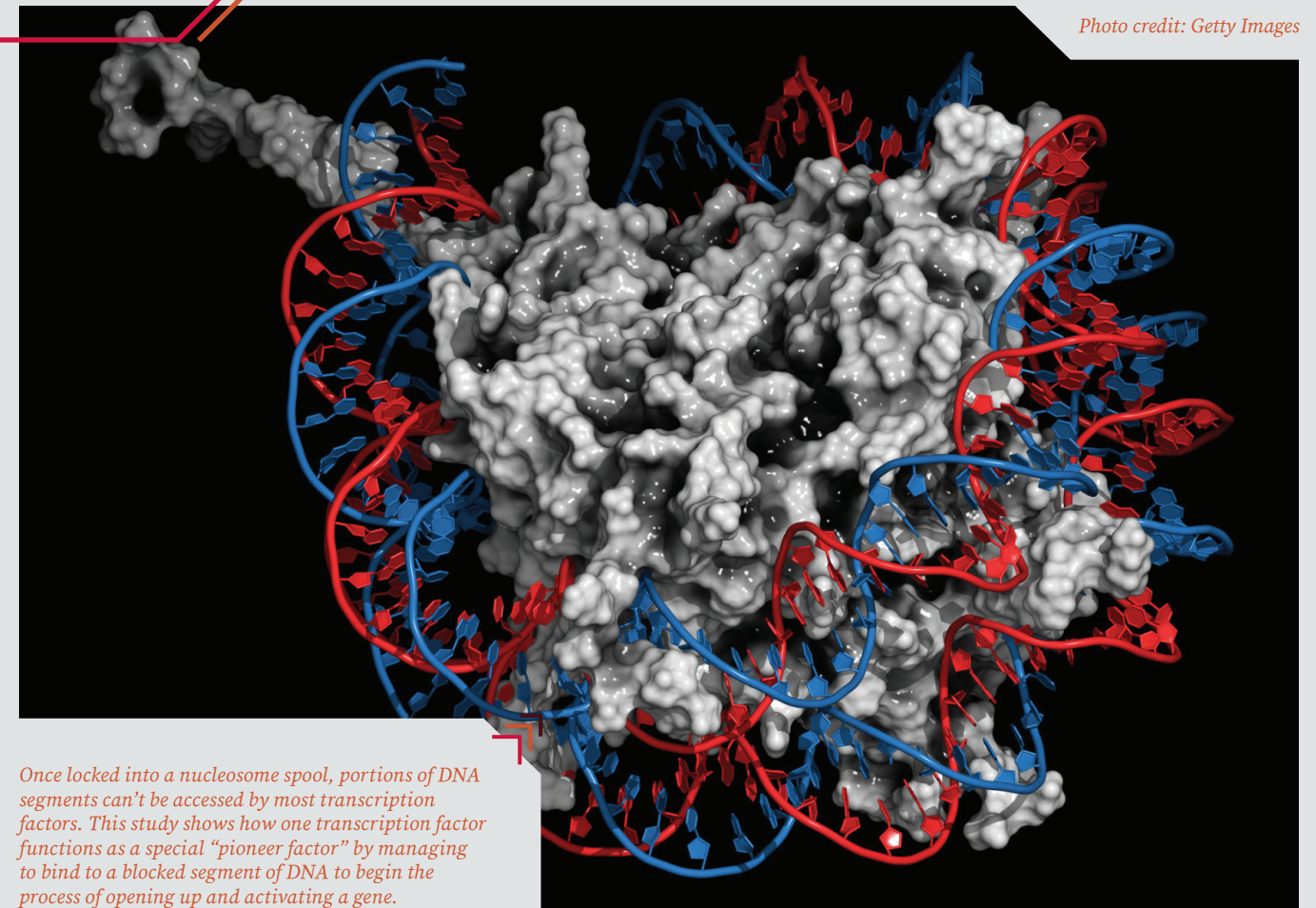


Photo credit: Getty Images

Once locked into a nucleosome spool, portions of DNA segments can't be accessed by most transcription factors. This study shows how one transcription factor functions as a special "pioneer factor" by managing to bind to a blocked segment of DNA to begin the process of opening up and activating a gene.

In a previous paper, Poirier, Bai, Donovan and collaborators showed that the Cbf1 transcription factor could bind to its target site despite that site being embedded within a nucleosome, essentially revealing Cbf1 is equivalent to a pioneer factor. The researchers also observed with single molecule microscopy that this capability was related to the protein's unexpected tendency to remain present within the spool for an unusually long time. Most transcription factors that manage to bind within nucleosomes aren't able to maintain the connection for very long – they disengage quickly through a process called dissociation.

"We showed that this long retention of Cbf1 generated very efficient occupancy within a nucleosome even though the binding site is largely blocked so it had to wait for the nucleosome to unwrap to then bind. But that paper gave no insight into how it worked: How does pioneer factor Cbf1 stick around for so long? And why?" Poirier said.

In this new study, the team tested their theory that Cbf1 sticks around by making use of the histone proteins around which nucleosomes form.

Using single molecule measurements, Donovan revealed that the helix-loop-helix structure of Cbf1, which resembles the structure of another well-studied yeast transcription factor, could play a role in its special capabilities. A series of experiments confirmed this structure was essential to the nucleosome binding success.

Electron microscopy from the Tan lab showed Cbf1's positioning indicated the helix-loop-helix region of its structure interacts with histones, and the scientists

confirmed the attachment location by mutating histone-interacting regions and observing a weakening of the bond. These extra histone interactions facilitated Cbf1's ability to function as a pioneer factor by retaining, for typically a minute, Cbf1 at its target DNA site within the partially unspooled nucleosome. The researchers call this phenomenon a dissociation rate compensation mechanism.

Studies from the Bai lab in live budding yeast showed nucleosomes were displaced by Cbf1, and that its histone interactions resulted in expected functional outcomes.

Once pioneer factors bind to a nucleosome, other proteins and enzymes enter the picture to move along the process leading to gene expression and protein building.

"We've explained molecularly and mechanistically how a pioneer factor can function and shown where the dissociation rate compensation mechanism comes from: in part, from histone interactions," Poirier said. "If they don't bind, none of this can get started – they are key to launching gene expression."

This work was supported by the National Institutes of Health, the National Science Foundation and the Estonian Research Council.

Additional co-authors include Hengye Chen of Penn State, Preet Eek of Tallinn University of Technology, and Zhiyuan Meng and Caroline Jipa of Ohio State.

■ Reposted from [news.osu.edu](https://news.osu.edu)

# Novel quantum entanglement lets researchers spy on atomic nuclei

BY TATYANA WOODALL

Nuclear physicists have found a way to peer inside the deepest recesses of atomic nuclei, according to a new study.

The finding was made possible using the Relativistic Heavy Ion Collider (RHIC) at the Brookhaven National Laboratory in New York, which is capable of colliding gold ions at near light-speed. It led to the discovery of a new kind of quantum entanglement.

The term quantum entanglement describes an invisible link that connects distant objects; no matter how far away they are in space, they affect each other. That means if two particles are entangled on a quantum level, by measuring the quantum state of one of the particles, you can immediately know the quantum state of the other, wherever it may be. For example, using a coin analogy, if one particle is “heads,” scientists instantly discern that the other particle is “tails,” no matter where in the universe it is.

Theoretical physicist Albert Einstein once dismissed the phenomenon of quantum entanglement as “spooky action at a distance,” but Daniel Brandenburg, co-author of the study and a professor of physics at The Ohio State University, said that learning more about this codependent relationship is fundamental to understanding the mysteries of the world around us.

“Entanglement is one of the defining characteristics that makes quantum mechanics so different from the kind of physics that normally happens around us,” he said.

The study of how photons and electrons interact with and affect matter, quantum mechanics is the foundation on which many technologies – such as quantum computing and quantum chemistry – are built. Despite these advancements, scientists previously believed that only particles of the same kind were capable of quantum interference: Photons could only interfere with photons and neutrons with neutrons. That is, until now.

This new study, published in the journal *Science Advances*, describes how a team of researchers – called the STAR Collaboration – used the RHIC to uncover a form of quantum entanglement that shows that particles of all different kinds are able to interact with one another, leading to interference in a variety of different patterns.

“We’ve gotten different kinds of particles to interfere for the first time, even though previously people thought that it wasn’t possible in quantum mechanics,” said

Brandenburg. Using the collider like a large 3D digital camera, researchers used light to track the particles that escaped from the center of the machine once the atoms collided, taking high-resolution, two-dimensional images much like how a PET scan can be used to image and measure changes in the human body.

This method allowed researchers to map the arrangement of gluons – glue-like particles that act as a binding force for quarks, the particles within the protons and neutrons inside atomic nuclei. These interactions produced a subatomic particle called a pion that, by measuring the velocity and angles at which light struck the collider, researchers were able to essentially use as a microscope to see inside atomic nuclei in a way like never before.

“By playing these quantum mechanical tricks, we can get to a precision which shouldn’t be possible otherwise,” Brandenburg said. “This precision allowed us to actually see, within an individual gold nucleus, where the protons and the neutrons reside.”

This novel result was in part made thanks to a discovery Brandenburg made about two years ago, called the Breit-Wheeler process, which details how light can be turned into matter and antimatter. Building on the physics of this previous discovery, the team was able to view inside the nucleus on a scale of a tenth to a hundredth the size of an individual proton.

“That’s mind-blowingly small,” said Brandenburg.

The findings could eventually help advance research in several fields, from quantum computing to astrophysics, he said.

Brandenburg, whose interest in nuclear physics originally began in astronomy, notes that because all matter is connected, investigating the inner workings of atomic nuclei could also allow astrophysicists to discern aspects like a star’s stability, its size, density, and even how it formed. “By doing this work here on Earth, we’re helping to actually understand better the things that are far out in the universe,” Brandenburg said.

“By playing these quantum mechanical tricks, we can get to a precision which shouldn’t be possible otherwise.”

– Daniel Brandenburg  
Assistant Professor, Department of Physics

Going forward, the team hopes to extend its work by mapping the depths of other kinds of quantum objects.

“One of the big questions in our field is how do we understand the properties of this fundamental building block of matter,” he said. “With the discovery of this new type of entanglement, we can start to test these ideas for the first time.”

This work was supported by the Office of Nuclear Physics within the U.S. Department of Energy Office of Science, the U.S. National Science Foundation, the National Natural Science Foundation of China, and others.

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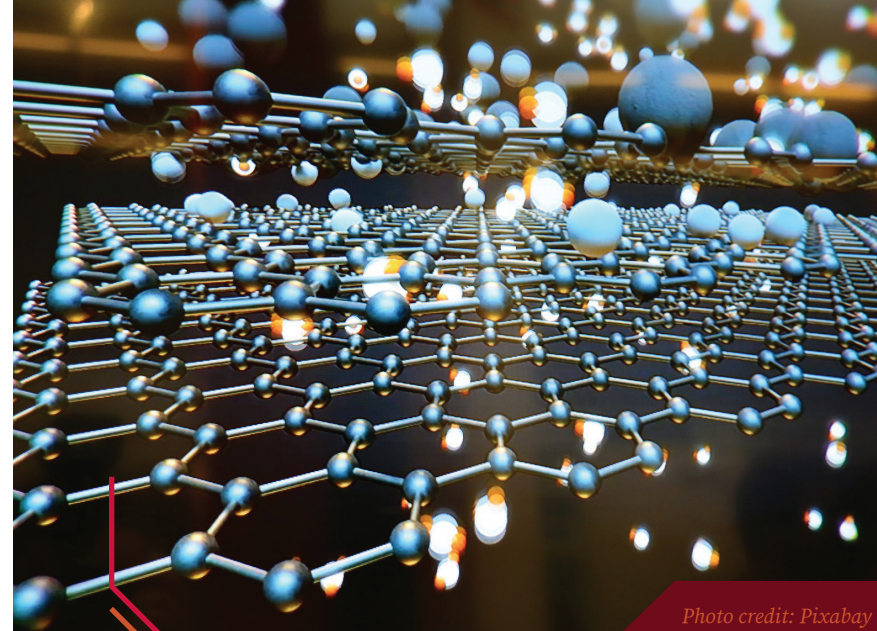


Photo credit: Pixabay

## Discovering the magic in superconductivity’s ‘magic angle’

BY JEFF GRABMEIER

Researchers have produced new evidence of how graphene, when twisted to a precise angle, can become a superconductor, moving electricity with no loss of energy.

In a study published today (Feb. 15, 2023) in the journal *Nature*, the team led by physicists at The Ohio State University reported on the key role that quantum geometry plays in allowing this twisted graphene to become a superconductor.

Graphene is a single layer of carbon atoms, the lead that is found in a pencil.

In 2018, scientists at the Massachusetts Institute of Technology discovered that, under the right conditions, graphene could become a superconductor if one piece of graphene were laid on top of another piece and the layers were twisted to a specific angle – 1.08 degrees – creating twisted bilayer graphene.

Ever since, scientists have been studying this twisted bilayer graphene and trying to figure out how this “magic angle” works, said Marc Bockrath, professor of physics at Ohio State and co-author of the *Nature* paper.

“The conventional theory of superconductivity doesn’t work in this situation,” Bockrath said. “We did a series of experiments to understand the origins of why this material is a superconductor.”

In a conventional metal, high-speed electrons are responsible for conductivity.

But twisted bilayer graphene has a type of electronic structure known as a “flat band” in which the electrons move very slowly – in fact at a speed that approaches zero if the angle is exactly at the magic one...



Read the full story at:  
[news.osu.edu/discovering-the-magic-in-superconductivitys-magic-angle](https://news.osu.edu/discovering-the-magic-in-superconductivitys-magic-angle)

## Ohio State establishes Center for Quantum Information Science and Engineering

NEW CENTER BUILDS ON UNIVERSITY'S EMERGENCE AS A KEY LEADER IN QUANTUM FIELD

The Ohio State University recently announced it is establishing the Center for Quantum Information Science and Engineering (CQISE), building on the momentum around a discipline with far-reaching economic and societal impacts.

Quantum information science and engineering is a broadly interdisciplinary field, with the potential to impact the entire STEAM enterprise through the development of new quantum technologies, the exploitation of those technologies to enhance existing activities, and considerations of the societal and cultural impacts of these transformative changes.

“I am pleased to announce a new Ohio State Center for Quantum Information Science and Engineering, where our scientists and engineers will use the properties of quantum mechanics to transform communications, computation and sensing,” said Kristina M. Johnson, president of Ohio State, during her State of the University address on April 21.

The new center will focus not only on creating synergy among the university’s current activity, but look to build on Ohio State’s emergence as a key leader in pushing the field forward. In July 2021, Ohio State joined the Chicago Quantum Exchange, a growing intellectual hub for the research and development of quantum technology. Then in September, the QuSTEAM initiative led by Ohio State was awarded \$5 million from the National Science Foundation to

» story continues on next page...

develop a diverse, effective and contemporary quantum-ready workforce by revolutionizing and creating more equitable pathways to quantum science education.

These efforts are being further enhanced by an aggressive faculty recruitment effort, including ongoing searches in computer science and engineering, and an interdisciplinary search for two positions across five departments, including physics, chemistry, computer science and engineering, electrical and computer engineering, and materials science and engineering.

Co-directors for the center are Ezekiel Johnston-Halperin, professor in the College of Arts and Sciences Department of Physics, and Ronald M. Reano, professor in the College of Engineering Department of Electrical and Computer Engineering.

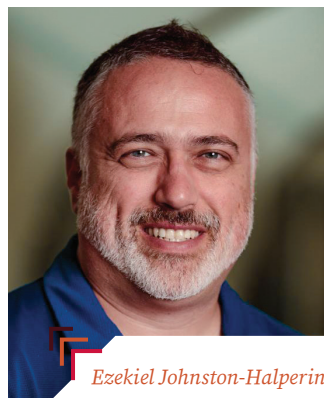
“The inherently interdisciplinary nature of the field necessitates this type of institution-level response,” said Johnston-Halperin. “By increasing collaboration among our best minds in chemistry, biochemistry, physics, computer science, engineering and more, we can solve complex, societal challenges through advancing quantum science.”

“From sensors, to communications, to computing and simulation, advances in quantum information are laying the foundation for a paradigm shift bridging much of modern science and technology,” added Reano. “We’re excited to have this opportunity to establish Ohio State as a leader in this area and help create a quantum-literate workforce that advances with the technologies.”

“**The inherently interdisciplinary nature of the field necessitates this type of institution-level response. By increasing collaboration among our best minds in chemistry, biochemistry, physics, computer science, engineering and more, we can solve complex, societal challenges through advancing quantum science.**”

– **Ezekiel Johnston-Halperin**  
Professor, Department of Physics

The center has established goals in research, teaching and outreach and is already developing strategies that support development of the quantum ecosystem at the university. Work is already underway to develop training programs and short courses to train researchers in the scope and use of critical quantum-relevant tools and create seed funding to support interdisciplinary quantum research.



Ezekiel Johnston-Halperin



Ronald M. Reano

CQISE will also have significant synergy with existing internal and federally supported centers and institutes at the university. These centers focus on research that is either “quantum adjacent” or where there is opportunity to expand into emerging quantum information related directions – including the Institute for Materials Research, Translational Data Analytics Institute, Center for Emergent Materials and Institute for Optical Science.

The launch of the center is part of the university’s strategic plan to increase convergent research opportunities and accelerate societal impact. The center will also provide additional opportunities for collaboration with leading organizations and companies to advance quantum science across sectors.

“It is exciting to see our peers at Ohio State advance research in quantum computing,” said AJ Lang, global chief technology officer at JPMorgan Chase and an Ohio State alumnus. “Given the importance of quantum technology for JPMorgan Chase’s competitive edge long term, we look forward to collaborating with the new Center for Quantum Information Science and Engineering and broadening the pipeline of talent that will support quantum deployment across future financial applications.”

“We’ve been proud to partner with Ohio State on quantum research and in the national effort to prepare a diverse, quantum-ready workforce. The Center for Quantum Information Science and Engineering will help further establish the Midwest as the leading region for the field,” said David Awschalom, the Liew Family Professor in Molecular Engineering and Physics at the University of Chicago, director of the Chicago Quantum Exchange and director of Q-NEXT, a Department of Energy Quantum Information Science Center. “We are excited to work with CQISE to continue developing these collaborations and advance the nation’s emerging quantum economy.”

CQISE will report to the Enterprise for Research, Innovation and Knowledge in partnership with the colleges of Arts and Sciences and Engineering.

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## Resolving the black hole ‘fuzzball or wormhole’ debate

### STUDY ADDS MORE CERTAINTY TO THEORY INVOLVING INFORMATION PARADOX

Black holes really are giant fuzzballs, a new study says.

The study attempts to put to rest the debate over Stephen Hawking’s famous information paradox, the problem created by Hawking’s conclusion that any data that enters a black hole can never leave. This conclusion accorded with the laws of thermodynamics, but opposed the fundamental laws of quantum mechanics.

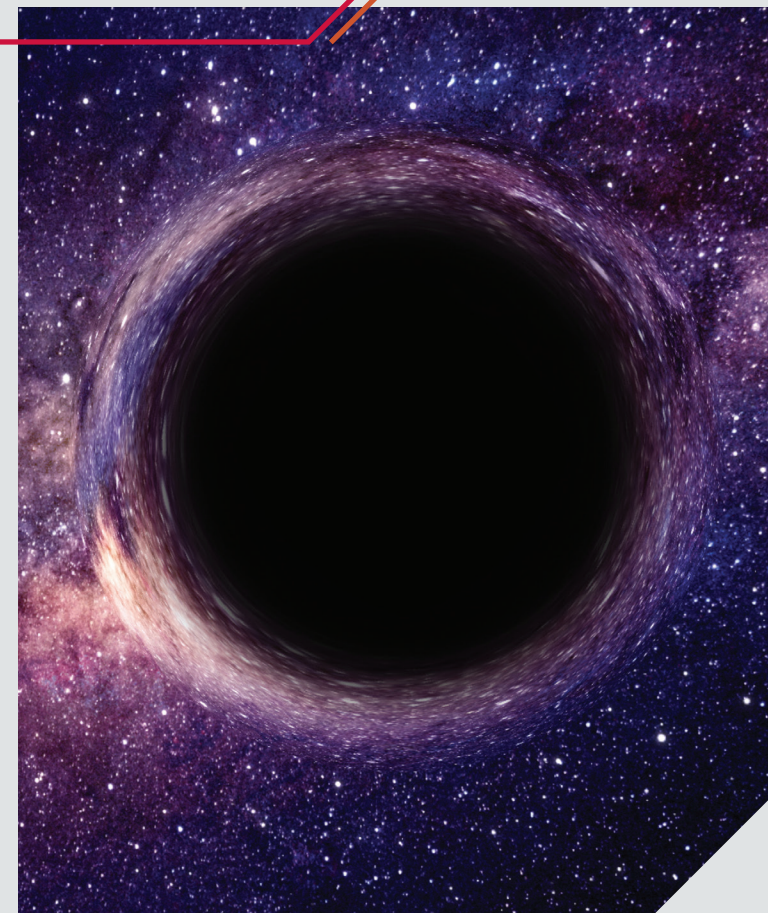
“What we found from string theory is that all the mass of a black hole is not getting sucked in to the center,” said Samir Mathur, lead author of the study and professor of physics at The Ohio State University. “The black hole tries to squeeze things to a point, but then the particles get stretched into these strings, and the strings start to stretch and expand and it becomes this fuzzball that expands to fill up the entirety of the black hole.”

The study, published Dec. 28 in the Turkish Journal of Physics, found that string theory almost certainly holds the answer to Hawking’s paradox, as the paper’s authors had originally believed. The physicists proved theorems to show that the fuzzball theory remains the most likely solution for Hawking’s information paradox. The researchers have also published an essay showing how this work may resolve longstanding puzzles in cosmology; the essay appeared in December in the International Journal of Modern Physics.

Mathur published a study in 2004 that theorized black holes were similar to very large, very messy balls of yarn – “fuzzballs” that become larger and messier as new objects get sucked in.

“The bigger the black hole, the more energy that goes in, and the bigger the fuzzball becomes,” Mathur said. The 2004 study found that string theory, the physics theory that holds that all particles in the universe are made of tiny vibrating strings, could be the solution to Hawking’s paradox. With this fuzzball structure, the hole radiates like any normal body, and there is no puzzle.

After Mathur’s 2004 study and other, similar works, “many people thought the problem was solved,” he said. “But in fact, a section of people in the string theory community itself thought they would look for a different solution to Hawking’s information paradox. They were bothered that, in physical terms, the whole structure of the black hole had changed.”



Studies in recent years attempted to reconcile Hawking’s conclusions with the old picture of the hole, where one can think of the black hole as being “empty space with all its mass in the center.” One theory, the wormhole paradigm, suggested that black holes might be one end of a bridge in the space-time continuum, meaning anything that entered a black hole might appear on the other end of the bridge – the other end of the wormhole – in a different place in space and time.

In order for the wormhole picture to work, though, some low-energy radiation would have to escape from the black hole at its edges.

This recent study proved a theorem – the “effective small corrections theorem” – to show that if that were to happen, black holes would not appear to radiate in the way that they do.

The researchers also examined physical properties from black holes, including topology change in quantum gravity, to determine whether the wormhole paradigm would work.

“In each of the versions that have been proposed for the wormhole approach, we found that the physics was not consistent,” Mathur said. “The wormhole paradigm tries to argue that, in some way, you could still think of the black hole as being effectively empty with all the mass in the center. And the theorems we prove show that such a picture of the hole is not a possibility.”

Other Ohio State researchers who worked on this study include Madhur Mehta, Marcel R. R. Hughes and Bin Guo.

■ Reposted from [news.osu.edu](https://news.osu.edu)

# Physicists Observe 'Unobservable' Quantum Phase Transition

Measurement and entanglement both have a "spooky" nonlocal flavor to them. Now physicists, including Brian Skinner in the Department of Physics at Ohio State, are harnessing that nonlocality to probe the spread of quantum information and control it.

► Read the full story on the *Quanta Magazine* website at: [quantamagazine.org/physicists-observe-unobservable-quantum-phase-transition-20230911](https://quantamagazine.org/physicists-observe-unobservable-quantum-phase-transition-20230911)

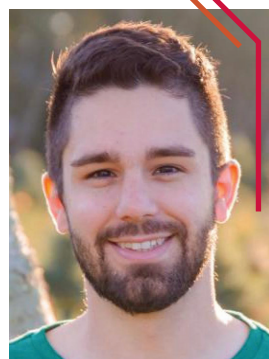
# Using Top Quarks to Probe Nature's Secrets

Despite its exceptional success, we know that the standard model (SM) is incomplete. To date, the LHC has not yet found clear indications of physics beyond the SM (BSM), which might mean that the BSM energy scale is above what can be directly probed at the LHC. An alternative way to probe BSM physics is through searches of off-shell effects, which can be done using the effective field theory framework (EFT). By treating the SM Lagrangian as the lowest order term in a perturbative expansion, EFT allows us to include higher-dimension operators in the Lagrangian, while respecting the experimentally verified SM symmetries.

The team of Ohio State researchers involved in this project includes Professor Brian Winer, Dr. Brent Yates (postdoc) and Aashwin Basnet (grad student).

► Read the full story in the *CERN Courier* at: [cerncourier.com/a/using-top-quarks-to-probe-natures-secrets](https://cerncourier.com/a/using-top-quarks-to-probe-natures-secrets)

## MEET OUR NEW FACULTY



**Daniel Brandenburg**  
assistant professor

My name is James Daniel Brandenburg (I go by Daniel) and I started as an assistant professor in the physics department in January 2023. My research is in nuclear experiment. I conduct research at the Relativistic Heavy Ion Collider as part of the STAR collaboration. Using this collider, we study a hot and dense form of nuclear matter called the Quark-Gluon Plasma

that is produced momentarily when heavy nuclei smash together at nearly the speed of light. My research has recently focused on the effects of the ultra-strong electromagnetic fields produced in heavy-ion collisions. In 2019 I published the STAR measurement demonstrating that these ultra-strong electromagnetic fields can be used to achieve the Breit-Wheeler process, the simplest process in Quantum Electrodynamics for converting light quanta (photons) into matter and anti-matter (in the form of an electron-positron pair). This discovery paved the way for my recent work in which I am imaging the internal structure of heavy nuclei to understand the 'glue' that binds nuclear matter together. My current work led to the observation of a novel quantum phenomenon in which the wavefunctions of distinguishable but entangled particles interfere allowing sub-diffraction limited imaging of the protons and neutrons inside nuclei. For this research I was awarded a Blavatnik Award for Young Scientists in 2022 and I recently received the 2023 Department of Energy Early Career Award to continue new research in this same direction.

### What brought you to Ohio State?

Before coming to The Ohio State University, I was a Goldhaber Fellow at Brookhaven National Laboratory. While I greatly enjoyed the environment at Brookhaven National Laboratory, I have always known that I wanted to be at a university. Unlike the national laboratory environment, universities' positions offer the opportunity to enrich students through teaching and through advising PhD students in a research group. I like the environment of a large university like Ohio State due to the diversity of students and academic departments. One thing I found very attractive about the university is the opportunity to develop relationships with colleagues exploring other fields of physics. I really enjoy being able to attend colloquia on other topics to expand my physics horizons. Such cross-discipline interaction challenges me and helps me to connect my work to others' interests outside of nuclear physics.

In addition to the strength of the physics department in general, The Ohio State University was also a very attractive option for me due to the international recognition of the existing nuclear experiment and theory groups. As a young researcher, I have greatly benefited from and gained great respect for the contributions of the nuclear experiment and nuclear theory faculty at Ohio State. Being able to join a group whose faculty have such a respected reputation and whose work has so significantly contributed to my development as a researcher causes me to feel a great sense of accomplishment, inspiration and responsibility.

### What do you most look forward to during your first year here?

As I start my career at The Ohio State University, I am eager to get to know others in the department and to develop my unique role as a new member of the physics department. I am excited to work with and learn from the other faculty in the nuclear theory and experimental groups as I develop my independent research program. I am especially excited to initiate and lead Ohio State's involvement in the Electron Ion Collider project, the next generation nuclear physics experiment in the United States. Through this role I will have the challenge and opportunity to develop Ohio State's role in the developing program and to attract future talent to the nuclear experiment group.

### What advice would you offer to students?

I would encourage students to try to enjoy the stage of life and academic career that they are currently in. It's easy to constantly look to the next milestone, whether that's graduating, going to grad school or finishing a PhD thesis. As an undergraduate or graduate student, life can get busy and complicated - between classes, social life, sleeping and eating it can be hard to balance everything, even harder to enjoy it. But I think it is important to take time to slow down and reflect on what we are studying and why, especially for physics students. While we all have a different personal reason for studying physics, one of them is undoubtedly because we personally enjoy the challenge and satisfaction of understanding nature's secrets. Life as a student is a unique opportunity to focus on learning the foundations of physics for yourself and to discover some of the aspects of nature that intrigue you most. So, my advice to students is to learn about the big questions in each field of physics - try to ask your professors about their research and attend some colloquia or talks on a topic that's new to you. That way, no matter what you do in the future, whether that's a career in physics or something else, you will look back on your physics education as a positive and exciting part of your life.



**Jacki Chini**  
associate professor

I work in the area of physics education research. I am specifically interested in accessibility and inclusion in physics teaching, learning, and research as well as the physics community and workforce overall. I completed my undergraduate degree at Drew University, a small

liberal arts college in New Jersey, where I developed a dual love for physics and sociology. My physics advisor knew that one graduate from our program had gone into graduate school for physics education research, actually at Ohio State! He thought that area of research may be a great way to combine my interests. I did a research experience for undergraduates (REU) at Kansas State University in PER and returned there for graduate school. Many active learning practices have been shown to benefit physics learning at the class level and for some subgroups, but disability identity has not frequently been explored in postsecondary STEM education research. I live with both mental health and chronic health conditions and have

experienced personally and from peers how environments can either enable or disable participation. My goal is to use research to create enabling physics environments.

### What brought you to Ohio State?

I have known the other faculty in physics education research, both in the physics department and in education, for many years. I am so excited to get to work with them! I was also impressed by Ohio State's commitment to equity through the RAISE initiative. I had not previously been to Columbus, but on my visits so far I have loved exploring the Metro Parks and eating Jeni's ice cream.

### What do you most look forward to during your first year here?

I am lucky to be hired at the same time as three other STEM discipline-based education researchers (DBER) across physics and chemistry as well as to join existing DBER folks in sciences, engineering and education. I am most excited to connect with these new colleagues!

### What advice would you offer to students?

I encourage students to follow their passions and try out opportunities that come their way. Working on multiple projects during my undergraduate years helped me to identify both what I was and what I was not interested in.

### Anything else you would like to share?

Students often ask about my connection with the other Dr. Chini in the department! He is indeed my husband. We have a seven-year-old named Josiah and two black-and-white mutts named Lola and Ellie. I love exercising as well as baking and crafting with Josiah.



**Mike Chini**  
associate professor

I am an experimentalist who works in the field of attosecond science. We generate flashes of light in the extreme ultraviolet and soft x-ray spectral regions and use them to track the fast motion of electrons in atoms, molecules and solids. Electrons are the "glue" that

hold atoms together in molecules and solids, and electronic excitations are the first step in a number of important processes in chemistry and condensed matter physics. More recently, I've become fascinated with the idea of using carefully sculpted ultrafast light fields to control the properties of materials. In certain classes of materials, for example monolayer-thick 2D materials, small external perturbations can cause significant changes in the electronic and optical properties. Our recent work seems to indicate that exposing these materials to strong light fields can lead to new "light-matter" states that can't be accessed with more conventional condensed matter tools like temperature, pressure or doping. These states only last a few femtoseconds, but luckily we have the attosecond tools needed to observe them!

► story continues on next page...

On a day-to-day basis, my research involves working with laser technology which is really at the frontiers of human achievement. Since the invention of the laser in 1960, scientists have gradually developed the tools to control light across essentially every axis of parameter space and with ever-increasing levels of precision. I started my undergraduate career with the intention of studying the physics of sound, and I think of the lasers I work with as a well-tuned orchestra that I have the special opportunity to conduct.

### What brought you to Ohio State?

Ohio State has been at the center of attosecond science for more than two decades, as exemplified by the 2023 Nobel Prize being awarded to Pierre Agostini for his seminal work in characterizing attosecond pulses. Of course, it is attractive to come to a department with such a strong legacy in my field of research. Even more exciting, however, is what is to come: The NSF NeXUS (National Extreme Ultrafast Science) Facility will come online this year, which is a user facility for attosecond science. The facility is based around a high-power laser system coupled to several advanced experimental end-stations for gas-phase physics and chemistry, surface science and solid-state physics, and it is expected to expand access to attosecond techniques and bring researchers from other fields into the community. I expect NeXUS to have a huge impact on the attosecond community, and Ohio State to grow as THE major hub for attosecond science in the U.S. for the foreseeable future.

### What do you most look forward to during your first year here?

Building a new laboratory is always exciting and I've had experience doing it as both a graduate student and as a PI. There are also a lot of neat things happening in the laser technology community, which makes this a particularly exciting time to be able to start a new lab. I think what I'm most excited about is getting back into laser development. When I was a graduate student and postdoc, the lasers were mainly home-built and I was involved in designing and building the lasers that I ultimately got to use for experiments. In my current lab, however, we have transitioned mainly to turn-key industrial laser platforms. At Ohio State, my labs will have a balance between turn-key lasers for running experiments that demand reliability and home-built custom systems capable of really pushing the state-of-the-art, and so I'm excited to be able to get back to my roots in laser technology development.

### What advice would you offer to students?

As a junior faculty member, I was told that "happy physicists do good physics," and I think this is an important aspect of being a physicist that can get lost in the stress of classes, qualifiers and publishing. My main advice to students is to try to take care of yourself mentally and physically, and to avoid getting hung up on things that are beyond your control. You can't control whether another group beats you to a good result, or whether a reviewer likes your paper, but you can control how you respond to challenges and setbacks.

### Anything else you would like to share?

Outside of the lab, I like listening to punk music and doing cryptic crosswords.



### Geraldine Cochran associate professor

I conduct equity-oriented physics education research. I like to think of equity-oriented work as identifying and addressing or mitigating the negative impact of things that are unjust or unfair.

### What brought you to Ohio State?

I am excited to join the physics department at Ohio State because it has a physics education research group that was supportive and excited about my interest in doing equity-oriented work. I was also excited to return to the Midwest, being geographically closer to my family in Chicago.

### What do you most look forward to during your first year here?

I am most excited about my work on the Inclusive Graduate Physics Programs Collaborative funded by the National Science Foundation - Alliances for Graduate Education and the Professoriate. As a part of this project, I get to work with faculty, staff and students across 16 institutions that are striving to make the culture within physics graduate programs more inclusive. From a programmatic perspective, we are building a community of people who will be able to learn from each other's successes and failures. From a research perspective, we will document efforts to improve inclusion and identify challenges to doing so. Additionally, we will gain a better understanding of the pathways for physics graduate students, particularly the milestones they face, the ways in which their departmental support structure changes, and stopping points that may hinder their persistence.

### What advice would you offer to students?

My advice to students is to follow your passion. I don't always have a grand plan. I only took physics in high school because I wanted to go to an amusement park, Six Flags Great America, for free. I joined my first physics education research project because I wanted to work with middle school students in my community on the Southside of Chicago. I tend to pursue opportunities because they are connected to or allow me to pursue something about which I'm passionate. That's seemed to me work for me thus far; so, I encourage it.

### Anything else you would like to share?

I am an introverted extrovert; so, I really enjoy social interactions. I encourage students to come to my office with or without something planned to discuss. A fun fact is that I used to be proficient in Tagalog. I can still hold a conversation, but I need practice.

“ I tend to pursue opportunities because they are connected to or allow me to pursue something about which I'm passionate.”

– Geraldine Cochran  
Associate Professor,  
Department of Physics



### Kaeli Hughes assistant professor

My name is Kaeli Hughes and I am an assistant professor with the Department of Physics. I am an experimental astrophysicist and I am especially interested in learning about the most energetic accelerators in the Universe. To investigate this, I build neutrino detectors

in some of the most extreme environments in the world, including at the South Pole, in the middle of the Greenlandic Ice Sheet and on a balloon bound for space. The data we take is in the radio frequency band, so I spend a lot of my time investigating background radio signals, figuring out new ways to analyze our data sets and going to the sites and installing the experiments themselves!

### What brought you to Ohio State?

I am an Ohio State alumna, so I am thrilled to be back! I love the Columbus area, especially the metro parks and the Olentangy trail. I really love the culture of Ohio State too - I felt supported and valued throughout my time as an undergraduate and I'm excited to be part of that same environment as a faculty member and a mentor. Something else that really impressed me about Ohio State was how many people I met during my visits who had been working at Ohio State for decades. As an academic, there is always a pressure to keep moving on to the next job, the next project, the next career stage. And it really appealed to me to pick a place like Ohio State that would encourage me and my family to settle down, potentially for good.

### What do you most look forward to during your first year here?

I'm excited to get my lab set up! The space is finally ready to be filled with science equipment, which I'll start purchasing now. And I'm excited to start working with postdocs and graduate students to get my projects up and running here at Ohio State. I am also looking forward to teaching - I know lots of students in lots of majors take some type of intro physics course, and I hope to become better and better at teaching those courses over the course of my career.

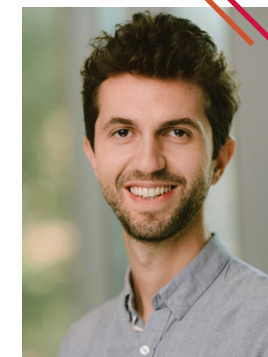
### What advice would you offer to students?

My first piece of advice is don't focus on the big goal, focus on lots of little goals. It's daunting to map out your career trajectory starting at 18! Instead, just try to do one thing a little better than you did before. Maybe that's doing an extra practice problem a week before the exam. Maybe that's applying for an REU program that you think sounds interesting. Maybe that's going to office hours for your favorite class and developing a relationship with your professors so they can write you letters of recommendation! Each of these things can help you have a well-rounded portfolio by the time you graduate and each of them will take less time than you imagine.

My second piece of advice: Fred Rogers once said that during times of disaster, to "look for the helpers." I would like to encourage you to be the helpers. It is our responsibility as physicists and as humans to participate and exist in the world in a way that makes things better for as many people as possible. Really take time to think about how you can make things better: for your classmates, for your community and for the world. Doing even a little bit of good, and really thinking critically about how you can put your talents toward helping others, is absolutely worth the time and energy.

### Anything else you would like to share?

I am a huge Ohio State football fan - I've been going to games with my dad since I was a kid. I can't wait to buy season tickets this year!



### Pierre Heidmann assistant professor

I am Pierre Heidmann, an assistant professor in the Department of Physics. I completed the majority of my education in France, earning my bachelor's and master's degrees in physics at the Ecole Normale Supérieure in Lyon and Paris. I specialized in theoretical

physics, focusing on High Energy Physics and string theory during my PhD thesis at CEA Saclay in Paris. In this initial research experience, my work centered on exploring the fundamental nature of black holes in string theory. Following this enriching experience, I spent four years as a postdoctoral fellow at Johns Hopkins University. During this period, I established my own research line, dedicated to studying the fundamental aspects of gravity and quantum gravity. My goal is to comprehend the emergence of new objects that can help explain the nature of black holes while also manifesting in various ways within our universe.

### What brought you to Ohio State?

After spending four years in the United States as a postdoctoral fellow, I was eager to take a significant step forward by applying for professor positions. Additionally, U.S. universities are renowned for their tradition of providing excellent support to young researchers, offering high-quality resources and financial assistance at the beginning of their professorial careers. Therefore, I aimed to apply for a professorial position in the U.S., and my interest led me to consider Ohio State.

Choosing Ohio State was simpler than it might seem for several reasons. Unfortunately, the job market in High Energy Physics string theory is quite limited. In the previous year, only two universities, UCLA and Ohio State, opened positions in this specific field of research. Fortunately, I secured the position here. While this might appear somewhat arbitrary, I was genuinely thrilled to be accepted at Ohio State.

» story continues on next page...

My enthusiasm stemmed from the strong appeal of the Department of Physics here, which presented significant potential for collaborations with existing researchers. Moreover, the department covered a diverse range of topics, including particle physics, condensed matter, and astrophysics – all of which align with my areas of interest. This alignment, along with the university's supportive environment, made Ohio State an ideal choice for advancing my academic career.

### What do you most look forward to during your first year here?

I am genuinely thrilled about the prospects for the upcoming year. Securing this assistant professor position represents a significant opportunity for me to further develop my research interests and evolve as a theoretical physicist. The prospect of establishing a group of talented young researchers, including PhD students and postdocs, and guiding their work within my area of expertise has always been a compelling aspiration. I feel fortunate to have the chance to realize this vision at Ohio State.

Moreover, I am eagerly anticipating the teaching aspect of my role here. The opportunity to communicate scientific concepts to a diverse range of individuals has always interested me. I firmly believe that physics should be accessible to a broad spectrum of students, each with their unique perspectives. Physics serves as a powerful tool for questioning the world around us and I am enthusiastic about imparting this valuable lesson to a wide audience.

### What advice would you offer to students?

Each journey in the academic world is profoundly personal, and what one person considers necessary for success may not resonate with another. Therefore, my foremost advice to students aspiring to follow this path is to listen to themselves and construct their own set of guiding principles that instill confidence and propel them forward. Everyone operates differently, so it is crucial not to let others dictate how one should navigate this journey. Perseverance and self-confidence emerge as crucial elements. Rather than adhering to a one-size-fits-all approach, recognize your unique strengths and working style. Trust in your abilities and maintain a resilient spirit. Ultimately, success in academia is a highly individualized pursuit and embracing your own path with determination is key.

“Rather than adhering to a one-size-fits-all approach, recognize your unique strengths and working style. Trust in your abilities and maintain a resilient spirit.”

– **Pierre Heidmann**  
Assistant Professor,  
Department of Physics

## GRADUATE STUDENTS

# Physics graduate students awarded Ohio State Presidential Fellowships

The Presidential Fellowship is the most prestigious award given by the Ohio State Graduate School to recognize the outstanding scholarly accomplishments and potential of graduate students entering the final phase of their dissertation research or terminal degree project. We are immensely proud of our eight winners from the department in the past two years and are looking forward to seeing what else these talented researchers accomplish in the future!

### 2022-2023 PHYSICS WINNERS

**Shi Feng** (advisor: Prof. Nandini Trivedi)  
Theoretical Condensed Matter Physics  
Thesis Title: “On Frustrated Quantum Systems”

**Heyang Long** (advisor: Prof. Chris Hirata)  
Theoretical Astrophysics | Thesis Title: “Impact of clumpy regions on the progress of ionizing fronts”

**Jaychandran Padayasi** (advisor: Prof. Ilya Gruzberg)  
Theoretical Condensed Matter Physics  
Thesis Title: “Conformal invariance in statistical physics”

**Zhichao (Carton) Zeng** (advisor: Prof. Annika Peter)  
Theoretical Astrophysics | Thesis Title: “Constraining self-interacting dark matter with simulations”

### 2023-2024 PHYSICS WINNERS

**Po Wen Chang** (advisor: Prof. John Beacom)  
Theoretical Astrophysics | Thesis Title: “Advancing the frontier of supernova neutrino astronomy with machine learning”

**Igor Lyalin** (advisor: Prof. Roland Kawakami,  
Experimental Condensed Matter Physics  
Thesis Title: “Magneto-Optical Study of the Orbital Hall Effect”

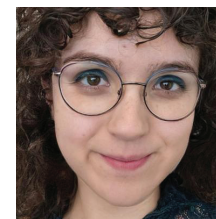
**Madhur Mehta** (advisor: Prof. Samir Mathur)  
Theoretical High Energy Physics | Thesis Title: “Through the looking glass - Black holes in String Theory”

**Haidong Tian** (advisor Prof. Jeanie Lau)  
Experimental Condensed Matter Physics  
Thesis Title: “Exploring Quantum Anomalous Hall Effect in Helical Twisted Trilayer Graphene”

## UNDERGRADUATES

# Students awarded National Science Foundation (NSF) Fellowships

### 2022-2023 WINNERS



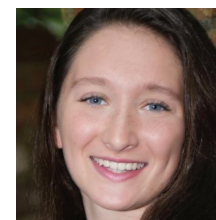
### Melanie Zaidel

Zaidel is a first-year graduate student in the Department of Physics advised by Professor John Beacom. Her research interests are centered in applying theoretical principles of microscopic particle

physics to understand macroscopic astronomical systems. Zaidel's proposed research project focuses on analyzing the properties of dark matter using observations of gamma-rays, neutrinos and cosmic rays.

Before starting graduate school at Ohio State in August 2022, she attended Pennsylvania State University and double-majored in physics as well as astronomy and astrophysics with a minor in mathematics. In addition to involvement in undergraduate research experiences at Michigan State University, Fermi National Accelerator Laboratory and Penn State, Zaidel was involved in the Penn State Millennium Scholars Program and the Ronald E. McNair Post-baccalaureate Achievement Program.

Outside of research, she is excited to mentor undergraduate students and hopes to help engage the general public with physics and astronomy.



### Mackenzie Scott

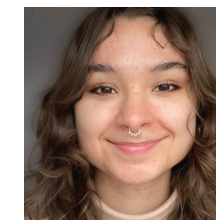
Scott, an honors student advised by Professor Michael Lisa, double majored in astronomy and astrophysics and physics with a minor in history while at Ohio State. She graduated from the university

in 2023 and is currently an astrophysics PhD student at Michigan State University.



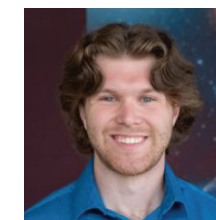
The NSF Graduate Research Fellowship Program (GRFP) recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering and mathematics disciplines who are pursuing research-based master's and doctoral degrees at accredited United States institutions. Fellows share in the prestige and opportunities that become available when they are selected. Fellowships provide the student with a three-year annual stipend of \$37,000 along with a \$12,000 cost of education allowance for tuition and fees (paid to the institution), as well as access to opportunities for professional development available to NSF-supported graduate students.

### 2023-2024 WINNERS



### Anya Phillips

Phillips double majored in physics and astronomy and astrophysics with a minor in math while at Ohio State. After graduating in May, she will attend Harvard University to pursue a PhD in astronomy.



### Michael Kuban

Kuban majored in engineering physics with a focus in computer science engineering while at Ohio State. After graduating in May, he will attend Carnegie Mellon University to work toward his PhD in electrical and computer engineering.

» story continues on next page...

## Students receive Goldwater Scholarships



The Goldwater scholarship is awarded annually to about 300 college sophomores and juniors and is based on merit. It provides an award to cover the cost of tuition, fees, books and room and board up to a maximum of \$7,500.

**Mackenzie Scott** and **Anya Phillips** were recently each awarded a Goldwater Scholarship, the most prestigious national award for undergraduate researchers in science, math and engineering.

**Scott** received the scholarship in 2022 as a junior honors student, double majoring in astronomy and astrophysics and physics with a minor in history. While at Ohio State, her research was advised by Professor Michael Lisa.

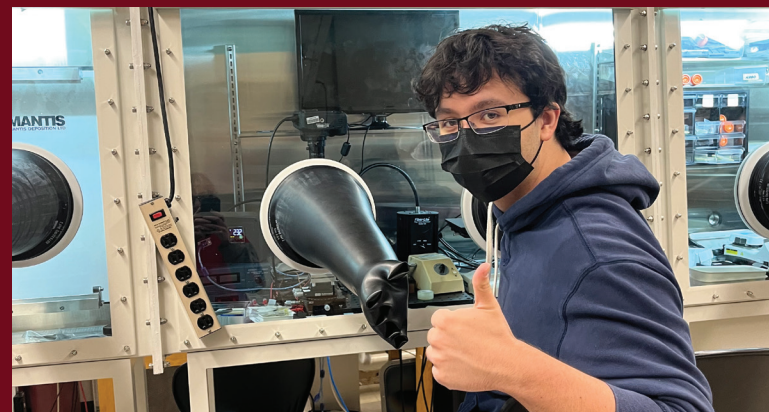
**Phillips** received the scholarship in 2023 as a junior honors student, double majoring in astronomy and astrophysics and physics with a minor in math. During her time at Ohio State, she participated in research with Professor Chris Kochanek, working to understand ASAS-SN variable stars based on their period, luminosity, binarity, rotation speed and other physical properties.



### Harrison Blake awarded an Astronaut Scholarship

Congratulations to Harrison Blake, a double major in physics and astronomy and astrophysics, for being awarded an Astronaut Scholarship. Harrison has been working with Professor Chris Hirata on extreme mass ratio inspirals around supermassive black holes as a test of General Relativity. His career goals are to continue studying gravitational physics and sources of astrophysical gravitational waves.

The Astronaut Scholarship Foundation (ASF) is proud to welcome the 2023 Astronaut Scholar Class. This year ASF has awarded 68 scholarships to students from 46 different universities across the nation. Astronaut Scholarships are awarded to students in their junior and senior year of college studying science, technology, engineering or mathematics with the intent to pursue research or advance their field upon completion of their final degree. Astronaut Scholars are among the best and brightest minds in STEM who show initiative, creativity and excellence in their chosen field.



### Physics Summer Research Scholarship awarded to undergraduate students

The Physics Summer Research Scholarship provides funds up to \$5,000 to support undergraduate physics and engineering physics majors pursuing research projects with Ohio State faculty members. Jason Balek (pictured above), paired with Professor Jeanie Lau, worked on projects in condensed matter involving graphene and other two-dimensional materials. He explained, "I learned how to mechanically exfoliate some of these materials and started to learn how to stack these materials on top of each other to create heterostructures. I grew my programming skills while developing a tool to use in the lab to help with graphene exfoliation."



### Ohio State student paves the way in accessibility and inclusion in STEM

As a freshman, Caitlin O'Brien worked with SciAccess on hosting the annual science accessibility conference. Feeling inspired after it ended, she asked: "What's next?"

SciAccess is a nonprofit that aims to develop and advocate for methods of increasing equity and accessibility in science. The program was initially founded in 2018 by O'Brien's mentor and Ohio State graduate Anna Voelker, a recipient of The Ohio State University's President's Prize awarded to students committed to social change.

O'Brien graduated in 2023 with a double major in astrophysics and astronomy and physics with a minor in science and engineering in the public interest. Inspired by her experience with SciAccess, she is finding ways to advance access and inclusion in science, technology, engineering and math (STEM).

**"Astronomy is often assumed to be a very visual science — most of the students we work with have never had someone even attempt to explain these concepts to them. We are letting them hear and feel the stars."**

— Caitlin O'Brien

"I've always had these dual interests in astronomy as research — hard science — and then outreach and education and working on space policy," she said.

O'Brien helped found SciAccess' mentoring program, Zenith. The student organization offers blind and low-vision students the opportunity to learn about space science.

Mentees receive 3D models of astronomical phenomena, including constellations, galaxies and the scale of the universe. They also use sonified data, or non-speech audio to convey information.

"Astronomy is often assumed to be a very visual science — most of the students we work with have never had someone even attempt to explain these concepts to them. We are letting them hear and feel the stars," O'Brien said.



► Read the full story at: [news.osu.edu/ohio-state-student-paves-the-way-in-accessibility-and-inclusion-in-stem](https://news.osu.edu/ohio-state-student-paves-the-way-in-accessibility-and-inclusion-in-stem)

» story continues on next page...

## DIVERSITY, EQUITY AND INCLUSION



## Polaris program fosters physics student community

This year, new heights were reached for the Polaris program. Run by graduate and undergraduate students in the Departments of Physics and Astronomy, Polaris aims to increase retention of students from underrepresented and nontraditional backgrounds in physics and astronomy by providing mentorship, community and support early in students' experience at Ohio State. This occurs through two major programs: the Polaris Mentorship Course and Polaris's Undergraduate Residential Summer Access (URSA) program.

The Mentorship Course covers content from overcoming imposter syndrome to designing dynamic presentations. Each student also collaborates with a graduate student mentor on a mini research project. Through the curriculum design, the course develops students' science identity; through the community built between peers and mentors, the course develops students' sense of belonging.

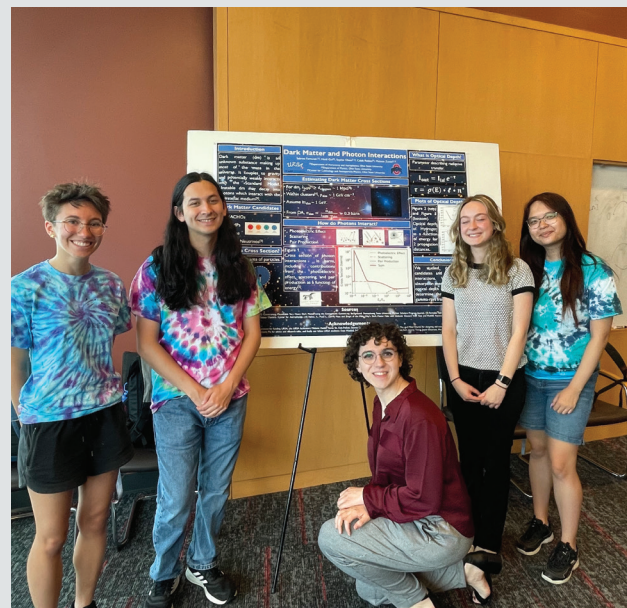
URSA students arrive on campus two weeks early and are immediately introduced to a cohort of peers with whom they connect in both interests and background.



One reported, “URSA personally impacted me on a very deep level because of the connection we all shared before the program even began...I felt a sense of community.” Students participate in lessons in astrophysics and metacognition, learn basic coding skills, engage in community-building social activities and produce a group research poster at the end of the program.

In 2022-2023 the Mentorship Course reached a record of 30 students and was split into two lecture sections to accommodate the size, while URSA enrolled 14 students. A study conducted by the Department of Physics showed significant increase in retention of underrepresented STEM students if they were involved in Polaris. Program alumni consistently cite involvement with Polaris as an important influence in their retention. “Polaris was an invaluable part of my undergraduate experience at Ohio State... I give Polaris a lot of credit for giving me the confidence and community essential to succeeding in college,” said one Polaris alum.

The impact of Polaris on diversity, equity, inclusion and accessibility of physics and astronomy is significant and has only increased since its inception. Members of the team continually strive to reach even more students by developing new programming and bolstering already-successful ones. As an independent organization, Polaris depends on contributions from supporters in the Departments of Physics and Astronomy, the College of Arts and Sciences and our Ohio State community. If you are interested in supporting Polaris to continue its mission of creating and maintaining an inclusive learning community, you can contact Polaris at [osupolaris@osu.edu](mailto:osupolaris@osu.edu).



“Polaris was an invaluable part of my undergraduate experience at Ohio State... I give Polaris a lot of credit for giving me the confidence and community essential to succeeding in college.”

– Polaris alum

## ALUMNI AND SUPPORT



**David Vernier**  
BS '69 Physics  
Beaverton, Ore.

David Vernier is the co-founder of Vernier Science Education, a company whose mission is to support educators in the sciences, develop high-quality products within a school's budget, and promote fun, hands-on learning that engages students.

### If you had any advice to offer current or future physics students, what would it be?

I would just stress to them that a physics degree is a great way to start a whole lot of careers. At our small company of 115 people, we have 15 physics majors working for us. Some of them do some physics-related work (developing products for physics teachers and technical support for physics instructors), but many do other things like programming, hardware engineering and management. We value a physics degree on an applicant's resume because it probably means they are smart and can learn new things, which are the key things a technology company looks for when hiring.

### You started your career teaching physics and physical science in inner-city Cleveland. Did that experience help inspire you and your wife to start a company devoted to developing creative ways to teach and learn using hands-on science?

Absolutely. I found out right away that most of my students were not going to learn much if I stood up in front of the class and lectured. I decided labs and interesting demonstrations were the only way to go and I still feel that way. Some students learn well in lectures, but many more learn more and are more motivated by hands-on activities.

### Following up on the previous question, tell us about Vernier Software & Technology and how your work has changed over the last three decades?

I was lucky to be teaching physics just as small computers became available to the general public and schools. I started writing programs to help me teach physics. That included a grading program, simulations of things we could not do in the lab, and data collection using sensors. We started selling our first programs on Apple II floppy disks. We quickly got involved with making and selling sensors to go with the software. Over the 42 years at the company, we have designed products for Commodore 64, MS-DOS, every version of Windows and Macintosh, TI calculators and even Palm Pilots. Now, Chromebooks, iOS and Android are a big deal. You could say we are doing pretty much the same thing we were doing in the 1980s, but with much better and cheaper hardware. (Our company is now called Vernier Science Education.)

### You've been a loyal supporter of physics at The Ohio State University. What inspired you to give back?

We have worked very hard, but we have also been lucky to be financially successful. Neither my wife nor I came from wealthy families and we got degrees from Ohio State without any debt; in fact, I do not think I even heard of a student loan while I was in college. In those days, tuition was such that if you worked hard at a summer job and maybe had a small scholarship or a part-time job you could get by. We know things are very different now, but we also know how important a college degree is.



**Steven Richardson**  
MS '81, PhD '83  
Atlanta, Ga.

When Steven Richardson transferred from MIT to Ohio State in 1978 with his graduate research advisor, Bruce Patton, he really had no idea what to expect as a new graduate student living and working in Columbus, Ohio. Having been born and raised in Brooklyn,

N.Y., Richardson soon realized that living in the Midwest would be quite a new experience for him. As it turned out, he found both the faculty members and fellow graduate students in the Department of Physics at Ohio State to be very welcoming and supportive in helping him adjust to his new life. While working six days a week in his cubicle office in the old Smith Lab on West 18th Avenue learning and doing physics, Richardson was able to decompress at least one day on the weekend at one of his favorite clubs and bars in Columbus (alas, they have all since closed) or at R&B and smooth jazz concerts by many renowned artists at the Ohio Theatre, Mershon Auditorium and the Veterans Memorial Auditorium (fortunately, they have not closed). He notes that, “In addition to the Department of Physics, I was very fortunate to have the support and guidance of the late Dr. Frank Hale, the former Vice Provost for Diversity and Inclusion and Professor Emeritus at Ohio State, and Minnie McGee, Assistant Dean of the Minority Engineering Program in the College of Engineering (now retired), for helping me stay focused and motivated to continue my work. Their support and friendship were invaluable as I was one of a handful of Black STEM graduate students on the Ohio State campus at that time.”

“...their support and friendship were invaluable as I was one of a handful of Black STEM graduate students on the Ohio State campus at that time.”

– Steven Richardson

» story continues on next page...

After Ohio State, Richardson did a postdoc at the University of California, Berkeley and then embarked on a career in industry as a senior research scientist in the Eastman Kodak Corporate Research Labs in Rochester, N.Y. During his time at Kodak, he took a sabbatical leave to run the theoretical condensed matter physics program at the National Science Foundation (NSF) in Washington, D.C. While at NSF, Richardson learned that Howard University in Washington, D.C. had been awarded a multi-million grant to start a research center in materials science. He subsequently left Kodak and NSF in 1988 and decided to remain in the D.C. area to join the faculty at Howard as a key member of this research center where he spent most of his professional career doing research in computational chemistry and computational materials science.

“While teaching and doing research at Howard University, I discovered that these two activities were quite synergistic and I tried to spend sufficient time on both. In fact, many of my teaching skills were developed and refined during my years as a graduate teaching assistant and course grader while a graduate student at Ohio State.” During his 28-year career at Howard, he primarily taught graduate courses and mentored many Black electrical engineers who went on to pursue productive careers in industry, academia and government. In fact, his first PhD student at Howard, Shaune Allen, went on to be a senior research engineer at NASA where he worked on the James Webb Space Telescope project. Richardson was selected by his faculty colleagues and former students as the recipient of the 2013 Howard University Faculty Senate Award for Exemplary Teaching. When asked about his career at Howard, he said, “A wise person once reminded me that talent is everywhere, opportunities are not. If the United States is going to remain competitive in STEM for the 21st century, then it needs to step up its game in identifying and mentoring a diverse cadre of future students, and our historically Black colleges and universities (HBCUs) can play an important role in that mission.” Richardson is very happy to learn of the efforts in the physics department to actively recruit and mentor underrepresented and minority students both in physics and STEM in general. He feels that, “although it is unfortunate that some elements of today’s political climate are hell bent in attacking and restricting the nation’s efforts in DEI (diversity, equity and inclusion), such efforts are essential if we are going to maintain our technological preeminence in STEM in the 21st century.” Were it not for the specific efforts of IBM and Xerox to recruit and support Black physics graduate students back in the day, Richardson says that “his STEM career at Ohio State may never have started.”

A common theme of his research is using supercomputers to compute the total energies of important molecules and materials from the laws of quantum mechanics. This ranged from working with IBM punch cards on the IBM System/360 Model 91, the supercomputer of the late 1960s, to modern supercomputers housed at Berkeley and the University of Texas at Austin that are now easily accessed through the internet. He has been a visiting scientist at the Center for Computational Materials Science of the Naval Research Laboratory in Washington, D.C. (1997-2014), a featured participant for the 2012 series The HistoryMakers: Science Makers, a co-principal investigator in the NSF Science and Technology Center for Integrated Quantum Materials (2013-2025), and he was the 2016-2017 Dr. Martin Luther King, Jr. Visiting Professor of Chemistry at MIT. Richardson was also a visiting professor at Bradley

University, Emory University, Iowa State University and the University of Lisbon and he has lectured extensively on his research throughout the United States, Europe, Asia, Mexico and South Africa. He is currently a Faculty Associate in Applied Physics in the John A. Paulson School of Engineering and Applied Sciences at Harvard University and he is a 2022-2024 Sigma Xi Distinguished Lecturer. In 2021, Richardson was elected a Fellow of the American Association for the Advancement of Science.

Although Richardson is a Professor Emeritus of Electrical Engineering at Howard University and he is no longer teaching students, he and his collaborators are now performing density-functional theory calculations on impurity-vacancy centers in diamond for possible applications in quantum computers and quantum networks. His advice for students studying physics today is to appreciate the analytical skills a physics education can provide. Richardson notes that his nephew Jared (‘11 physics) is now a senior talent manager at Novelis, the world’s largest recycler of aluminum based in Atlanta. He also suggests that physics students “take as many computer programming and mathematics courses as possible as these skills are going to be invaluable for future work in STEM and its applications. In fact, linear algebra is the gateway subject for really understanding the exciting fields of machine learning, quantum computing and artificial intelligence.” Finally, Richardson remarks that, “At the age of 70, human biology reminds me that I have far more years behind me than I have ahead. Despite this I still intend to continue working on my science with wonderful collaborators on interesting and important problems in materials science, condensed matter physics and chemistry. A lot of folks at Ohio State and elsewhere have invested their time, energy and money in providing me opportunities and this is my way of giving back.”

## Support

We are proud of the work we do in the Department of Physics and we invite you to help us make it better.

### OPPORTUNITIES TO GIVE:

Thank you for your support of the Department of Physics at Ohio State. If you wish to make a donation to enhance our work and create opportunities for our students, please consider directing your contribution to one of the highlighted funds listed below:

#### Undergraduate Support

**Alva Smith Memorial Fund / 606708**

Promotes and recognizes high standards in scholarship among undergraduate physics majors.

#### Graduate Student Support

**Physics Graduate Assistance Fund / 316001**

Assists graduate students in the department with vital expenses not covered by other scholarship awards. Students may receive awards more than once.

## FACULTY NEWS AND AWARDS

### Workshop on Stellar Intensity Interferometry

In May 2023, Prof. Mike Lisa and the Center for Cosmology and AstroParticle Physics (CCAPP) hosted the Workshop on Stellar Intensity Interferometry (SII), a three-day meeting on the Ohio State Columbus campus that drew roughly 50 in-person participants from around the world. SII uses tiny (part-per-million) correlated fluctuations between pairs of telescopes to measure the spatial features of stars. Lisa and his team capture the fluctuations using fast electronics mounted to the large optical telescopes of the VERITAS observatory in Arizona. Then they use the Ohio Supercomputer Center and custom resources to dig out the correlations. Their first paper has been submitted for publication in December. While only a couple of years old, there is already a community of scientists working on SII, and the Ohio State workshop is the first in what is expected to become a series. The next workshop is in 2024 in France.



#### Research

**Physics Graduate Research Fund / 312254**

Provides support for research and related expenses for graduate students in physics.

**Biard Scholarship Fund / 640449**

Undergraduate research scholarship(s) to a student(s) enrolled in the College of Arts and Sciences, Division of Natural and Mathematical Sciences, majoring in physics.

#### Diversity and Inclusion

**Graduate Bridge Program Funds / 315288**

Provides programming, operational, research and/or scholarship support for the Physics Bridge Program in the Department of Physics. The MS to PhD Bridge program at Ohio State strives to enhance the diversity of qualified applicants to physics PhD programs.

#### Physics Chair Discretionary

**Physics Chairman’s Discretionary Fund / 302325**

Provides the chair with the flexibility to fund small but urgent academic and research priorities as well as the ability to host important community building events within the department.



► For a full list of funds and ways you can give to support the department, visit: [physics.osu.edu/giving-opportunities/physics-development-funds](https://physics.osu.edu/giving-opportunities/physics-development-funds)

# Physics by the numbers

54 / faculty

58 / Staff (administrative, research and facility, instructional)

29 / postdocs

205 graduate students with about 30 PhDs each year

67 graduating seniors – 46 physics and 21 engineering physics majors are expected to graduate during the 2023-2024 academic year

386 undergraduate students – our undergraduate programs host 277 physics majors and 109 engineering physics majors

80% of our majors participate in research or an internship prior to graduation

5 endowed faculty positions

\$18 million in endowments

1 / 2023 Nobel Prize winner in Physics

1 / Rhodes Scholar

1 / Marshall Scholar

2 / Churchill Scholars

6 / Fulbright Scholars

24 / Goldwater Scholars

21 / NSF Graduate Fellows

31 / American Physical Society Fellows

13 / American Association for the Advancement of Science Fellows

1 / New Horizons Prize winner

1 / Onsager Prize winner

1 / Schawlow Prize winner

16 / University Distinguished Scholars or Professors

15 / University Distinguished Teaching Awards

29 / Faculty having won young investigator awards

1 / John Bardeen Prize

# Awards



Over 300 Ohio State students, staff and faculty greet Professor Agostini at the entrance to the Physics Research Building at a clap-in event on March 20, 2024. There was a sea of smiles as the excited group waited for their turn to meet him and listen to him speak.

## Prof. Mohit Randeria awarded John Bardeen Prize

The 2022 John Bardeen Prize was awarded to Jörg Schmalian (Karlsruhe Institute of Technology), Mohit Randeria (The Ohio State University) and Peter Hirschfeld (University of Florida) “for pioneering theoretical work that has provided significant insights on the nature of superconductivity, its realization in strongly correlated systems, and experimental probes of unconventional superconductors.” The Bardeen Prize is awarded once every three years.

## Prof. Beatriz E. Burrola Gabilondo named to APS EDI Fellow Program

Beatriz E. Burrola Gabilondo has been named an EDI Fellow and will be trained in how to foster EDI discussions in the classroom. The APS EDI Fellows Program seeks to address the gap between available EDI resources and physicists' lack of expertise in critical conversations by training a cohort of physicists and pairing them with critical conversation specialists to present interactive workshops that address fear and build capacity for physicists to engage in EDI conversations.

## Prof. Brian Skinner receives 2024 Early Career Distinguished Scholar Award

Prof. Brian Skinner was surprised at a recent faculty meeting with the news that he had received the 2024 Early Career Distinguished Scholar Award. This award is among the most prestigious of the annual awards given by Ohio State, and winners are nominated by their departments and fellow faculty. Prof. Skinner is an assistant professor of physics and is a PI in Ohio State's Center for Emergent Materials (CEM)."

## Prof. Jay Gupta awarded President's Research Excellence Accelerator Grant

Fifteen teams have been awarded a total of nearly \$750,000 in funding in the second year of the President's Research Excellence (PRE) Accelerator Grant program. Each grant of up to \$50,000 is designated for small teams formed to pursue curiosity-driven, novel, high-risk and high-reward research. Prof. Jay Gupta is the PI on one of the awards titled "Developing the 'van der Waals' vacuum as a host for quantum bits." Co-Investigators are David McComb and Shamsul Arafin of the College of Engineering.

## Prof. Brian Winer wins Undergraduate Teaching Award

Professor Brian Winer was surprised on Wednesday in his Physics 1251 classroom by Prof. Tom Humanic, vice-chair for undergraduate studies, with the 2022 Physics Undergraduate Teaching Award. This award is given annually and is voted on by undergraduate physics and engineering physics majors.

## Prof. Nandini Trivedi selected College of Arts and Sciences Distinguished Professor of Physics

The College of Arts and Sciences has selected Prof. Nandini Trivedi as a College of Arts and Sciences Distinguished Professor of Physics. According to the award letter, Nandini's "work at each stage has been critical for the Department of Physics reaching its present high levels of quality. Your accomplishments have brought honor to the college and to Ohio State, and we very much appreciate your continuing contributions."

## Prof. John Beacom awarded 2022 Outreach and Engagement Impact Grant

Three Arts and Sciences faculty members, including Prof. John Beacom, received 2022 Outreach and Engagement Impact Grants from the Ohio State Office of Outreach and Engagement. Across the university, there were only 11 awardees for this funding cycle. Beacom, Henry L. Cox Professor of Physics and of Astronomy, won the grant for SciAccess, Inc., an international non-profit organization dedicated to advancing disability equity and access in STEM.

## Prof. Alexandra Landsman awarded NSF Grant

Prof. Alexandra Landsman was awarded a 2022 National Science Foundation (NSF) grant titled "Strong Field Physics with a Twist" to study the interaction of intense ultrafast laser pulses with atoms and molecules. It is a three-year award for \$200,000.

## Prof. Daniel Gauthier awarded NSF grant for QISET workshop

Daniel Gauthier, professor in the Department of Physics, received a \$49,994 grant from the National Science Foundation (NSF) in support of the two-day NSF Project Scoping Workshop "Accelerating Progress Towards Practical Quantum Advantage" that occurred in June 2022. At Ohio State, the U.S. quantum information, science, engineering and technology (QISET) community took stock of recent scientific advancements, identified current challenges, and discussed opportunities to overcome those challenges and map a way forward.

## Prof. Amy Connolly awarded single-PI NSF Grant

Prof. Amy Connolly was awarded a single-PI NSF grant entitled "Precision Ultra-High Energy Neutrino Astrophysics and New Signatures Enabled by a Complete Treatment of Birefringence in Antarctic Ice" for \$385k over 3 years. Connolly identified that birefringent properties of the ice near South Pole could be responsible for unusual behaviors of polarizations of radio-frequency signals observed in in-ice detectors. This award enables Connolly's group to further characterize birefringence in the South Pole ice using existing cross-disciplinary data at radio frequencies, which will be important for the design of future experiments. The award also provides first federal funding for the student-led, Ohio State-based GENETIS project, which uses genetic algorithms to evolve novel detector designs, as well as further support for the ASPIRE workshop for high school women.

## Prof. Mohit Randeria elected 2022 AAAS Fellow

The American Association for the Advancement of Science (AAAS) has elected 505 scientists, engineers and innovators from around the world and across all disciplines to the 2022 class of AAAS Fellows, one of the most distinguished honors within the scientific community. Among the honorees was Mohit Randeria, professor of physics, for contributions to the theory of BCS-BEC crossover, to the understanding of angle-resolved photoemission of cuprate superconductors, and for providing rigorous bounds on the superconducting transition temperature in two-dimensional materials.

## Prof. Jeanie Lau named APS Outstanding Referee for 2023

The American Physical Society (APS) has selected 153 Outstanding Referees for 2022 that have demonstrated exceptional work in the assessment of manuscripts published in the Physical Review journals. Among these is Jeanie Lau, who joins an impressive number of professors given this honor from our department in the past.

## Prof. Michael Lisa named College of Arts and Sciences Distinguished Professor

Michael Lisa has been selected as a College of Arts and Sciences Distinguished Professor. The title of Arts and Sciences Distinguished Professor serves to honor full professor colleagues who have excelled in teaching, service and research/creative activity, and whose work has demonstrated significant impact on their fields, students, college and university, and/or the public.

## Prof. Mohit Randeria receives 2023 Distinguished Scholar Award

Mohit Randeria, professor of physics in the College of Arts and Sciences, has earned The Ohio State University 2023 Distinguished Scholar Award. "I'm thrilled to get this news," said Randeria upon learning of his award. "It's a great honor but also very humbling." Randeria is a condensed matter theorist whose research focuses on correlated and topological states of quantum matter, especially superconductivity and magnetism.

» story continues on next page...



A replica Nobel Prize medal was gifted to chair Michael Poirier and the Department of Physics by Pierre Agostini during the clap-in on March 20, 2024 as a gesture of gratitude and appreciation for his time at The Ohio State University.

### **Prof. Rolando Valdés Aguilar wins Undergraduate Teaching Award**

Rolando Valdés Aguilar was surprised on Friday, April 21, 2023 during the Physics Undergraduate Awards Ceremony when Professor Tom Humanic, Vice-Chair for Undergraduate Studies, announced to the audience that Dr. Valdés Aguilar won the 2023 Physics Undergraduate Teaching Award. This award is given annually and is voted on by undergraduate physics and engineering physics majors.

### **Prof. Samir Mathur wins Undergraduate Teaching Award**

Professor Samir Mathur was surprised on Tuesday, April 23 during the Physics Spring Picnic when Professor Tom Humanic, Vice-Chair for Undergraduate Studies, announced to the audience that Dr. Samir Mathur won the 2024 Physics Undergraduate Teaching Award. This award is given annually and is voted on by undergraduate physics and engineering physics majors.

### **Prof. Kovchegov awarded Distinguished Visiting Academic Award from IPPP at Durham University**

Yuri Kovchegov has been awarded the Distinguished Visiting Academic (DIVA) Award from the Institute for Particle Physics Phenomenology (IPPP) at Durham University in Durham, U.K. Professor Kovchegov will use this award to travel to the IPPP Durham in 2024 to collaborate with colleagues from Oxford University, IPPP and Birmingham University on constructing a Monte Carlo event generator for the upcoming Electron-Ion Collider (EIC).

### **Brian Skinner named to Provost's Early Career Scholars Program for 2022-2023**

The Ohio State University has selected its inaugural cohort for the Provost's Early Career Scholars Program, a new initiative designed to attract and develop the highest caliber early-career faculty. Assistant Professor Brian Skinner is one of the eight named to the cohort. Skinner's research program focuses on new quantum materials and finding ways that these materials can do things traditional materials cannot. He also applies concepts from solid state and material physics to different settings, ranging from quantum information to the dynamics of human groups.

### **Brandenburg selected for DOE's Early Career Research Program**

Daniel Brandenburg, an assistant professor in the Department of Physics, has been selected as one of 93 scientists across the country to receive funding from the U.S. Department of Energy's Early Career Research Program.



► Read more at: [artsandsciences.osu.edu/news/brandenburg-selected-does-early-career-research-program](https://artsandsciences.osu.edu/news/brandenburg-selected-does-early-career-research-program)

### **Prof. Jim Beatty named Winstein Distinguished Visiting Fellow by the University of Chicago Department of Physics**

Professor Jim Beatty has been named a Winstein Distinguished Visiting Fellow by the University of Chicago Department of Physics. The Winstein Fellowship is sponsored by the family of Prof. Bruce Winstein, who was an eminent high energy physicist and astrophysicist, and supports two-to-three-week faculty-level collaborative visits to the department. Beatty will visit Chicago in April 2024.

### **Prof. John Beacom awarded for the SciAccess Outreach Program**

Physics and Astronomy faculty member John Beacom was named a 2024 Ohio State Community Engaged Scholar from the Office of Outreach and Engagement for his work on the SciAccess Outreach Program. The Community Engaged Scholar Award recognizes faculty members who have demonstrated co-created engaged scholarship that has positively impacted communities. Community Engaged Scholars have made significant contributions to Ohio State's culture of engagement, further establishing and strengthening the institution's commitment to communities.

### **Former Ohio State postdoc named MacArthur Fellow**

Steven Prohira, a physicist and a former postdoctoral researcher at The Ohio State University, has been named a recipient of the 2022 MacArthur Fellowship, a prize often called the "genius grant."



► Read more at: [news.osu.edu/former-ohio-state-postdoc-named-macarthur-fellow](https://news.osu.edu/former-ohio-state-postdoc-named-macarthur-fellow)



Students, staff and faculty from the Department of Physics celebrate reading day together at our biggest event of the year, the Spring Picnic!

Photo credit: Lindsey Thaler



Shoppers walk through the Christmas Market in Gamla Stan, Stockholm's "Old Town". The small island is known for its historic buildings, hotels, restaurants and cafes. In the background: The Nobel Museum (tan and orange building) and the Storkyrkan Cathedral (pink and white building).

Photo Credit: Dan Gauthier



Lou DiMauro welcomes the guests of Nobel Laureate Pierre Agostini at a celebratory breakfast hosted by The Ohio State University in Stockholm, Sweden. Long-time colleagues and friends shared cherished memories of friendship and scientific work with Pierre Agostini.

Photo Credit: David Foley

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*Pictured below from left to right are Michael Poirier, Chair and Professor in the Department of Physics, Nobel Laureate and Professor Emeritus Pierre Agostini, Professor and Director of the Institute for Optical Science Lou DiMauro, and Dean of the College of Arts and Sciences David G. Horn, shown here celebrating before the Nobel Ceremony in Stockholm, Sweden in December 2023.*



*Photo credit:  
Fanny Staveby Widinghoff*