

APS News



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Francis Halzen and the search for ghost particles

Halzen, the 2026 APS Medal winner, leads the world's first gigaton neutrino detector — at the bottom of the world.

BY ERICA K. BROCKMEIER

Beneath 1.5 kilometers of ice near the geographic South Pole, the IceCube Neutrino Observatory is on the hunt for ghost particles. As the world's first gigaton neutrino detector, IceCube is used by astrophysicists to better understand cosmic objects by observing the neutrinos — abundant, nearly massless, and mysterious elementary particles — that they produce.

But building a massive neutrino detector in the middle of Antarctica was once just a “cute” idea, said Francis Halzen, the Vilas Research Professor and Gregory Breit Professor at the University Wisconsin–Madison and IceCube's principal investigator.

“Our attitude was, ‘let's study the ice, let's design a hot water drill, let's see if it works,’” said Halzen. “We started small and, to our own amazement, we overcame all these hurdles. And suddenly, we had the tools to build a kilometer cube detector.”

Halzen is the 2026 recipient of the APS Medal for Exceptional Achieve-



By studying neutrinos, “you could see things in the universe you couldn't see any other way,” says Francis Halzen. Credit: El País/Bernardo Pérez (www.elpais.com)

ment in Research, the society's largest prize, for his “contributions to the field of neutrino astrophysics, especially leadership of the IceCube Neutrino Observatory and the discovery of high-energy astrophysical neutrinos and their sources.”

Halzen's scientific career began at KU Leuven in Belgium, where he earned a master's degree in math

and physics. He also earned his Ph.D. at KU Leuven, where he completed his thesis on the broken symmetries of hadrons. In 1971, while working at CERN in Geneva, he received an invitation from a colleague for a six-month research visit to UW–Madison, where he's been ever since.

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Q&A with Anatole von Lilienfeld, chief editor of APS' newest open access journal

PRX Intelligence, launched in November, will cover machine learning and AI in scientific research.

BY LIZ BOATMAN

On Nov. 19, APS debuted *PRX Intelligence*, the newest journal in the highly selective Physical Review portfolio. Covering machine learning and artificial intelligence in scientific research, this open access journal will cater to physical scientists who rely on data-intensive approaches.

Leading the effort is the journal's chief editor, Anatole von Lilienfeld, a professor of chemistry, materials, and physics at the University of Toronto. Von Lilienfeld is also the Clark Chair of Advanced Materials and CIFAR AI chair at the Vector Institute for Artificial Intelligence.

“I'm very attracted to the open science culture of APS,” says von Lilienfeld. “I feel honored to be given this opportunity.”

After earning his doctorate in 2005 from the Swiss Federal Institute of Technology in Lausanne, von



Anatole Lilienfeld. Credit: Anatole Lilienfeld.

Lilienfeld held research positions at New York University, the Max-Planck Institute for Polymer Research in Germany, and Sandia and Argonne National Laboratories. He also held faculty positions at universities in Belgium, Switzerland, and Austria.

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Delayed flight? Check out O'Hare's new quantum computer.

An APS-funded exhibit at Chicago's biggest airport invites the public to explore quantum technology.

BY AARON RAGAN-FORE



The IBM System One dilution refrigerator model, which houses and cools a quantum computer, installed in the O'Hare airport in Chicago. Credit: Anne Ryan / anneryanphoto.com

Labs, universities, and companies are racing to develop quantum technology solutions for diverse applications, from finance, manufacturing, and medicine. But many members of the public aren't sure what a quantum computer is, exactly, or even what it looks like.

Nancy Kawalek, the founding director of the University of Chicago's Scientists, Technologists,

and Artists Generating Exploration (STAGE) Center, is utilizing a 2024 APS Innovation Fund grant to bring some quantum bling to O'Hare International Airport.

In a collaboration between the STAGE Center, IBM, and United Airlines, Kawalek and her team installed an IBM System One dilution refrigerator model — the chande-

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NSF to issue 'flexible' grants to nontraditional teams

The initiative aims to build “novel platform technologies” akin to the internet or polymerase chain reaction.

BY CLARE ZHANG

On Dec. 12, the National Science Foundation announced plans to award large, multi-year grants to a few teams “operating outside of existing academic, startup, and industry constraints.” Each award under the Tech Labs initiative will be significantly larger than the average NSF award, ranging from \$10 million to \$50 million per year and running for at least four years.

“Tech Labs recognizes that there are certain high-risk, high-reward technical problems that require more flexibility and focused resourcing than traditional institutions can often provide,” said Erwin Gianchandani, the head of NSF's Technology, Innovation, and Partnerships Directorate, at a webinar this week discussing NSF's accompanying request for information.

The initiative will support teams that “move beyond traditional research outputs,” such as publications and datasets, and instead aim to “transition critical technology from early concept or prototypes to commercially viable platforms,” NSF's announcement states. In the webinar, Gianchandani pointed to the internet and polymerase chain reaction as examples of “novel platform technologies” that the initiative aims to build.

NSF said it will select around three topic areas “in which the U.S. must retain or regain technical dominance,” possibly including quantum technology, AI, critical materials, semiconductor manufacturing, and biotechnology. The agency will select two to four teams per top-



NSF said it will focus on roughly three areas, possibly including quantum technology, AI, critical materials, biotechnology, and semiconductor manufacturing, shown here.

ic for an initial nine-month phase and then choose one to two teams per topic to execute their proposals, said Rebecca Chmiel, associate program director for emerging technologies. After that, teams might transition away from NSF funding or into the “companion” NSF Tech Accelerators Initiative that will focus on projects at a later stage of technology readiness, Chmiel added.

The Tech Labs awards will be funded as Other Transaction (OT) contracts, so they are not subject to NSF's uniform guidance like other NSF awards, which Chmiel said will “allow for greater flexibility, operational autonomy, and reduced administrative burden.”

In the webinar, NSF staff highlighted that all Tech Lab researchers must be full-time after the initial nine-month phase, which they noted could be achieved by reimbursing the researcher's employer for their salary and benefits.

“I've been really inspired by watching some of the startups that we're interacting with around TIP. The startup culture is often... quite intense and quite dedicated to the mission that they're looking to accelerate,” Chmiel said. “I think that's the type of employment that we're looking for for the different key personnel of the teams. But there is going to be quite a bit of flexibility in exactly what that means,” she added. NSF staff also said the initiative is not limited to “very established scientists.”

NSF intends to issue a solicitation for the Tech Labs in the spring of 2026 and expects to select teams in the first half of 2026.

A new model for federal grants

The idea of “flexible block grants” to support team-based science outside a traditional university structure has been “bubbling up in the ecosystem for a little bit,” said Caleb

Science policy continued on page 4

Want the world to know physics? Teach the teachers.

The 2025 PhysTEC Teacher of the Year shares her story, strategy, and syllabus with anyone who asks.

BY CYPRESS HANSEN

Deborah Armstrong never took physics in high school, and her college physics class revolved mostly around worksheets and math. So when she learned she'd be teaching physics two months before her first day as a new teacher, she looked inward to build her class curriculum.

"I used my personality to develop the course how I wanted to do it, which involved a lot of hands-on, engineering-focused labs," she says. This learn-by-doing strategy has worked wonderfully for her students at Mineola High School in Mineola, Texas.

Armstrong's impact also reaches far beyond her classroom: she has been named the 2025 National PhysTEC Teacher of the Year, an award that recognizes outstanding physics educators. The Physics Teacher Education Coalition (PhysTEC) — an initiative of APS and the American Association of Physics Teachers — seeks to address a shortage of qualified physics teachers in the U.S. As the winner, Armstrong receives funding to attend an upcoming AAPT conference and a \$1,000 grant for classroom materials.

APS News spoke with Armstrong about her journey into physics, her teaching style, and the value of teaching teachers.

This interview has been edited for brevity and clarity.

Which came first, your interest in STEM or in teaching?

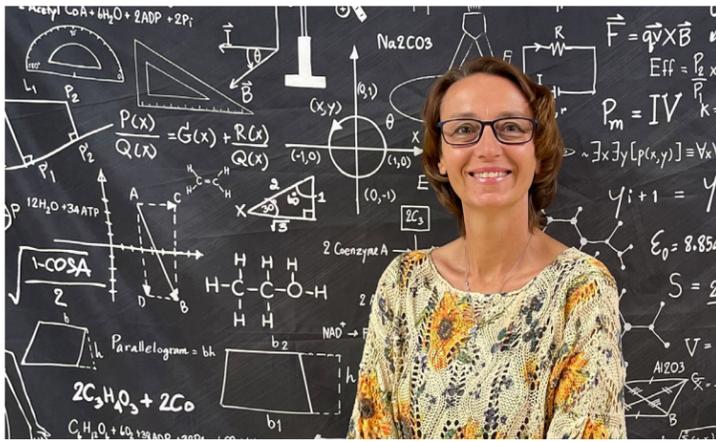
Definitely STEM. I originally had no interest in being a teacher. In college, one of my professors gave me a summer job running an environmental science camp for eighth grade students. Then he got ill and couldn't lead the camp. He emailed me and the other five college students saying, "Do the best you can."

The other four had no interest, but I jumped right in and ended up running the summer camp. I shocked myself, but I absolutely loved it. I was like, "this might be what I want to do," and I changed my major from medical engineering to science education.

How did you end up teaching physics?

I graduated with a general science teaching degree. Then I took a job in inner-city Fort Worth because I was a broke college kid and they offered a \$4,000 cash bonus. I said "absolutely," didn't look into it, and signed on the dotted line. I thought I was going to be teaching biology and human anatomy, but when I showed up, they said, "You're teaching physics." That was a rough start.

But as soon as I started teaching, I thought, "Wow, this is amazing." There was all this fun hands-on stuff



After an unexpected stint running a summer science camp, says Deborah Armstrong, "I changed my major from medical engineering to science education." Credit: Deborah Armstrong

I could do. Biology is more about what you can't see, but physics is everything you can see. It clicked right away for me, and I've been teaching it for almost twenty years now.

What is your favorite physics unit?

I like projectiles — anything flying through the air. We're launching golf balls with slingshots, we graph these beautiful parabolas, and, oh my gosh, it's math, and it's in motion, and it's beautiful.

"I thought I was going to be teaching biology and human anatomy, but when I showed up, they said, 'You're teaching physics.' That was a rough start." — Armstrong

You're also focused on teaching teachers, right?

Yes. In my first year teaching, I had no curriculum, no guidance, no mentors, no experience. I had that one summer to try to get everything together. I knew I wanted to do hands-on lessons, but I only had a budget of a couple hundred dollars. From that point on, I started developing my own cheap physics labs. I mean, we make mouse trap cars out of craft sticks and glue and whatever we have laying around.

In the beginning, I would put my lessons on CDs, then I'd go to conferences and I would give everybody I could a CD. Now I have a Google Drive and I just give everyone a link. I've developed a little bit of a following this way. I'm going to the Conference for the Advancement of Science Teaching in two weeks, and I already have people emailing me saying, "You're going to be there, right? I want to go to your workshop."

People always say how much they've changed how they teach

based on the lessons they've gotten from me, and I think that is absolutely amazing. If we could all freely share everything we have, how much better would we be? I'm not just helping my hundred students now, I'm helping thousands of other students by helping their teachers.

You've earned many teaching grants and awards over the years. What's your secret?

I don't mind being turned down. I'll apply for fifty different opportunities, and if I get one of them, I'm super excited. I think that's what really gets my name out there, along with sharing my work with other teachers.

There's a couple of teachers that I pushed to apply for a grant last year, and they got denied. I asked them, "You're going to apply again, right?" They all said no. I applied for a program in Germany three years in a row, and I got it on the third try. I guess that's my motto — don't give up. It's okay to be rejected. It happens.

What challenges do you face in the classroom?

I think the hardest part of my job is the different math levels of my students. I have up to 120 students, and their abilities range from severe-resource special ed all the way up to advanced placement in college-level classes.

Many of our students also deal with mental health issues. I used to get frustrated by some of their frequent absences, but then a family member went through something similar, and I'll tell you, the empathy I feel for my students now... I wished I could have learned that lesson 10 years earlier, so that I could have had the patience these kids really do need. Anytime we can experience something ourselves, we're going to understand other people a thousand times more.

Armstrong Q&A continued on page 3

THIS MONTH IN PHYSICS HISTORY

January 31, 1958: The U.S. launches its first satellite, sparking discovery of the Van Allen radiation belts

A group of University of Iowa scientists made the extraordinary discovery.

BY KENDRA REDMOND

In early 1958, two scientists at the University of Iowa — James Van Allen and George Ludwig, one of Van Allen's graduate students — were puzzling over an unusual set of results.

They had just received early data from a Geiger sensor aboard Explorer 1, the first U.S. satellite, in orbit around Earth. The sensor was supposed to detect ionizing radiation, but the duo couldn't make sense of the results. Sometimes the data aligned with predictions, but other times, the instrument seemed to detect nothing at all. Was their apparatus faulty?

The detector was Explorer 1's primary payload, selected "by virtue of preparedness and good fortune," Van Allen wrote in a 1990 article for *Annual Review of Earth and Planetary Sciences*. He was one of few space physicists at the time, well-versed in high-altitude experiments that relied on balloons, sounding rockets, and combined "rockoons" to probe auroras and cosmic rays.

Van Allen had proposed satellite-based cosmic ray experiments in the mid-1950s, but the U.S. didn't

have a program for launching satellites yet. That changed in 1957 during the International Geophysical Year, a worldwide collaborative effort to study the Earth and sun. More than 60 countries participated, including the Soviet Union and the U.S., despite the geopolitical tension of the Cold War.

When the Soviet Union's satellite Sputnik went into orbit on Oct. 4, 1957, the U.S. was caught off guard and began racing to launch its own satellite. Van Allen was ready.

On Jan. 31, 1958, Explorer 1 became the first U.S. satellite in space.

Onboard was Van Allen's experimental instrument, consisting of a single Geiger-Müller tube that generated electrical pulses in response to ionizing radiation; a scaling circuit to optimize data collection; and a telemetry system that transmitted data — but only when the satellite was close to one of 16 ground-based

receiving stations.

Those gaps in transmission made the puzzling results even more difficult to interpret. Van Allen and Ludwig modified the design for Explorer 3, adding a magnetic tape recorder that could store data for a complete orbit. The satellite launched in March. Again, the sensor gave reasonable radiation event counts for altitudes of 200 or 300 miles, but gave very low or zero readings at altitudes of 500 to 600 miles.

When Carl McIlwain, another graduate student in the group, returned from a scientific expedition and saw the data, he offered an idea — "something that we all knew but had temporarily forgotten," Van Allen told *Scientific American* readers in 1959. "A sufficiently high level of radiation can jam the counter and send the apparent rate to zero."

A lab experiment confirmed that at more 35,000 counts per second, an identical sensor gave a reading of zero. In Van Allen's words, "We had discovered an enormously high level of radiation, not a lack of it." Each new data tape supported this interpretation.



William Pickering, James Van Allen, Wernher von Braun, hoist a replica of Explorer 1, the U.S.'s first satellite, at a news conference in Washington, D.C., after confirmation that the satellite was in orbit. Credit: NASA

"At altitudes below about 400 km (240 mi) we confirmed earlier measurements of cosmic ray intensity," Van Allen wrote in a 1981 article in *Air & Space*. But as the satellites swung out to higher altitudes, he said, "we encountered an enormous increase in intensity, hundreds of

Van Allen belts continued on page 3

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With PhysicsQuest, middle-schoolers learn with quantum algorithm dances and entangled playing cards

APS members and teachers team up to bring quantum mechanics to classrooms.

BY BRILEY LEWIS

Quantum mechanics has a long-standing reputation as one of the trickiest and least intuitive branches of physics. For many, quantum physics lessons bring to mind chalkboards covered with equations, describing phenomena that seem too bizarre to be real.

But in 2025, a team of educators set out to teach quantum mechanics to children in a different way — with coin tosses, card games, and dance.

The APS PhysicsQuest program develops lesson plans for middle school students, bringing concepts from modern physics research into the classroom with hands-on activities. For this year's lessons, the PhysicsQuest team focused on quantum mechanics and quantum computing for the 2025 International Year of Quantum Science and Technology.

Past iterations of the program delved into plasma, waves, and careers in physics, and were developed by APS staff and members. This year similarly involved APS members in the creative process, particularly those from the society's Division of Atomic, Molecular, and Atomic Physics and the Division of Quantum Information.

"If we have 50,000 physics experts as our members, we should be



A student shines blue filtered light on a circuit board, lighting up a bulb — part of a class activity called "Photon Frenzy," developed by a team of graduate students from MIT and Louisiana State University. Credit: Nataliya Fletcher

utilizing their expertise and helping them connect to the public in meaningful ways," says Nicole Schrode, the APS program manager for public engagement.

Twenty-two APS members developed activities to teach quantum-related concepts, and five K-12 teachers participated in a pilot program to test the lessons and provide feedback. In the end, APS sent out 829 activity kits to classrooms across all 50 states and Puerto Rico, potentially reaching over 100,000 students. With this new model for PhysicsQuest, APS helped participating physicists reach a wide audience,

aiming "to empower all scientists to conduct outreach as part of their position," says Schrode.

Teaching quantum physics to middle-schoolers was a challenge. "The tricky part is, when you're speaking about quantum mechanics, there is no analogy with normal physics — but when we're teaching, we still need to use analogy," explains Danyel Cavazos, laboratory instructor at the University of Chicago and designer of the "entangled and shuffled" card game in PhysicsQuest 2025.

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Quantum O'Hare continued from page 1

lier-like structure that houses and cools a quantum computer — in the United Airlines terminal at O'Hare International Airport.

The exhibit, titled "Imagining the Future: An Encounter with Quantum Technology," will call the terminal home for at least a year. Displaying the refrigerator is a simple, straightforward way to expose O'Hare's visitors to quantum computing. It's an engagement method very much in the STAGE Center's wheelhouse, says Kawalek, given her team's charter to generate "emotional engagement, storytelling, and entertainment as a way to get people interested in and excited about science."

world's crossroads, to come face-to-metallic-face with the future.

Among the fast-food kiosks and shops of the airport, the device's elegant, almost ethereal structure stands out. And there's a bit of playful juxtaposition in the installation's placement, too. The futuristic device shares a corridor with an emissary of the past: the nearby "Ernestine," a fiberglass replica of a brachiosaurus skeleton, formerly housed in Chicago's Field Museum.

The quantum technology exhibit uses QR codes to direct visitors to online interpretive materials that explain the basics of quantum physics and affirm the refrigerator's crucial role in the study of quantum

The installation is accessible by "people from every walk of life," Kawalek adds, so it's a good opportunity for "a lot of eyeballs in one year to get a glimpse into quantum technology."

"With so much mistrust of science and false information floating around, I think it's important for people to understand the truth and the facts," she says. The installation is accessible by "people from every walk of life," she adds, so it's a good opportunity for "a lot of eyeballs in one year to get a glimpse into quantum technology."

One of the six Innovation Fund projects APS supported for the International Year of Quantum Science and Technology, the exhibit enables a broad cross-section of humanity, passing through one of the

properties, all in a digestible format that can keep travelers engaged during a layover.

"I hope they will come away with a sense of wonder," Kawalek says. "That they won't look at science and technology as something fearful and distant from their lives."

"And," she adds, "I hope that people who might not have any role models or might think they're not smart enough to be a scientist will realize that science truly is for everyone."

Aaron Ragan-Fore is a head of communications at APS.

Van Allen belts continued from page 2

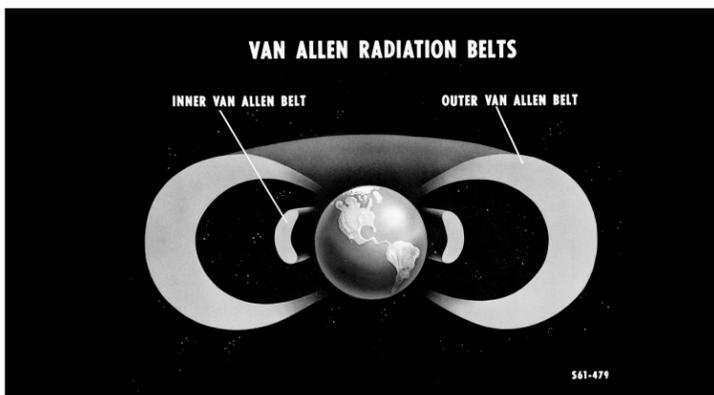
times what we expected."

The radiation was so intense, Van Allen realized, that prolonged space travel through the area would devastate humans and scientific instruments. These became key considerations in the planning of future space missions.

Explorer 4, Pioneers 1 and 3, and Sputnik III, all of which launched later in 1958, shed light on the dynamic structure and dimensions of the high-radiation region. Within a few years, the discovery had coalesced into a two-belt system, described by Van Allen in *Air & Space* as two distinct radiation belts encircling Earth like a donut, with the Earth occupying the center hole.

The inner belt is dominated by energetic protons thought to be produced by interactions between cosmic rays and particles in the Earth's atmosphere. The more variable outer belt is dominated by lower-energy electrons thought to originate in the sun and magnetic storms.

Although the discovery was largely unexpected, some scientific



This early schematic of the Van Allen radiation belts was created after their discovery in 1958. Credit: NASA's Goddard Space Flight Center/Historic image courtesy of NASA's Langley Research Center

groundwork had been laid nearly 50 years earlier. Norwegian mathematician and physicist Carl Størmer had demonstrated that the Earth's magnetic field could trap incoming charged particles — given the right energy and direction — and even worked out their spiraling orbits.

As solar wind, cosmic rays, and geomagnetic storms approach the Earth's magnetic field, charged par-

ticles experience the Lorentz force and begin spiraling around the Earth's curved magnetic field lines. Because magnetic field strength increases near the poles, some particles slow in the direction parallel to the field line, reverse course, and spiral back toward the other pole. Particles can be trapped in a cycle of spiraling back-and-forth between poles for hours to years, leading to a

buildup of ionizing radiation.

Størmer's theoretical work gave the researchers a strong framework for understanding their experimental observations early on. In May 1958, they reported the existence of the high-radiation region at the APS Spring Meeting in Washington, D.C., positing that charged particles trapped by the Earth's magnetic field were the source.

The discovery caught the attention of the scientific community and the public, making headlines around the country. In July, President Dwight Eisenhower signed the National Aeronautics and Space Act of 1958, establishing a civilian space agency.

"Space exploration was transformed from being an arcane field with only a handful of participants to an activity of high national visibility," Van Allen recalled in the Annual Review article. The following year, astrophysicist Thomas Gold coined the term "magnetosphere," and scientists began writing papers on "magnetosphere physics."

Over the years, space-based experiments continued uncovering the story of particles trapped in what we now call the Van Allen radiation belts, including many led by Van Allen's group at the University of Iowa. Radiation belts have also been discovered around other planets.

In 2012, NASA sent two robotic probes into the Van Allen belts to explore the origins of their high-energy charged particles, how they respond to solar variations, and how they evolve in the environment. Among other discoveries, the probes detected a temporary third radiation belt, highlighting the dynamic nature of these systems.

"Space science is not a professional discipline in the usual sense," Van Allen wrote in the Annual Review article. "Rather, it is a loosely defined mixture of all of these fields plus an exotic and expensive operational style."

Kendra Redmond is a writer based in Minnesota.

PRX Intelligence

This new open-access journal is dedicated to high-impact research at the intersection of physics and machine intelligence.

go.aps.org/prxi

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What advice do you have for other physics teachers?

There's so much support out there right now. When I first started teaching, the internet was just a baby and we didn't have all these resources. There are physics teacher groups everywhere, and they really want to help you.

My favorite is my Facebook group. Someone will post about a lab that didn't work, asking, "What else can I do?" And everyone throws in ideas. I don't care if you're in the middle of nowhere in Oklahoma with no physics teachers around, you can find help and support. You just need to be open and look for it. Don't be the teacher that thinks they know

everything, because none of us do, and we all need help.

Do you have plans for your PhysTEC award grant?

I got a grant a while back to buy 15 Oculus Quest virtual-reality headsets, and then I was able to purchase five more. So I'm at 20, but my class size is 24, so there are always four students who don't have headsets during labs, and I can't stand that. The Oculus Quests are down to \$300, so this grant will get me three-and-a-half, and I'll use some of my science budget to finally get to a full classroom set. My students are going to be super, super excited.

Cypress Hansen is a freelance science writer based in Southern California.

In memory of Katherine Wright

We pay tribute to our friend and colleague, whose journalistic talent and commitment to inclusivity left an indelible mark on *Physics Magazine*.

BY THE EDITORS OF APS' PHYSICS MAGAZINE



Katherine Wright.

This year, *Physics Magazine* lost a remarkable writer and a kind, thoughtful colleague. Katherine Wright, whose byline appears on more than 450 stories in the archive, passed away last September, far too early. She was a prolific writer and a passionate advocate for women and minority rights. She is deeply missed by all who had the privilege to work with her.

Katherine's voice will be familiar to anyone who has read *Physics Magazine* over the past decade. Her clear-eyed reporting made some of the most complex physics results accessible and human.

Born in Texas and raised in England, Katherine studied polymer physics at the University of Cambridge, UK, earning her Ph.D. in 2010. She received a research fellowship at the Max Planck Institute for Dynamics and Self-Organization, Germany, but soon realized that her true passion lay elsewhere. "I thought I had wanted to be an academic, but I realized partway through that the bit I enjoyed the most was communicating my science," she recounted in a recent Women in Quantum panel discussion.

She began writing on the side for blogs and other outlets. In 2013, Katherine joined the American Physical Society as an editor for *Physical Review Letters*. From that perch, she began contributing to *Physics Magazine*, publishing her first stories later that year. She made a full transition to science writing by joining the magazine's staff in 2015. While working full time, she also pursued formal training in journal-

ism, earning a master's degree from Stony Brook University in New York. She was appointed *Physics Magazine's* deputy editor in 2021.

Over her ten years at the magazine, Katherine played a central role in expanding the publication's coverage, championing timely reporting and more people-centered stories. She constantly encouraged us to seek out a wider range of voices, particularly those from communities historically underrepresented in physics.

Among her many memorable articles were news stories on the first black hole images, on planetary defense systems, and on the demonstration of ignition in inertial confinement fusion; a fun story on quantum-inspired poetry; and a review of a book on the contributions of women scientists. Katherine brought rigor and energy to every assignment. She was always up for taking on another story, even when her plate was full, and she relished the challenge of explaining the most complex topics with clarity and care.

We feel privileged to have worked with Katherine and to have learned from her. She made our magazine better, and we hope her legacy will endure in the breadth of our coverage and in the integrity of our journalism.

Our thoughts are with her family.

Physics Magazine is an online periodical published by APS. APS News also published stories by Katherine, who was a friend to many at APS. A complete collection of her stories can be found online at go.aps.org/katherine.

Science policy continued from page 1

Watney, co-founder of the Institute for Progress think tank. In August, Watney published a proposal for 25 federally funded "X-Labs," which would be independent research organizations receiving between \$10 million and \$50 million per year for seven years for "team-based, exploratory, and infrastructure-heavy work" in AI for science.



The home page for NSF's Technology, Innovation, and Partnerships Directorate. Credit: NSF

Watney said both the size of the Tech Lab awards and their flexibility are "key" to funding large research centers that allow researchers to "really be able to push out the limits and not worry, every twist in the road, like, 'Oh, do I need to go back to the NIH and ask for additional flexibility on this,' or... that constant rat race of thinking about your next grant a year or two away, I think could really end up warping the incentives of scientists to work on more short-term, incremental projects."

"I would love to see these models be applied to more blue sky, basic research," Watney added.

Watney noted some potential challenges with the Tech Labs model, including a greater need

to "bet on the right team" when awarding a large grant, and navigating oversight of the team while "giving them space to do their thing."

"It's not a true experiment unless there's some way for the thing to fail," he added. "And I think the NSF is very amenable to viewing this like an experiment and trying to generate data during the process to figure out, 'How is this doing? Are we seeing better results here than we would have expected from a traditional set of grants?'"

Clare Zhang is a science policy reporter at FYI, published by the American Institute of Physics.

APS Medal continued from page 1

Halzen became interested in neutrinos in the mid-1980s, when he started looking into the possibilities for building a neutrino telescope with his postdoc Enrique Zas, now a professor at the University of Santiago de Compostela.

holes in the ice thousands of meters deep using hot water "hoses," then dropping cables lined with sensors inside before the ice froze back over.

AMANDA's initial results were published in 2001, paving the way for IceCube's construction, which



The IceCube Lab, shown here under the stars, hosts the computers that collect data from thousands of sensors in the ice. Credit: Felipe Pedreros, IceCube/NSF

The advantage of using neutrinos to do astronomy is that, unlike photons, neutrinos can travel through objects, "so maybe you could see things in the universe you couldn't see any other way," he said. "And that was, of course, the big appeal. In fact, in the almost 40 years of this AMANDA/IceCube adventure, nobody ever told us that this was uninteresting. It was really a question of the technology."

IceCube's technology relies on the same design found in both historic particle detectors, like the Irvine-Michigan-Brookhaven detector, and modern neutrino observatories like Super-Kamiokande: a massive Cherenkov detector. When a neutrino interacts with the detector's extremely clear water, it leaves behind a charged particle. This charged particle travels through the water faster than light, which causes it to emit electromagnetic Cherenkov radiation that can be picked up by the many highly sensitive sensors that surround the detector.

To meet this kilometer-scale challenge, Halzen and his team started small. "Especially for what we proposed, [which was] to switch from water to ice, there were a lot of things that had to be realized: the ice had to be clear, the drilling methods we developed in Madison had to work, and we had to be able to reject the backgrounds," he said.

IceCube's experimental proving ground was the Antarctic Muon and Neutrino Detector Array, or AMANDA. Thanks to funding from the National Science Foundation, in the 1990s researchers began drilling

began in 2004, again with NSF funding. AMANDA was formally incorporated into IceCube, whose final string was lowered into the ice in December 2010. IceCube's first fully instrumented physics run began in May 2011.

When talking about IceCube at conferences and seminars, Halzen often begins with what he considers its most significant finding: "Neutrino astronomy exists."

"After one and a half decades of development, and another decade of construction, there was no guarantee we would ever see anything," he says. "Many people thought we wouldn't, but we did. After two years of data, there were neutrinos from way beyond — not from the atmosphere, not from our own galaxy, but reaching us from across the universe with enormous energies."

Halzen added that while it was "relatively easy" to spot these cosmic neutrinos with incredibly high energy levels, figuring out where they came from was the next question. IceCube has recently observed where they originate, however. Their results point to the potential locations for so-called "cosmic accelerators," which are also the source of cosmic rays, high-energy particles discovered more than a century ago.

"That's why everybody thought neutrino astronomy was interesting, because cosmic rays, wherever they

are born, make neutrinos, but at the time we had no idea where or how," said Halzen. "Now, by seeing neutrinos, we start to see the first cosmic accelerators, and that's really exciting."

IceCube is also a powerful tool for understanding the underlying physics of these mysterious elementary particles, Halzen said. "Compared to [Fermilab], we have very few neutrinos, but some are a million times the energy levels," he said. "Our expectation is not only to see the universe — like many astronomers did in other ways — but to hopefully make some contributions to neutrino physics."

And while many big experiments fall apart after operating for decade-long time scales, said Halzen, IceCube is still growing, with the collaboration now including more than 450 researchers from institutions across 14 different countries.

Work is also now underway on the IceCube upgrade, which will deploy seven new strings along with new and improved sensor modules. With a larger and more sensitive detector, Halzen hopes that IceCube will be able to not only solve the cosmic ray problem but also make some "totally unexpected" discoveries along the way.



The in-ice component of IceCube consists of an array of 5,160 digital optical modules (DOMs), which are lowered on vertical "strings" deep into the ice before it freezes. Here, a DOM is lowered into the array. Credit: IceCube/NSF

"We have these neutrinos of enormous energies, but all the physics that we are doing seems to be consistent with the standard model neutrino physics that we know and love, and we want to break that," he said.

For Halzen, there's so much to be excited about for this "booming" field to spend much time reflecting on the impact of his career. "I have no time to think about my legacy — I only look at the future," he said. "I have been incredibly lucky, and I want to enjoy the rest of it."

Erica K. Brockmeier is the science writer at APS.

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2025-26 PRIZES AND AWARDS

APS congratulates the recipients of this year's APS prizes and awards, which recognize achievements in research, education, and public service.

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APS Medal

Francis Halzen
University of Wisconsin–Madison

For contributions to the field of neutrino astrophysics, especially leadership of the IceCube Neutrino Observatory and the discovery of high-energy astrophysical neutrinos and their sources.



Adler Lectureship Award in the Field of Materials Physics

Nicola Marzari
École Polytechnique Fédérale de Lausanne

For new theory and method developments that have advanced the predictive power of first-principles calculations, and for sustained leadership and community-building in computational materials physics.



Allis Prize for the Study of Ionized Gases

Mounir Laroussi
Old Dominion University

For seminal contributions to the physics and diagnostics of low-temperature plasma jets and guided ionization waves, and for conducting pioneering work on their biomedical applications.



Apker Award

Samuel Crowe
University of Virginia

For groundbreaking undergraduate research achievements that uncovered a new stellar nursery, magnetically aligned ionized hydrogen filaments, and key evidence reshaping understanding of magnetic fields and protostellar outflows in massive star formation.



Apker Award

Justyn M. Friedler
Williams College

For groundbreaking undergraduate research integrating theory and experiment to reveal the fracture energy of adsorbed proteins, advancing fundamental understanding of surface-tension-driven thin film fracture.



Ashcroft Early Career Award for Studies of Matter at Extreme High Pressure Conditions

Danae N. Polsin
University of Rochester

For pioneering experiments mapping the evolution of electronic and ionic structural complexity of alkali metals to TPa conditions.



Bethe Prize

Chris Fryer
Los Alamos National Laboratory

For broad and pioneering contributions to our understanding of stellar collapse, supernovae, and compact object formation, and for leadership in the field of time-domain multi-messenger nuclear astrophysics.



Bonner Prize in Nuclear Physics

Christopher L. Morris
Los Alamos National Laboratory

For pioneering work to develop an ultracold neutron source and establish ultracold-neutron-based physics research in the U.S., and for leadership in measuring the free neutron lifetime to unprecedented precision using a magneto-gravitational trap and in-situ detection of neutrons.



Bouchet Award

Laura A. Lopez
The Ohio State University

For pioneering contributions to X-ray astronomy, including foundational studies of supernova remnants, compact objects, and stellar feedback in galaxies, and for transformative leadership in advancing equity and inclusion in physics through innovative mentorship programs, national advocacy, and unwavering support for students from historically marginalized communities.

TEAM PRIZE

Buckley Condensed Matter Physics Prize

For groundbreaking experiments that uncovered the role of vortices in the superfluid phase transition in helium films and observed anyonic braiding statistics of quasiparticles in the fractional quantum Hall effect, thus establishing the significance of topological excitations in two-dimensions.

David J. Bishop
Boston University

Gwendal Fève
Sorbonne Université

Michael James Manfra
Purdue University

John D. Reppy
Cornell University



Burton Forum Award

Paul Wofo
University of Yaoundé I

For exceptional contributions to advancing and disseminating physics in Africa, including founding the Cameroon Physical Society, facilitating student research that benefits local communities, and organizing in Cameroon international conferences on solving real-life problems in developing countries.



Corrsin Award

Z. Jane Wang
Cornell University

For original and innovative work on insect flight that provided fundamental insights into unsteady aerodynamics, flight efficiency, flight stability, and neural control, and for opening new dimensions of research in biological fluid dynamics.



Davisson-Germer Prize in Atomic or Surface Physics

Herman Batelaan
University of Nebraska-Lincoln

For pioneering work in the development of the field of free electron quantum optics, particularly with regard to the Stern-Gerlach Effect for electron beams, the first demonstration of the Kapitza-Dirac effect, and the elucidation of the quantum physics of the Aharonov-Bohm effect.

TEAM AWARD

Dawson Award for Excellence in Plasma Physics Research

For the first laboratory realization and theoretical investigations of both the hydrodynamic stability and the magneto-rotational instability in axisymmetric and non-axisymmetric forms that were proposed to operate in accretion plasmas to form planets, stars, and supermassive black holes.

Fatima Arezu Ebrahimi
Princeton Plasma Physics Laboratory

Erik P. Gilson
Princeton Plasma Physics Laboratory

Jeremy Goodman
Princeton University

Hantao Ji
Princeton University

Yin Wang
Princeton Plasma Physics Laboratory



Delbrück Prize in Biological Physics

Boris I. Shraiman
University of California, Santa Barbara

For contributions to morphogenesis, evolution, and biological information processing, combining mastery of biological knowledge, innovative analysis of biological data, and rigorous theoretical reasoning to uncover deep insights into the underlying principles of biological processes.

Dillon Medal

Liheng Cai
University of Virginia

For pioneering the understanding and applications of architecturally complex polymers and networks using experiments and theory.



Dresselhaus Prize in Nanoscience and Nanomaterials

Evelyn L. Hu
Harvard University

For pioneering and sustained contributions to nanomaterials and nanofabrication of electronic, optoelectronic, and quantum devices.



Early Career Award for Soft Matter Research

Scott Waitukaitis
The Institute of Science and Technology, Austria

For resolving the core mystery of contact electrification and consistently bringing clarity and rigor to complex problems in soft matter through elegant and thoughtful experiments.



Education Award

Theodore Hodapp
Gordon and Betty Moore Foundation

For leadership in the development and implementation of outstanding physics education programs that have led to sustainable, systemic changes in the teaching and learning of physics at all levels, with a focus on broadening participation and making physics more accessible to all.



Faculty Research Prize

Daniel A. Pitonyak
Lebanon Valley College

For excellent contributions to our understanding of the spin and multi-dimensional structure of hadrons, and for outstanding mentoring of undergraduate students by engaging them in high-impact research projects.



Feshbach Prize in Theoretical Nuclear Physics

Martin J. Savage
University of Washington

For pioneering contributions to computational quantum chromodynamics for nuclear physics, especially through large-scale lattice quantum chromodynamics simulations, and for exploring applications of quantum computing.



FIAP Career Lectureship Award

Gil Travish
ViBo Health

For research and development within academic and industry settings in medical devices and the dissemination of this work to the general public and entrepreneurial students.



Fluid Dynamics Prize

Sanjiva K. Lele
Stanford University

For contributions to computational aeroacoustics and the understanding of sound generation, sustained research elucidating the physics of compressible turbulence, and development of foundational numerical methods for high-fidelity flow simulations.



Freedman Award in Experimental Nuclear Physics

Wei Jia Ong
Lawrence Livermore National Laboratory

For spearheading a multifaceted effort that uses radioactive beams to better understand Type-I X-ray bursts and other astrophysical phenomena through studies of beta decay, nuclear reactions, and nuclear masses.



Heineman Prize for Mathematical Physics

Charles B. Thorn III
University of Florida

For fundamental contributions to elementary particle physics, primarily the theory of strong interactions and the development of string theory.



Isaacson Award in Gravitational-Wave Science

Patrick R. Brady
University of Wisconsin-Milwaukee

For trailblazing work in gravitational wave data analysis techniques, computing, and cyberinfrastructure, and for leadership in gravitational wave science that enables multi-messenger astronomy with gravitational wave observations.



Isakson Prize for Optical Effects in Solids

Junichiro Kono
Rice University

For pioneering contributions to optical physics, light-condensed-matter interactions, and photonic applications of nanosystems, including artificial quantum structures and carbon-based nanomaterials.



Kadanoff Prize

Heinrich M. Jaeger
University of Chicago

For precise experimental contributions that have launched new areas of inquiry and reshaped our understanding of many soft-matter systems, including granular materials and concentrated suspensions, their structure and rheology, and applications such as robotic grippers.



Keithley Award for Advances in Measurement Science

Jianwei (John) Miao
University of California, Los Angeles

For pioneering coherent diffractive imaging and atomic electron tomography with X-rays and electrons and advancing quantitative 3D and 4D measurement techniques for crystal defects and amorphous materials from the nanoscale to the atomic scale.



Landauer-Bennett Award in Quantum Computing

Abhinav Kandala
IBM Thomas J. Watson Research Center

For extraordinary achievements in the development and implementation of error mitigation techniques to extract information from noisy quantum hardware and the exploration of quantum utility.



Lilienfeld Prize

Hitoshi Murayama
University of California, Berkeley; Kavli IPMU, University of Tokyo; Lawrence Berkeley National Laboratory

For contributions to theoretical and experimental particle physics, as well as inspirational public outreach and effective science advocacy.



Maxwell Prize for Plasma Physics

William Walter Heidbrink
University of California, Irvine

For studies of resonant and non-resonant energetic particle transport in magnetized plasmas, innovative diagnostic methods, and the experimental discovery of detrimental fast-ion driven instabilities.



Mayer Award

Kayla Nguyen
University of Oregon

For pioneering contributions to electron microscopy, including the co-invention of the electron microscope pixel array detector, imaging of negative capacitance in topological ferroelectrics, advances in electron ptychography, and efforts to democratize science.

TEAM PRIZE

McGroddy Prize for New Materials

For seminal contributions to the implementation of ultra-thin, hafnium-based ferroelectrics in microelectronic devices.

Thomas Mikolajick
Nanoelectronic Materials Laboratory (NaMLab gGmbH)

Sayeef Salahuddin
University of California, Berkeley



Narain Mentoring Award

Kevin P. Lannon
University of Notre Dame

For mentoring and leadership in reforming graduate admissions by championing evaluation criteria that value perseverance, resilience, and drive alongside academic rigor, thereby broadening access while upholding excellence.



Nicholson Medal for Outreach

Matt O'Dowd
CUNY, Lehman College

For bringing the universe down to Earth for people with little or no science background through media appearances, television documentaries, and hundreds of high-quality videos for PBS' online portal "SpaceTime."



Onsager Prize

Mehran Kardar
Massachusetts Institute of Technology

For groundbreaking contributions to statistical physics, including the Kardar-Parisi-Zhang equation, Casimir forces, active matter, and aspects of biological physics.



Oppenheim Award

José Polo-Gómez
Max-Planck-Institut für Quantenoptik

For showing that the second law of thermodynamics limits the ability to distinguish between quantum states.

TEAM AWARD

Oppenheim Award

For using symmetries to determine parametric resonance conditions for coupled oscillators.

Abhijeet Melkani
École normale supérieure de Lyon

Jayson Paulose
University of Oregon

TEAM PRIZE

Pais Prize for History of Physics

For research on the history of quantum physics between 1900 and 1927 that culminated in *Constructing Quantum Mechanics*, an exemplary work that uses primary sources masterfully and employs scaffold and arch metaphors to describe developments in the quantum revolution.

Anthony Duncan
University of Pittsburgh

Michel Janssen
University of Minnesota



Pake Prize

Jay Gambetta
IBM

For expert leadership in fundamental science, particularly the development and deployment of quantum computing technologies, as well as making quantum computing available for researchers around the world.



Panofsky Prize in Experimental Particle Physics

Joel Butler
Fermi National Accelerator Laboratory

For wide-ranging scientific, technical, and strategic contributions to particle physics, particularly exceptional leadership in fixed-target quark flavor experiments at Fermilab and collider physics at the Large Hadron Collider.



Plyler Prize for Molecular Spectroscopy and Dynamics

Anne B. McCoy
University of Washington

For impactful contributions to the anharmonic vibrational spectroscopy and dynamics of molecular radicals, ions, and clusters.

**Polymer Physics Prize****Nitash P. Balsara**
University of California, Berkeley

For fundamental studies of thermodynamics and ion transport in block copolymer electrolytes.

**Primakoff Award for Early-Career Particle Physics****Elena Pinetti**
Flatiron Institute (Simons Foundation)

For original ideas and innovative research in the study of particle dark matter, compact astrophysical objects, high energy astrophysical sources, and cosmic radiation across the electromagnetic spectrum.

**Rahman Prize for Computational Physics****Stefano Baroni**
Scuola Internazionale Superiore di Studi Avanzati

For seminal contributions to the development of first-principles methods to investigate the electronic and thermal properties of condensed systems, and for the development and dissemination of open-source software for electronic structure calculations that has been widely adopted.

**Sakharov Prize****Yoel Fink**
Massachusetts Institute of Technology

For defending the academic freedom and human rights of scientists working in the U.S.

**Sakurai Prize for Theoretical Particle Physics****John F. Donoghue**
University of Massachusetts, Amherst

For original and lasting contributions to the development of effective field theories, including work on gravity as an effective quantum field theory, and important contributions to chiral perturbation theory.

**Schawlow Prize in Laser Science****Alexander L. Gaeta**
Columbia University

For groundbreaking innovations in the fields of quantum and nonlinear optics.

**Stix Award for Outstanding Early Career Contributions to Plasma Physics Research****Jack D. Hare**
Cornell University

For the development and exploration of pulsed-power experimental platforms to investigate magnetic reconnection in novel regimes and, in particular, their use in the study of reconnection in the presence of strong radiative cooling.

**Valley Prize****Lorenzo Gavassino**
University of Cambridge

For contributions to the field of relativistic viscous fluid dynamics that settled longstanding questions about the relation between stability and causality.

**Wilson Prize for Achievement in the Physics of Particle Accelerators****Jie Wei**
Michigan State University

For seminal contributions in the physics of high-intensity hadron accelerators, and for leadership in the development, construction, and commissioning of the world's highest power hadron accelerators, particularly the first continuous-wave superconducting linac for heavy ions above 200 MeV/nucleon.

TEAM PRIZE**Ramsey Prize in Atomic, Molecular, and Optical Physics, and in Precision Tests of Fundamental Laws and Symmetries**

For seminal developments of quantum information processing with neutral atoms that allow the investigation of many-body problems that are intractable by classical computing.

Antoine Browaeys
*Institut d'Optique, CNRS***Mark Saffman**
The University of Wisconsin–Madison**Reichert and Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction****John Essick**
Reed College

For sustained leadership and innovation in advanced laboratory instruction, for developing influential curricular materials, and for nurturing the success of students and of colleagues throughout the advanced laboratory community.

Fellowships

APS General**Xiang-Bin Wang**
*Tsinghua University***Division of Atomic, Molecular, and Optical Physics****Chin-wen (James) Chou** (鄒景文)
*National Institute of Standards and Technology, Boulder, CO***Stephen Hughes**
*Queen's University***Benjamin McMorran**
*University of Oregon***Luca Salasnich**
*University of Padova***Deniz D. Yavuz**
*The University of Wisconsin–Madison***Qi Zhou**
*Purdue University***Division of Astrophysics****Steven Furlanetto**
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*University of Maryland***Giles Novak**
*Northwestern University***Neelima Sehgal**
*Stony Brook University***Abigail Vieregg**
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*Laboratoire de physique de l'École normale supérieure***Steve Pressé**
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*University of Trieste***Stefano Bonetti**
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Rutgers, the State University of New Jersey



M. Hildred Blewett Fellowship

Elizabeth Hicks
Northwestern University

Anja Weyant
University of Pittsburgh

Stanford R. Ovshinsky Sustainable Energy Fellowship

Luis R. De Jesús Báez
University at Buffalo

Dissertation Awards

Acrivos Dissertation Award in Fluid Dynamics

Michael J. Wadas
University of Michigan

For an impressive theoretical, computational, and experimental analysis of shocked material interfaces and vortex rings, including a scaling of shock-generated vortex rings extending classical vortex ring theory to compressible, variable-density flows and a plausible mechanism describing structure formation in Supernova 1987A.

Anderson Division of Laser Science Dissertation Award

Emily D. Caldwell
University of Colorado, Boulder

For the original demonstration of the time-programmable optical frequency comb and for the application of these combs to provide critical advances in the field of free-space optical time transfer, demonstrating femtosecond timing distribution over 300-km links with quantum-limited sensitivity.

Dissertation Award in Hadronic Physics

Parker T. Gardner
Rice University

For groundbreaking research uncovering collective phenomena in high-multiplicity jet fragmentation, advancing our understanding of quark-gluon interactions in dense QCD environments through innovative experimental analyses and phenomenological frameworks.

Dissertation Award in Nuclear Physics

Bruno Sebastian Scheihing Hitschfeld
Kavli Institute for Theoretical Physics, University of California, Santa Barbara

For defining and computing the QCD correlation functions that govern the dissociation and recombination of quarkonia in quark-gluon plasma, and for developing a systematic theoretical framework to describe the out-of-equilibrium dynamics and hydrodynamization of QCD matter.

Dissertation Award in Nuclear Physics

Zhiwan Xu
University of California, Los Angeles

For significant contributions to quantum chromodynamics through innovative methods to suppress experimental backgrounds and interpret observables at the relativistic heavy ion collider.

Dissertation Award in Statistical and Nonlinear Physics

Jonas Veenstra
University of Amsterdam

For an exemplary synthesis of experimental, theoretical, and computational research on non-reciprocal active matter, and demonstration of the broad relevance of the subject to the mechanics of solids and robotics through discovery of new phenomenology in this class of materials.

Greene Dissertation Award in Experimental Condensed Matter or Materials Physics

Thomas Werkmeister
Columbia University

For pioneering investigation of unusual integer and fractional quantum Hall states in a graphene-based quantum Hall interferometer.

Jankunas Doctoral Dissertation Award in Chemical Physics

Olivia A. Krohn
University of Colorado and JILA

For experimental achievements on astrochemical cold ion-neutral reactions between trapped ions in Coulomb crystals.

Jin Award for Outstanding Doctoral Thesis Research in Atomic, Molecular, or Optical Physics

Ricky Elwell
University of California, Los Angeles

For groundbreaking contributions to the laser excitation of the thorium-229 nuclear clock transition.

Metropolis Award for Outstanding Doctoral Thesis Work in Computational Physics

Benjamin Xu Shi
Flatiron Institute

For the development of pioneering computational tools that achieve experimental-level accuracy at low cost in modeling molecule-surface interactions on ionic materials.

Outstanding Doctoral Thesis Research in Beam Physics Award

Rachel Margraf-O'Neal
Argonne National Laboratory

For experimental demonstrations of a Low-loss, stable, hard X-ray Bragg cavity to enable Cavity-based X-ray Free Electron Lasers (XFEL) and for research into microbunching rotation in an XFEL as a novel outcoupling mechanism for Cavity-based XFELs.

Outstanding Doctoral Thesis Research in Biological Physics

François X. P. Bourassa
McGill University

For groundbreaking contributions to the biophysical understanding of T cell response, providing a low-dimensional theory of immune response and indicating promising future avenues in cancer immunotherapy.

Rosenbluth Doctoral Thesis Award

Jaron E. Shrock
University of Maryland, College Park

For the first demonstration of multi-GeV laser wakefield acceleration using a plasma waveguide in an all-optical scheme.

Sakurai Dissertation Award in Theoretical Particle Physics

Zhiquan Sun
University of California, Berkeley

For applying effective field theory to advance our understanding of QCD, including establishing a new formalism to study heavy quark fragmentation, determining how confinement affects energy correlators, and revealing an overlooked complexity of the axion solution to the strong CP problem.

Tanaka Dissertation Award in Experimental Particle Physics

Christina Wang
California Institute of Technology

For pioneering a novel technique using CMS muon chambers to search for weakly-coupled sub-GeV mass dark matter using long-lived particle searches, and for groundbreaking work in quantum sensing to enable new probes of dark matter.

PRX Intelligence continued from page 1

Von Lilienfeld has focused on developing methods to study materials and chemical compound spaces, relying on machine learning, quantum and statistical mechanics, and high-performance computing. He also has deep editorial experience, having served as the editor in chief of *Machine Learning: Science and Technology*; associate editor of *Science Advances*, *Journal of the American Chemical Society*, and *Journal of Chemical Theory and Computation*; and editorial board member of *Scientific Data*.

APS News spoke with von Lilienfeld to learn more about what the APS community can expect from *PRX Intelligence*.

This interview has been edited for length and clarity

What makes the timing right for *PRX Intelligence*?

Physics started like all the sciences — with experiments. Then theory was developed, and we arrived at theoretical frameworks with some equations that were too difficult to solve.

Since the digital revolution, we've used computers to numerically solve approximations to these equations, and to accelerate the experiments. We've enjoyed more and cheaper access to computation, thanks to Moore's law. And by combining these three pillars of science, we've gotten very large datasets, which makes more of the field amenable to statistical learning.

Now, we've seen the emergence of AI, a fourth pillar of science. So a new journal dedicated to AI and physics is timely.

What attracted you to the chief editor role?

My own research has benefited from physics, which I've incorporated into my work developing machine learning models. I think this lesson holds in general — that there's an important role that physics can play in developing new and improved machine learning approaches.

I'm very excited about these opportunities. I felt that the ideal publisher for this type of work is APS, and the community of APS is the perfect audience for it.

What's your vision for *PRX Intelligence*?

AI is a common theme in research right now, but in a lot of work being submitted to journals, it's not always clear what advancement an insight could lead to.

APS has a strong reputation for

high-quality content. We want to preserve, or even raise, the standards of APS journals by trying to identify studies that truly represent a major new insight or advancement in the field, and to relate those advances to physics.

PRX Intelligence is also run by scientists for scientists. We want editors and referees to do full justice to the authors' work. All our editors and editorial board members are active researchers, and we'll match submitted manuscripts with the most competent referees.

From your own work, what challenge might machine learning research help resolve?

In the physical sciences, we have always struggled to establish a robust understanding to make more of our approaches predictive. The hope is, given enough data and machine learning models for training, we will be able to improve the situation, which could benefit not only our understanding but also the design and discovery of new materials, which could be useful for renewable energy or new chip designs.

Another challenge from my field is chemical and materials synthesis. Even if you've identified a material that you think has all the properties and behaviors you'd like to see, its synthesis is still a challenge. We hope we can make progress using new tools to design synthesis routes.

These are typical problems for atomic and materials sciences — my background — but other fields will also benefit, because statistical methods manifest themselves in a variety of approaches. They include supervised learning, unsupervised learning, generative learning, AI — a lot of new tools that have become ever more useful.

Describe the primary audience for *PRX Intelligence*.

I view my personal research interests in the physics of the chemical and materials sciences as representative of the kinds of readers we'd like to address. But we are also addressing researchers in other domains of physics who have connected theory to simulation, AI, and experiments. We would especially like to involve those who combine data with physics and statistical insights to train more predictive models.

What new or surprising features might we see in the journal?

From my own work, where I've contributed data sets — such as QM7, QM9, or VQM24 — that have

proven important for the field, it's shown me that a new article form such as a 'data paper' could be valuable. There's a need for a journal that can offer that in the APS family of journals. We will also publish new code to facilitate the dissemination of methods and the reproducibility of results. These are just a few of our ideas to make this journal useful for authors and readers.

What's been challenging about the journal process for you?

Finding the right people. This is a journal by scientists, for scientists, so we've tried to cover all the domains of physics that could benefit from machine learning, without singling out a particular trend. We want to be an open-minded journal. So far, the leadership team has representatives from condensed matter physics, particle physics, nuclear physics, and astrophysics, as well as a member who's an experimentalist.

What else would you like the APS community to know about *PRX Intelligence*?

The peer review system has faced criticism, and it's especially problematic when a referee is asked to make the call on whether a paper is appropriate for the journal, and the referee says, 'It's a good paper but not the right fit for the journal.'

For *PRX Intelligence*, we're working to avoid this issue by no longer asking referees if a paper is appropriate for the journal or not. Our editors will first make the call on whether the paper is appropriate, and then the referees will make recommendations to improve it.

The focus will be on improving the quality of the content, rather than fighting to get published. It's a cultural change we are excited about.

Why does it matter that the journal is open access?

My personal philosophy has always been to make heavy use of arXiv and open source — to not hide research behind paywalls. This is particularly important for scientists in developing countries where academic libraries cannot necessarily afford subscription fees.

We want people from around the globe to be able to access the content, because we believe that sharing science openly helps humanity as a whole. This is something that the open access model enables.

Liz Boatman is a materials scientist and science writer based in Minnesota.

PhysicsQuest continued from page 3



Danyel Cavazos walks local teachers through his activity at the Teachers Day professional development event at the Global Physics Summit in March 2025. Credit: Nicole Schrode

His strategy is to use analogy to your advantage as a teacher, identifying both the parts that work and the parts that break down in the quantum realm to highlight the differences between classical and quantum physics. But using those concrete objects to build students' intuition is crucial. A student may think, "if you can explain it using normal objects, objects that I know

"When you're speaking about quantum mechanics, there is no analogy with normal physics — but when we're teaching, we still need to use analogy," explains Danyel Cavazos.

Wolfshagen, a science outreach professional and one of the creators of the 2-Qubit dance, found it interesting to explore how students can "learn through play, or they develop curiosity, or even frustration of not knowing why it works that way."

Wolfshagen — a biochemist by training, now a physics educator — appreciated how the PhysicsQuest lessons found a new way to teach difficult concepts. She jokingly recalled how her physics colleagues would say about quantum mechanics, "Oh, it's easy. You look at the math!" She adds, "the challenge is to translate things that are often well-expressed in math, and make them understandable without the math."

Other lessons explore quantum teleportation with coins, use augmented reality to think about qubits, and visualize crystal lattices with ping-pong balls. All were a hit with students. "I was testing all these labs with my students, and they really loved it," says Nataliya Fletcher, a physics teacher in Florida who pilot-tested the PhysicsQuest quantum lessons.

APS members and participating teachers got a lot out of the activities, as well. "Working on and implementing PhysicsQuest lessons gave me additional opportunities for my own learning and being able to share that experience with my students," says Ann-Marie Dubick, who teach-

and understand, then maybe I can do more with quantum mechanics myself later on," he adds.

Cavazos' lesson uses playing cards to teach students about the Bell Inequality, a limit of probability that only quantum entanglement can surpass. Playing cards are a helpful tool to learn about basic probability, which can then be expanded to the correlations in an entangled system. One teacher even told Cavazos that some of her students changed the rules of the game a bit, and got a result that had



Students play "Entangled & Shuffled," a classroom game developed by Danyel Cavazos of the University of Chicago that helps students conceptualize quantum fundamentals, like superposition and entanglement. Nataliya Fletcher

some interesting physical meaning — they ended up dabbling in theories that go beyond the limits of even quantum mechanics. "I think it shows that the game really is getting down to something, because then the students themselves are taking it and using it to understand something that even I didn't intend to," he says. "Once you get a lesson out there, then it's kind of alive, and it just turns into its own thing."

Another activity turns students into qubits, using their arms to represent the qubit's state: zero, one, or a superposition of the two. They move around, applying different logic gates to their qubits, resulting in a dance that represents a quantum computing algorithm. Dominique

es STEM to sixth through eighth graders and who participated in the lesson testing. Fletcher adds, PhysicsQuest has "given me a really great opportunity to not just grow personally, but actually see how my experiences can help other teachers."

For Cavazos, PhysicsQuest provided inspiration for his college courses, and Wolfshagen said the process helped her learn new research-backed education methods.

All PhysicsQuest lessons, from 2025 and previous years, are available for free on the APS website. APS encourages educators to download, use, and adapt PhysicsQuest resources in their own classrooms.

Briley is a postdoc at the University of California, Santa Barbara, and a writer.

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A new journal that expands global participation in physics research

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THE BACK PAGE

The fight to keep science global

Some nations are trying to shut the doors of international collaboration. Scientists can keep them open.

BY ROBBERT DIJKGRAAF

It was, in many ways, the worst possible time for scientists to work together internationally. At the height of Cold War tensions in 1950, American physicist Lloyd Berkner made an audacious proposal at a dinner party: organize an international year of scientific exploration focused on Earth's polar regions, like those of 1882 and 1932 — but this time, scientists would study physical phenomena across the entire planet, including the upper atmosphere that rocket technology had just made accessible.

The resulting International Geophysical Year of 1957 to 1958 proved a stunning success. Sixty-seven countries collaborated, including the United States and Soviet Union — Cold War adversaries. The initiative saw the launch of the first satellites, like the Soviet Union's Sputnik and the U.S.'s Explorer 1, yielded breakthroughs like the discovery of the Van Allen radiation belts and mid-ocean tectonic ridges, and produced the 1959 Antarctic Treaty, one of history's most successful diplomatic achievements. It designated Antarctica as a scientific preserve, banned military activity, and established principles that continue to enable climate research today.

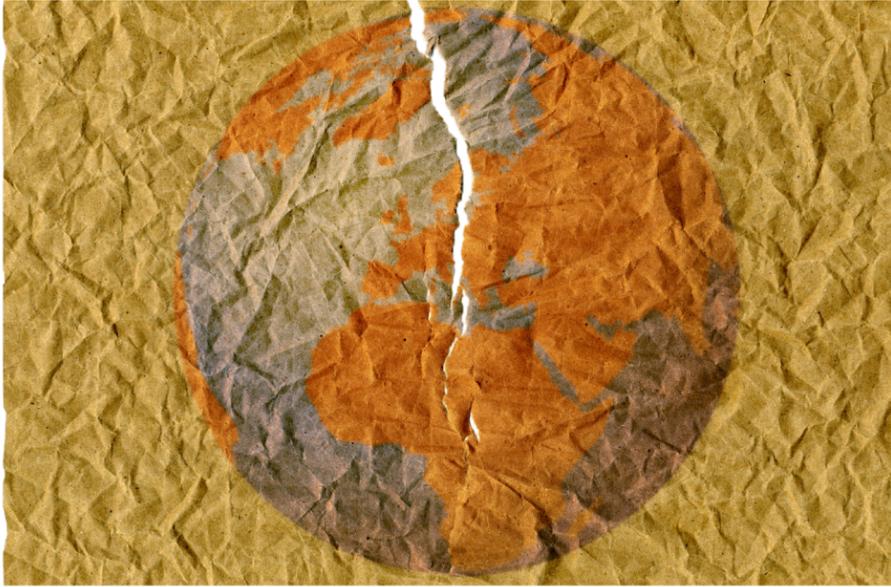
We live once again in times of severe geopolitical stress. The question is whether today's scientific community has the imagination and determination to forge similar partnerships capable of pushing back against divisive political forces.

The case for doing so is even more compelling now. Climate change, ocean degradation, biodiversity collapse, and pandemic threats demand worldwide cooperation. An unprecedented global pool of scientific talent has emerged from regions not previously engaged in international research. Tomorrow's Nobel laureates will come from every corner of the world.

Yet today's obstacles are also greater than during the Cold War, ironically partly because science has succeeded so spectacularly in transforming our societies and economies. Major powers now see technology as the primary battleground for economic competitiveness and national security. The United States, China, and Europe prioritize leadership in critical technologies such as artificial intelligence, quantum computing, semiconductors, and biotechnology. Scientific advancement is increasingly viewed through a zero-sum competitive lens.

This securitization of science creates a profound contradiction. While humanity's most pressing challenges require global cooperation, governments increasingly treat scientific collaboration as a threat. Research security protocols and visa restrictions multiply. Scientists face investigations for routine international partnerships. Universities implement screening mechanisms that treat academic openness as a vulnerability rather than a strength.

The multilateral system itself is under strain, with the United Nations facing active undermining. The U.S. has slashed financial contributions and withdrawn from several of its agencies, including the World Health Organization and UNESCO, institutions essential for coordinating global responses to shared



threats. Populist governments and large corporations view critical multilateral frameworks like the Paris Accord and the Sustainable Development Goals as a threat to national sovereignty and industrial autonomy. Scientific consensus reports, like those from the Intergovernmental Panel on Climate Change, are undermined by well-organized global disinformation campaigns, often disguised as legitimate science. Meanwhile, the Global South, bearing the heaviest burden of climate change and environmental degradation, loses faith that wealthy industrialized countries will finally help address longstanding inequalities.

It is hard to ignore the recent policy shifts of several nations, particularly the U.S. For decades, the world benefited from America's science umbrella — generous support for research on climate science, for example, and infectious diseases in Africa. With the U.S. now stepping back, other capable nations must step forward. Scientific competitors see opportunities to recruit American talent and have launched ambitious programs to do so. But the greatest need is strengthening the international networks that work for the global public good, not merely national advantage.

Opportunities for the scientific community

Scientists sitting in what might be called the “second ring” of the geopolitical theatre — not in the “splash zone” reserved for politicians — therefore have an important role to play. They are close enough to power to influence outcomes, yet sufficiently removed to maintain independence.

The scientific community commands authority through expertise that transcends political boundaries. International science organizations possess neutral convening power, bringing together researchers even from hostile nations. Science is one of the few converging forces in our fragmenting world. Scientific collaborations operate on timescales measured in decades rather than electoral cycles, building trust that survives political volatility.

When the International Science Council's predecessor was founded in 1899, an article in the journal *Nature* noted that science “can assert itself even when the political atmosphere is not unclouded.” These words ring truer than ever.

The creation of the European particle laboratory CERN in 1954 was a successful example of postwar diplomacy disguised as a scientific project. When European nations sought access to American nuclear expertise, Washington instead encouraged them to collaborate on particle physics, rebuilding European scientific capacity while keeping weapons technology separate. This brought former enemies France and Germany together as equal partners in a pan-European institution before the European Economic Community existed. CERN stemmed the brain drain to America, fostered European integration, and created rare neutral ground for East-West dialogue during the Cold War. Several countries joined the laboratory before joining the European Union.

An ambitious attempt to replicate CERN's bridge-building success in a conflict-ridden region is SESAME. This facility, established in 2017 in Jordan, brings together scientists from the Middle East to conduct research using a common synchrotron light source. It creates a rare neutral space where Israeli and Palestinian scientists work side by side and Iranian researchers collaborate with counterparts from Egypt and Turkey. While it faces ongoing challenges, SESAME demonstrates that academic diplomacy can be adapted even to the world's most intractable fault lines.

Another example of a joint science project under difficult political circumstances, including extensive UN sanctions, is the close collaboration between scientists from the U.K., the U.S., and North Korea studying Mount Peaktu, a volcano on the border of China and North Korea that in the past has been responsible for some of the largest recorded eruptions.

International collaborations practicing open science — the wide sharing of research outcomes and datasets — are crucial for addressing the deepening North-South divide. They ensure that science serves as a global public good, providing scientific expertise to low-income countries that often face the hardest policy decisions and most acute threats. Realizing this potential requires an ongoing dialogue across academic disciplines and with all stakeholders: policymakers, funders, the private sector, and local sources of knowledge.

The Pacific Academy of Science, established in 2024 in partnership

The Academy creates institutional capacity for Pacific scientists to lead the research agenda for their region, speak with collective authority, and ensure that decisions are made by and with Pacific peoples, not merely about them.

What can and must scientists do?

This is not a time to sit back. The academic community must organize itself, learn to “push back against the pushback,” and forcefully defend international collaboration, especially where political pressure is greatest. This requires moving beyond passive responses to active engagement with geopolitical realities.

Scientists must build and defend spaces for collaboration that formal diplomacy cannot. This means actively seeking out partnerships and exchanges with scholars and students from the growing lists of countries facing mounting bureaucratic obstacles. Researchers should not shy away from recruiting an excellent graduate student from, say, China or Iran, simply because of additional paperwork. At many major universities, faculty members have already formed working groups to support international students and scholars facing travel bans or restricted access, providing legal resources and advocacy.

It means making clear to university administrators and funding agencies the necessity of supporting exchange programs, rather than preemptively censoring the exchange of researchers, data, or communications. Working scientists must articulate to policymakers that, in many research areas, international collaboration is entirely in the nations' self-interest. Without access to global data, you cannot seriously study the atmosphere or infectious diseases, nor responsibly prepare for future hurricanes or pandemics.

Consider, as a positive example, the remarkable data-sharing networks that climate scientists have built. The World Climate Research Programme operates through a network of more than 190 member countries, making climate model data freely accessible to scientists worldwide, including those from developing nations lacking sophisticated monitoring infrastructure. Efforts like these transcend geopolitics.

Of course, some concerns about knowledge transfer in sensitive domains are legitimate. Responsible collaboration in fields that power

critical or dual-use technologies requires walking a narrow path between naïveté and paranoia, preserving open scientific exchange while managing genuine security risks. This demands a sustained dialogue between working scientists with deep domain knowledge and government security officials. Active researchers cannot delegate full decision-making about which areas of quantum physics or biotechnology are safe to share to university administrators or government experts alone.

As a better alternative, some universities have created committees bringing together faculty, security officials, and administrators to develop nuanced policies that protect both research integrity and security interests. This active engagement requires a culture change in many fields, drawing on the experience of domains like nuclear physics that learned these lessons decades ago.

One area that poses no threat to national security and knows no borders is basic research. With new centers of excellence appearing around the world, open exchange is crucial for advancing fundamental questions about the universe, matter, and life. Here the whole can be so much more than the sum of its parts. History demonstrates that science's contributions to human welfare often arrive after a long and winding road, and cannot be captured by any single nation. The computer emerged from investigations into mathematical logic. Quantum technology arose from curiosity about the structure of the atom. Genetic editing grew from understanding the molecular basis of life. Frontier research infrastructures, such as the next generation of particle accelerators, space telescopes, or gravitational wave detectors, are beyond the financial and organizational capacities of any single nation. Many scientific challenges demand world-scale laboratories.

But there's an even greater goal to international collaboration. Together we must defend the fundamental values that make science possible: academic freedom, free movement of scholars, collaboration across borders, pluralism, openness, transparency, integrity, and empowering the next generation. These aren't ideological goals. They're operational requirements for science to deliver on its promises.

The question before the scientific community is whether we can mobilize the political will and institutional creativity that characterized the International Geophysical Year, but at a moment when the political headwinds are stronger, the technological stakes higher, and the window for action on existential challenges narrower.

It is not easy, but scientists must rise to this moment. Geopolitics is too important to leave to politicians.

Robbert Dijkgraaf is a mathematical physicist and the president-elect of the International Science Council. He has been a leader in research and policy in many roles, including as minister of Education, Culture, and Science of the Netherlands (2022-2024) and director of the Institute for Advanced Study in Princeton (2012-2022).