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A climate for physicists

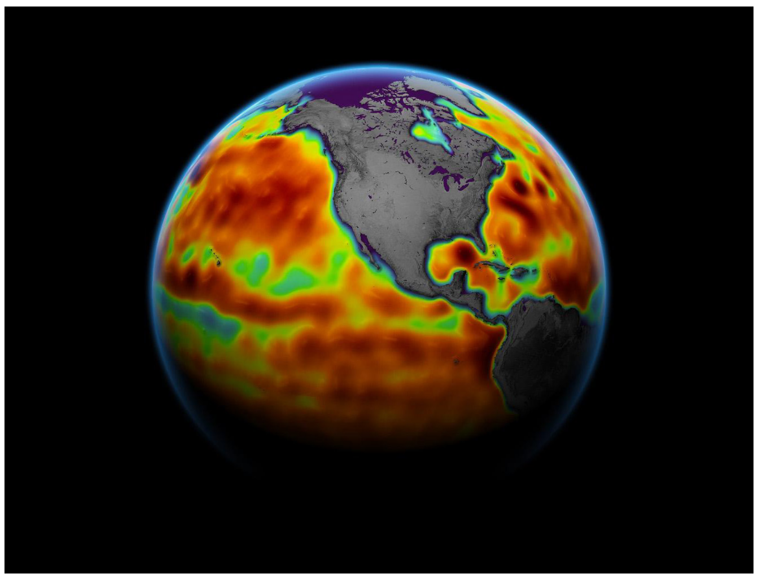
Scientists from fields ranging from gravitational wave astronomy to condensed matter physics are finding unexpected opportunities to contribute to climate research.

BY SOPHIA CHEN

Two and a half years into graduate school, Morgan O'Neill got scooped. A research team in another country published a nearly identical study before she could. "I was heartbroken," she says. At the time, O'Neill was studying tropical storms. She switched to studying Saturn instead.

The shift may sound dramatic, but O'Neill found the research pivot relatively smooth. The physics of Saturn's storms wasn't too different from that behind Earth's hurricanes. "I was able to borrow from tropical [meteorology] to develop a simple model and explanation of what's going on for Saturn," she says. For her Ph.D., O'Neill used computational models to study the Earth-sized cyclone at Saturn's north pole. Now a professor at the University of Toronto, O'Neill has come back full circle to studying storms on Earth.

O'Neill's career trajectory illustrates the broad connections between climate science and more conventional fields of physics. During a roundtable discussion at this year's



A map showing sea level measured by the Sentinel-6 Michael Freilich satellite in June 2021. Red areas are regions where sea level is higher than normal, and blue areas indicate areas where it's lower than normal. Credit: NASA Earth Observatory

APS Global Physics Summit in Denver, O'Neill joined Brad Marston of Brown University in Rhode Island and Valerio Lucarini of the University of Leicester in the U.K. to discuss these connections. He and the other panelists argued that climate research can benefit in many ways from a physics perspective.

Climate research continued on page 5

White House calls for science funding shake-up, US caps length of student visas, and more

The latest science policy news.

BY CLARE ZHANG, JACOB TAYLOR, AND LINDSAY MCKENZIE

U.S. eliminates 'duration of status'

The Department of Homeland Security has finalized its plans to overhaul immigration rules for international students, ending the decades-old "duration of status" system that gave students the flexibility to stay for as long as it took them to complete their studies.

DHS' final rule, published July 17, will take effect Sept. 15 and applies to F student visas, J exchange visitor visas, and I visas for foreign journalists. Instead of allowing these visa holders to remain in the U.S. for the duration of their academic program or journalistic assignment, DHS will now admit individuals for a fixed period of time tied to their program length and capped at four years.

Universities and scientific organizations warn that removing the duration of status system will create new administrative hurdles for international students and may deter them from choosing to pursue their

Markwayne Mullin being sworn in as the secretary of homeland security in March. Credit: Tia Dufour / DHS

studies in the US. The changes will have a significant impact on students pursuing advanced degrees, as doctoral and postdoctoral programs can take much longer than four years to complete. Under the new

Science policy continued on page 7

"It started with teaching": Maggie Hudson, chief editor of *PRX Energy*, on her path into publishing

In an interview, Hudson shares lessons from her career and her hopes for the journal.

BY CYPRESS HANSEN

"As an editor, I get to see the cutting edge of the field," says Hudson. "That's a cool aspect of my job." Credit: Maggie Hudson/APS

Maggie Hudson, a chemist by training, was initially drawn to science by a novel she read in high school.

In *People of the Book*, "the main character did this in-depth chemical materials analysis of an old manuscript to understand where it came from and all the different people that it touched," she recalls. "I loved the connection between people, their experiences, and the material world."

Later, during a summer program in college, Hudson performed her own chemical analyses of paintings and photographs to understand their histories — a full-circle moment fit for its own novel. Eventually, her interests shifted from mysteries of the past to what lies ahead.

"I became interested in where the future of materials science would lead us, and how materials could impact society, which led me into the energy side of things," she says.

After studying semiconductor quantum dots in grad school, then photocatalysis for a postdoc, Hudson joined the *PRX Energy* team when the journal launched in 2021.

Hudson Q&A continued on page 3

The showy science of fireworks

For America's 250th birthday, read up on the long history and strange physics behind pyrotechnics.

BY KENDRA REDMOND

Dazzling displays of skyward explosions have delighted crowds for centuries, eliciting collective oohs and aahs and spontaneous applause at celebrations worldwide. From the window-rattling booms of bright chrysanthemums to the crackling of cascading willows, fireworks are a crowd-pleasing blend of science, art, engineering, and technology.

Here are four facts you might find surprising.

1. Fireworks far predate the printing press.

The first firecrackers — fireworks that produce a loud bang — are widely attributed to ancient China, most likely appearing in the first or second century BCE. Bamboo was tossed into fires to ward off creatures and evil spirits because, when heated, the buildup of steam inside the hollow areas caused the stalk to explode with a loud crack.

Firecrackers received an upgrade in ninth-century China with the invention of black powder, the earliest form of gunpowder, which contained naturally occurring saltpeter (potassium nitrate, an oxidizer), charcoal (the primary fuel), and sulfur (an ignition and burn-rate enhancer). When ignited, the flammable trio generated rapidly expanding gas, leading to powerful explosions. Packing bamboo and, later, paper with black powder, then throwing it into the fire, created even louder bangs and flashes of light.

The next few centuries brought several innovations, including

For hundreds of years, fireworks have lit up the skies for events and celebrations.

twisted paper fuses, which meant firecrackers didn't have to be thrown into fire; intricate chain reactions; and shows combining fireworks and colored smoke. Gunpowder spread into the Middle East, India, Europe, and beyond, and monarchs commissioned elaborate fireworks displays for celebrations and military victories. Around the 13th century, the Chinese invented gunpowder-propelled rockets, and aerial fireworks joined the festivities.

2. Blue fireworks are the most challenging to produce.

The next major leap in fireworks technology occurred during the Renaissance. Artisans, especially those in Italy, began experimenting with additives and packing designs, achieving different colors and burst patterns. The vibrancy of their colors might not wow audiences today, but modern fireworks are colored in essentially the same way — by adding small bits of metals or other compounds, now called stars, to the shells.

During combustion, the stars heat up, forming excited gas-phase atoms and small molecules. As electrons drop back down into a lower state, they emit photons at wavelengths corresponding to specific colors. Today, red is typically produced by adding strontium salts, orange by calcium compounds, yellow by sodium compounds, and green by barium compounds.

Of all the colors, vibrant blue is the most difficult to achieve. Blue fireworks are generated by adding copper compounds that form the excited gas-phase copper chloride species during combustion. The process, however, requires a Goldilocks temperature zone. If the combustion temperature is a little too low, the additives don't fully vaporize

Fireworks continued on page 7

Bringing climate physics to middle and high school classrooms

APS PhysicsQuest kits offer teachers, many of whom don't have physics backgrounds, hands-on lessons and activities.

BY KENDRA REDMOND

This fall, APS will equip hundreds of middle and high school teachers with ready-to-use activities that help students explore the physics of the climate. The latest PhysicsQuest kit — developed by members and tested by teachers — brings topics like heat transfer and carbon sequestration to life and comes with an assortment of teaching materials, from an infrared thermometer to volcanic rocks.

"I've done PhysicsQuest from the very beginning," says Sandy Gady, a middle school teacher at a low-resource school outside Seattle. "It's the best thing I've ever seen." The kits help students make new connections, she says, and give them the tools and confidence to explore the world in ways they wouldn't be able to otherwise.

Most middle school science teachers and about 60% of high school physics teachers in the U.S. don't have physics degrees, says Nicole Schrode, the APS program manager for public engagement. The PhysicsQuest program is designed to support those educators by providing new, thematic, interactive lessons and materials each year. The kits are free and available on a first-come, first-served basis.

With this year's kit, students use hand boilers and other tools to explore how solar energy heats Earth's surfaces. In another "hands-on" experiment, they measure the temperature of their palms beneath films of different thicknesses to explore why planets have different temperatures. Students also recreate Eunice Newton Foote's groundbreaking 1856 experiment, which suggested that an atmosphere with more carbon dioxide would lead to a warmer earth. Next year's kit will build on these concepts by focusing on climate solutions.

APS created the first PhysicsQuest in 2005, in celebration of the World Year of Physics. While the early kits had simple experiments, Gady says, "they have really evolved." There is always at least one experiment that stretches her students' thinking. And she likes that PhysicsQuest tackles tough subjects like climate change and quantum science and technology.

Thomas Binninger, a Los Angeles middle school teacher, feels similarly. PhysicsQuest introduces students to science that goes beyond the standard curriculum and connects to current research, which he and his students find challenging and exciting. In a school focused on raising reading and math scores, he says, PhysicsQuest brings a sense of wonder into the classroom. "In science you have to be curious, and you have to wonder," he says. "It can't always be all about the scores."

Students in Nataliya Fletcher's high school science classes at a Florida collegiate academy also enjoy the kits. The experiments are a nice change of pace from lectures and problem-solving, she says, and they help students better retain information. "Students are actively doing science rather than just learning about it," she says. "When students can see a concept in action and relate it to their own experiences, the learning becomes much more meaningful and memorable."

Developing activities that resonate with students in grades 6–12 is a collaborative, yearlong process. After a topic is selected, Schrode invites subject-matter experts — members of relevant APS units — to submit outlines of possible activities. Then a group of veteran PhysicsQuest teachers reviews them and provides feedback.

At the Global Physics Summit in Denver last year, teachers tried out the heat transfer experiment from the upcoming PhysicsQuest lesson kit. Credit: APS

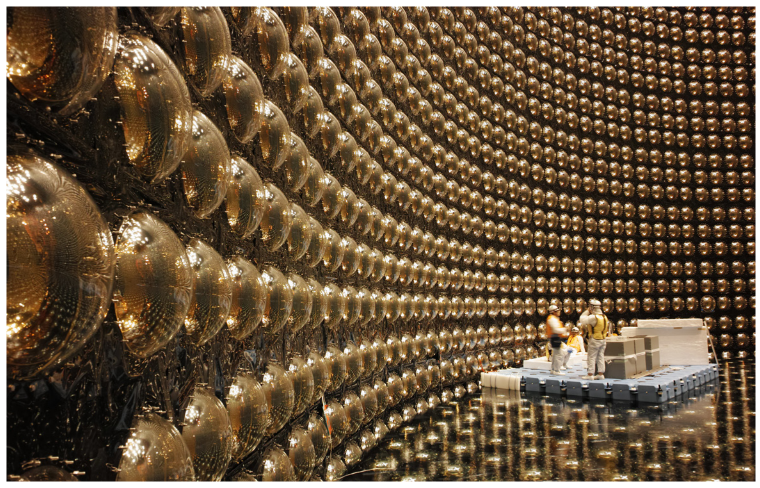
PhysicsQuest continued on page 6

THIS MONTH IN PHYSICS HISTORY

August 1998: Scientists publish evidence that neutrinos oscillate

Deep underground, Japan's "Super-K" detector picked up hints that the ghostly particles have mass — and switch from type to type.

BY NYLA HUSAIN



Workers inspect the photomultiplier tube array lining the interior of the Super-Kamiokande tank. Credit: Kamioka Observatory, ICRR (Institute for Cosmic Ray Research), The University of Tokyo

More than 3,000 feet beneath a forested peak in Japan's Northern Alps sits a 13-story, stainless steel cylindrical tank filled with 13 million gallons of ultra-pure water. This behemoth buried under Mount Ikeno, known as Super-Kamiokande, or "Super-K," is lined with 13,000 golden, bulb-like light sensors that capture signals of the lightest particles known to humanity: neutrinos.

When the detector began operating in 1996, neutrinos were still thought to be massless. But just two years later, Super-K would capture neutrinos changing "flavor," or type — upending decades-long assumptions about the nature of these elusive particles and definitively confirming that they do, in fact, have mass.

Nicknamed "ghost particles," neutrinos are notoriously hard to pinpoint. When Wolfgang Pauli postulated their existence in 1930 to explain why energy went missing during nuclear beta decay, he lamented that the particles could never be detected. Four years later, Enrico Fermi, knowing that the particles are chargeless and have little or no mass, devised the theory behind the weak nuclear force that governs their rare interactions with matter. But it wasn't until 1956 that physicists finally captured neutrinos by placing an underground detector near a nuclear plant, where nuclear fission provided a potent source of antineutrinos.

But the reactor experiment only scratched the surface. Earth is constantly being showered with neutrinos from extraterrestrial sources: the sun, cosmic rays, and even supernovae from the early universe. Trillions of these subatomic particles stream through our bodies every second. However, because they interact so weakly with matter, detecting even a handful requires a vast space and a shield from cosmic noise. Scientists began carving out enormous caverns deep underground to house giant detectors that could spot these phantom particles.

In 1968, the Homestake experiment used a 100,000-gallon vat of dry-cleaning fluid buried in a gold mine nearly a mile beneath South Dakota to capture neutrinos from the sun. The experiment proved that our star is powered by nuclear fusion and that solar neutrinos — generated as electron neutrinos during fusion processes in the sun's core — were reaching Earth. But it caught less than half of what theory predicted, hinting that these neutrinos could be "oscillating" en route to Earth, shapeshifting into undetected flavors. Although neutrino oscillations had been hypothesized more than a decade earlier, there was still no experimental proof. Homestake's solar neutrino anomaly would remain unsolved for the next three decades.

By the 1980s, the Kamioka Observatory, once a zinc and lead mine beneath the Hida Mountains, had become a major site for neutrino discoveries. In 1985, Super-K's predecessor, a particle detector originally designed to search for proton decay, began recording solar and atmospheric neutrinos. The latter are a mixture of electron and muon neutrinos created when high-energy cosmic rays collide with nuclei in Earth's upper atmosphere. But like the Homestake experiment, the Kamiokande detector's numbers were off. The measurements were missing roughly half of the muon neutrinos predicted by theory.

Scientists had observed atmospheric neutrinos in two deep gold mines 20 years earlier, but it wasn't until detectors like Kamiokande and IMB came online that researchers could achieve the scale, resolution, and particle identification capabilities necessary to see the anomaly. Takaaki Kajita, a young scientist working on the original Kamiokande experiment, was baffled by the results. After completing his doctoral studies in 1986, Kajita and his colleagues set about trying to find mistakes in the data. Ultimately, no errors or uncertainties could explain the anomaly, and, while the case for neutrino oscillations continued to grow, there was still no definitive proof.

Like its predecessor, Super-K is a water Cherenkov detector — a giant water tank outfitted with ultra-sensitive light sensors called photomultiplier tubes. When neutrinos pass through, they rarely but occasionally collide with water molecules. These collisions emit cones of faint blue light, called Cherenkov radiation, that project as rings onto the sensor-lined walls, helping determine the neutrinos' type and direction. With 16 times the water capacity and 10 times more photosensors than its predecessor, Super-K could capture more neutrino events with much higher precision. The detector was set to resolve the neutrino anomaly once and for all, and Kajita

A researcher works on the Super-Kamiokande detector during construction in July 1995. Credit: Kamioka Observatory, ICRR (Institute for Cosmic Ray Research), The University of Tokyo

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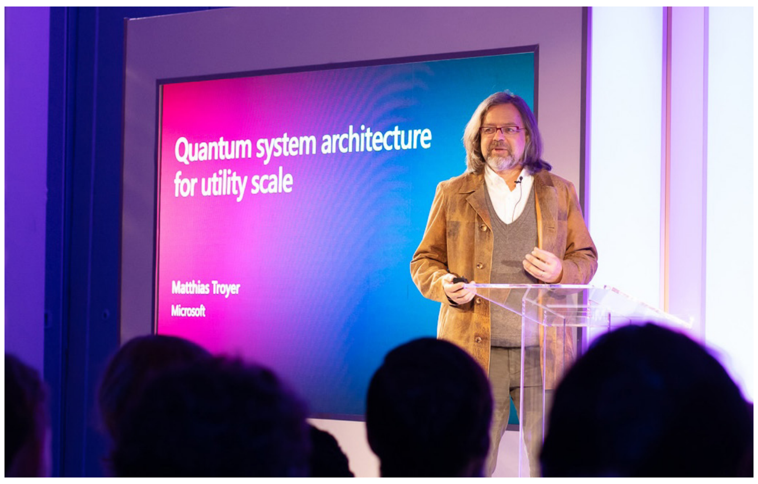
Matthias Troyer on his pivot to Microsoft — and the importance of mid-career recognition

In an interview, Troyer talks about his career, his involvement in APS, and his purpose in helping the Society launch its newest award.

BY LIZ BOATMAN

In 2017, computational physicist Matthias Troyer left a successful career in academia for a position leading Microsoft's quantum computing division. "I wanted to build something," he says — like the company's first quantum computer, and the software to run it.

More recently, Troyer — elected to APS Fellowship in 2011 — decided it was time to help APS build something new, too. Through his own generous donation, a matching donation from Microsoft, and donations he helped secure from other APS members, Troyer helped establish the Charlotte Froese Fischer Mid-Career Award in Computational Physics.



"To make progress in physics, we have to help get computation in physics recognized," says Matthias Troyer. Photo credit: Microsoft

The award, which just closed its inaugural application round, will annually offer one recipient a $5,000 stipend and a travel grant to deliver an invited lecture at an APS meeting. It honors the late Charlotte Froese Fischer, a Canadian-American applied mathematician, computer scientist, and physicist who published more than 300 articles on atomic theory, and whose prediction of the existence of the calcium anion led to its experimental discovery.

APS offers a range of prizes, including many for students, early-career scientists, and established scientists. But Troyer most liked the idea of supporting a new mid-career award. "A prize can actually have a bigger impact when it can still shape a person's career," he says.

APS News spoke with Troyer to learn more about his work, his inspiration to support its new mid-career award. This interview has been edited for length and clarity.

What core questions have driven your work as a computational physicist?

As a student, I was fascinated by trying to understand how nature works, from the smallest subatomic particle to the universe. When I got into computing and, with other students, developed our school's first software infrastructure, I wanted to bring these two interests together — to see how we could sim-

Troyer Q&A continued on page 6

Julia Phillips, dismissed from the NSF's advisory board, isn't done with Washington

Phillips was abruptly removed from the National Science Board, like all her co-members. Her advocacy hasn't stopped.

BY COREY FEUER

Julia Phillips. Credit: NSF

On a sunny Friday in April, Julia Phillips got an unexpected call. "I was driving home from a trip to Washington, D.C.," says Phillips, then a member of the National Science Board, so she pulled over on the side of the road and picked up the phone.

The call was from the chair of the board, Victor McCrary. "Have you read your email?" Philips recalls him asking.

That day, April 24, Phillips and McCrary — along with every other NSB member — received an email informing them that they had been fired, effective immediately. The message provided no reasoning for the dismissals.

The NSB was formed in 1950 to oversee the National Science Foundation, as well as to advise the executive and legislative branches on key science policy issues. Members are nominated by the president and confirmed by the Senate to serve as nonpartisan stewards of U.S. research.

Since the mass firings in April, no new members have been appointed to the board, leaving it essentially non-functioning.

"Some functions of the board are the closest thing the U.S. has to a Department of Science," noted Phillips, who chaired one of the Board's science and engineering policy committees. "We monitored the country's scientific progress so that we could maintain our standing as a global R&D leader."

That standing, the board found in a report completed before the dismissals, is in jeopardy. China surpassed the United States in global R&D expenditures in 2024. It now produces more science and engineering Ph.D.s than America and holds significantly more market share in semiconductor manufacturing and other high-tech industries.

At a recent Senate hearing on strategic research, Phillips testified about the importance of science to American foreign policy. "S&T is the new global currency of power," she told the committee. "The threat to our future economic prosperity and national security is very real."

But not all threats to Ameri-

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Hudson Q&A continued from page 1

With several years of editing experience under her belt, Hudson has taken the helm as chief editor for *PRX Energy*, APS' open access journal for energy and sustainability research.

We sat down with Hudson to learn more about her career, interest in science communication, and ideas for the journal.

This interview has been edited for clarity and brevity.

How did you land in scientific publishing?

It started with teaching. I was enthusiastic about teaching in grad school, and loved mentorship. But my postdoc began as the pandemic hit, and in-person teaching wasn't an option. In searching for opportunities, I did a scientific writing internship for the University of Chicago, which exposed me to the idea of working in science communication. It hadn't come across my table before, but it aligned with my interests in communicating scientific knowledge and staying connected to current research.

When my postdoc ended, the American Physical Society was creating *PRX Energy* and looking to expand their staff at a couple of journals. I applied, then transitioned from my postdoc into an associate editor position at APS. I started simultaneously at three journals, my time equally split between *PRX Energy*, *Physical Review Materials*, and *Physical Review Applied*.

Three journals at once! Was that a lot to handle?

It was a fantastic way to start. I got exposure to more ideas on how to handle papers, and I think it accelerated my understanding of the editorial process. As I move into this new role at *PRX Energy*, I'm taking with me a lot of experience gained from working at the other journals.

For example, both *Physical Review Materials* and *Physical Review Applied* have weekly briefings where we discuss decisions on papers. Seeing that process every week among two editorial teams has really strengthened my approach to manuscripts.

As you've shifted more of your time to *PRX Energy*, what have you been focused on?

I've been focusing more on the energy research and technology community. I go to six or seven energy conferences a year, and as I listen to talks and chat with researchers in the field, I hear more about how we can serve their needs as a journal. The more I've gotten to know the community, the more time I've wanted to devote to improving the journal to serve the community.

Maggie Hudson and David Scanlon, the lead editor of PRX Energy, at a reception for the journal.

What's your favorite part of working with researchers?

I love seeing researchers in the audience get excited about stuff they haven't seen before, and I love hearing their questions. As an editor, I get to see the cutting edge of the field. That's a cool aspect of my job.

My second-favorite thing is connecting with early-career researchers. I mentioned that my focus was teaching and mentorship for much of my education, and you can do that at conferences. As part of the APS community, part of my role has been teaching peer review workshops. I do this at smaller conferences and the Global Physics Summit every year.

Is there an outreach effort you supported that you're particularly proud of?

The biggest is a collaboration I did with the marketing team at APS, where we developed an online peer review training program. We took the materials we use in our author and reviewer training and adapted them to an online course that's now open to anyone. I wrote all the content for that, and we shared it publicly at the end of 2025.

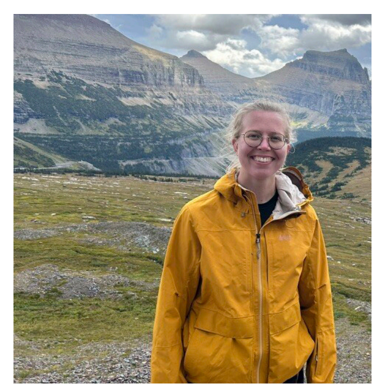
Which research trends are you watching for PRX Energy?

First is the explosion of artificial intelligence and machine learning. It touches all areas of research, and it intersects with *PRX Energy* because the computing uses so much energy. Do AI's benefits to society make up for the energy cost? I don't know, and I'm excited to see the research that figures it out.

Second, I've seen cool recent research on new computing methods that save energy. Researchers are going back to the fundamentals to see where energy is wasted and how paradigm shifts in programming and hardware can reveal more efficient pathways.

I'm also excited about practical energy research, like the newest solar cells and batteries, but I get most excited when advanced energy technology intersects with nitty-gritty physics concepts. *PRX Energy*'s unique position at that intersection helps these approaches shine.

What do you want prospective authors for *PRX Energy* to know?



"I work remotely in Portland, Oregon, so you can usually find me outside," says Hudson. Credit: Maggie Hudson

As part of APS, we are, by definition, a physics journal, but we publish the entire scope of energy and sustainability research. A paper for the journal doesn't necessarily have to have physics in it — that's not an expectation when the paper shows up on my desk. But your readers will include more physicists than a typical energy journal. I like to think of *PRX Energy* as a place to publish energy research that physicists should see.

When you're not editing or attending conferences, what are you up to?

I work remotely in Portland, Oregon, so you can usually find me outside. I ran in the Portland marathon this year, and I love hiking all over Oregon and western Washington. I also enjoy crocheting gifts for people — that's what I do when it's raining, which is a lot of the year.

Cypress Hansen is a science writer based in the San Diego area.

Finding hidden career opportunities outside academia

Five ways to use networking to build your career in physics.

BY ALAINA G. LEVINE

Career development relies, in large part, on gathering and scrutinizing data. You start with data about yourself, like your skills, values, needs, and wants — the full dataset of all that makes you, you.

But career development also requires external data on opportunities, sectors, industries, and organizations. Some of this data comes from static sources, like articles and podcasts, but the most valuable external data will come from networking based on a spirit of generosity, where you identify people with whom to engage, explore career opportunities, and craft win-win relationships over time.

Networking in this way can also reveal hidden jobs — roles that haven't been promoted yet, or positions created just for you — and give you a competitive advantage in a challenging job market. And it can help you create what I call your "Unicorn Career," the customized and authentic career that brings you joy, meaning, and money.

But before you network, you have to find folks to network with. Here are five ways to do that.

Networking can reveal hidden jobs and give you a competitive advantage in a challenging job market. Credit: APS

1. Explore your APS Membership

Your APS membership provides exceptional career-advancement resources, including communities of scientists with common interests, locations, and sectors; the opportunity to serve on committees and grow your skills in leadership; mentorship resources; award programs; and critically, networking. APS' directory is invaluable, because it's a list of people with whom you have a reason to connect (you're both members) and something to discuss (the society and profession you share). By reviewing the APS member directory, I discovered physicists who work in automobile manufacturing, aerospace, consumer goods, and countless other sectors.

When you email a contact, ask for an "informal conversation" (also called an informational interview) to learn about how you can position yourself for success in your career. Those discussions can provide insight into the skills valued in that sector and could potentially lead to collaborations or a job.

2. Check out the speakers at APS meetings, like the Global Physics Summit

Take another look at the meeting program, paying close attention to speakers' presentation topics and organizations. If you spot a company of interest, find the speaker's email in the membership directory, or message them on LinkedIn, and say that while you couldn't say hello at the conference, you'd welcome the chance to chat now. Ask if they have time for a 15-minute Zoom meeting, as you'd like to learn more about their work — and don't forget to offer to help them, too.

3. Review APS Journals

If you're considering research-related jobs that are academia-adjacent, take a close look at who has authored papers in your research area — specifically those not based in academia — to get a sense for who is sponsoring research in industry and government agencies. Contact them to learn more about their research and potentially "explore a collaboration."

4. Pursue industry clusters

An industry cluster is a critical mass of organizations in the same industry and geographical region. Well-known clusters include tech in Silicon Valley, quantum computing in Boulder/Denver, and energy in Houston. Cluster associations hold networking events, have an elected board, and have inside knowledge of opportunities at their member employers — and thus are excellent for networking. Look for clusters in the region you want to work in, or find out where clusters in sectors that interest you are located. Then, identify the cluster association, contact the membership director or a member of the board, and share that you're interested in "growing my career here" and would welcome the chance to chat over Zoom or WhatsApp. They're likely to meet you, because as a physicist, you command a high salary in industry and are worth money to these organizations.

5. Expand your gaze

Physics-educated leaders are not limited to careers with the words "physicist" or "physics" in the job description. Your physics degree gives you value, skills, and abilities far beyond, say, solving traditional physics problems — just look at the many career profiles in APS News that showcase physicists with unique jobs and titles.

As you look beyond "physics" jobs, you'll also learn the vocabulary to effectively communicate your value — and ultimately find meaningful Unicorn Careers beyond academia that align with your goals.

Note: Concepts in this article have appeared in the author's previously published works.

Alaina G. Levine is a STEM career expert, professional speaker, science writer, career coach, and author of the books Networking for Nerds *and* Create Your Unicorn Career. *Connect with her on LinkedIn @AlainaGLevine.*

Julia Phillips continued from page 3

can science are external, Phillips stressed. Oversight of the NSF, key to U.S. research, has been diminished without its board. Even when the Board was still active, she noted, they were sometimes blocked from accessing vital information, including agency budgets, facility operations updates, and NSF strategy development.

The dangers of an NSF without accountability have been well-documented. In 2024, a report from the House Committee on Science, Space, and Technology found that the agency failed to address pervasive sexual harassment in the U.S. Antarctic Program.

"We told the NSF director and deputy director, 'you cannot pretend this is not a problem,'" Phillips said about the findings. Thanks in part to the board's intervention, the agency worked with Congress to implement new safeguards protecting harassment victims in agency-funded programs.

The NSF and other federal science agencies have faced repeated attacks under the current administration. Months before the NSB firings, the board helped inform Congress about the impacts of a Trump administration proposal that would cut 57% of the NSF's budget for fiscal year 2026. But the Administration is now proposing a similarly large cut for fiscal year 2027, as well as cuts to agencies like NIST and NASA Science.

New immigration policies have compounded the damage done to federal science. Phillips' own immigrant son-in-law traveled to his native India for a family emergency right when the startup company he worked for shut down. Despite his advanced degree and ties to the U.S., he was denied reentry into the country. Phillips' daughter, a chemist, is now moving to the Netherlands to be with her husband. Phillips is losing proximity to her daughter. America is losing two skilled scientists — and thousands of others are in similar situations.

Today, Phillips continues to champion science as the chair of the AIP Foundation, a physics nonprofit, and as a member of Oregon State University's board of trustees. "I think we still have the wherewithal to push back against these challenges, but we've got to get our act together quickly," Phillips says. "Anything we tear down won't be built back up, and we will be ceding our science leadership without a fight."

Corey Feuer is the member advocacy specialist at APS.

APS Fellow Persis Drell heads DOE science advisory committee

Drell, a Stanford physicist, began in the new role in February.

Persis Drell, a particle physicist and former provost at Stanford and an APS Fellow, has been named chair of the Department of Energy's newly established Office of Science Advisory Committee (SCAC). The appointment, announced by DOE in February, puts Drell at the head of a 21-member body charged with advising the Office of Science, the federal government's largest funder of the physical sciences, with an annual budget of more than $8 billion.

For Drell, the role is both an honor and a duty. "If I'm asked to serve at that level for the national scientific enterprise, I'm going to say yes," she says. "It's a responsibility as a senior member in the field, and an opportunity to do something helpful."


Persis Drell Credit: L.A. Cicero/Stanford Report

SCAC was established by DOE's Office of Science in September 2025, and its members were announced in February 2026. The committee replaces six discipline-specific advisory panels that had advised the Office of Science for decades, including the High Energy Physics Advisory Panel, the oldest of the six, founded in 1967. Those six committees were disbanded in August 2025.

SCAC's membership draws from academia, national laboratories, and industry, and its composition reflects a particular emphasis on artificial intelligence: Five of its 21 members are computer scientists. DOE Under Secretary for Science Darío Gil, a computer scientist and former chair of the National Science Board, oversees the committee.

Unlike its predecessors, which each focused on a specific program area — like particle physics, nuclear science, and fusion energy — SCAC is charged with advising the Office of Science as a whole. "The previous committees tended to focus in their particular disciplinary area," Drell says. "We are being asked to look across the Office of Science. You lose some granularity, but for something like a facilities roadmap, you need that wider lens."

The committee has three active charges: advising on the Genesis Mission, DOE's initiative to integrate artificial intelligence into its scientific programs; a 10-year facilities roadmap; and quantum information science. Three subcommittees are currently at work on each charge, with reports expected at the full committee's July meeting. All SCAC meetings are open to the public, recorded, and include time for public comment; meeting information is available on the DOE Office of Science website.

Community members looking for ways to engage should watch for upcoming town halls. The quantum subcommittee had a town hall on June 12, and other subcommittees may host similar events in the coming months.

In the meantime, Drell noted, SCAC has been drawing heavily on the body of work produced by the previous committees. "We're using everything they've done," she said. "The problem isn't today — we have lots of community input to the process we have right now."

Drell acknowledges that the mechanisms for ongoing community engagement have yet to be worked out, and that charting a path forward on that front remains an open challenge for the committee. "The question of how that input flows going forward is a real concern, and one we're going to have to confront," she says.

Drell comes to the role with a deep grounding in physics and its leading institutions. She earned a bachelor's degree in mathematics and physics from Wellesley College in 1977 and a Ph.D. in atomic physics from The University of California, Berkeley, in 1983, before joining the Cornell physics faculty in 1988. In 2002, she moved to Stanford, where she has since served as director of SLAC National Accelerator Laboratory (2007-2012), dean of the Stanford School of Engineering (2014-2017), and provost of the university (2017-2023). She is a member of the National Academy of Sciences and the American Academy of Arts and Sciences, a Guggenheim Fellow, and a fellow of the APS, elected in 1997.

Drell is aware that many in the U.S. science community face uncertainty and change, and she encourages her fellow physicists to speak up on behalf of the field.

"The best thing the community can do is continue to do spectacular science, communicate it, and advocate for its importance," she says. "The more we talk about the positives, the better."

For one high school teacher, an APS meeting was a "life-changing" experience

Teacher Jack Stillman recalls highlights of an APS annual meeting, including the travel grant that helped him get there.

BY LIZ BOATMAN

Since attending an APS annual meeting in 2019, Stillman has expanded his reach as an educator; in the summers, he teaches in a school in Thailand. Credit: PWK School

For high school educator Jack Stillman, the 2019 April Meeting in Denver "was a life-changing experience," he says.

After graduating high school in Humboldt County, California, Stillman left home for one year to study mechanical engineering at the University of California, Santa Barbara, but quickly returned. "That's what's called the old 'Humboldt shuffle,'" he says, "where you move away for a year and then move back because you miss it."

Back home, he completed a semester of community college at the College of the Redwoods and then transferred to Humboldt State University to complete his four-year degree. "When I came to Humboldt State, they didn't have mechanical engineering," he says, "so I went to the next nearest thing, which was physics."

His academic advisor offered an experimental research opportunity in his National Science Foundation-funded program — "essentially a test of the inverse square law of gravity at very small length scales."

During Stillman's senior year, his research advisor was planning to attend the 2019 APS April Meeting. And because Stillman was "the most dedicated" of the research interns, his advisor invited him to attend and present the paper they had submitted on their research.

"But I didn't have any funding,"

Jack Stillman continued on page 7

Get to know IUPAP, physics' United Nations

APS will become the U.S. adhering body to the storied international organization.

BY COREY FEUER

The 33rd General Assembly of the International Union of Pure and Applied Physics took place in Haikou, China, in 2024. Credit: IUPAP

Decades before the United Nations, NATO, or European Union existed, there was IUPAP, the International Union of Pure and Applied Physics.

IUPAP was founded in 1922 to foster international physics collaboration following the devastation of World War I. The United States was a founding member, as were France, Japan, the United Kingdom, and nine other Allied or neutral countries.

The group's mission was simple: Unite the world's brightest physicists to solve humanity's biggest problems. Yet there was almost immediate tension between member states over who should be allowed to join. Central Powers like Germany had been banned from the Union in retaliation for the war. Many countries supported this embargo, while others protested. How could IUPAP be a global body, some asked, when it shunned major parts of the world?

Today's scientific community is struggling with similar tensions. Global conflicts threaten the very international research organizations the U.S. helped build. The National Academy of Sciences, which manages the U.S.'s presence in global initiatives like IUPAP, has faced major cuts to the federal grants and contracts that make up most of its operating budget.

This July, the National Academy passed some of its IUPAP responsibilities to APS, which will officially become the United States' institutional representative to the Union in October. The move underscores an urgent need for science nonprofits to fill gaps left by U.S. funding cuts.

"It's becoming increasingly difficult for U.S. researchers to collaborate internationally," says Amy Flatten, APS director of international affairs. "APS' growing involvement in IUPAP is one step we are taking to be a welcoming global hub for inter-

IUPAP continued on page 7

Climate research continued from page 1

"A lot of climate scientists self-identify as physicists," says Marston, who is also the current APS president.

The panel came at a consequential time for climate action. In 2023, the Intergovernmental Panel on Climate Change (IPCC) released a report describing paths the world could take to limit global temperature rise to 1.5°C compared to preindustrial levels. Even if warming is limited to 1.5°C, the risks of extreme weather events, ocean acidification, and other climate impacts would increase. Yet compared with a 2°C rise, the consequences would be substantially less severe and would require significantly less adaptation to climate change, according to the IPCC.

Achieving that target will require political commitment — and that commitment is uncertain, particularly in the U.S., the second-biggest carbon emitter globally. The current U.S. administration has cut funding for climate science research; eliminated climate science positions at the Environmental Protection Agency; and announced plans to dismantle the National Center for Atmospheric Research, an institution whose research includes climate science, meteorology, and space weather.

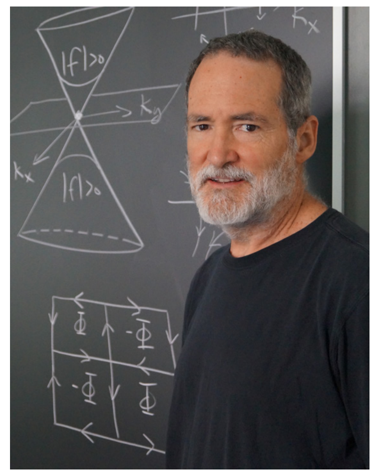
O'Neill anticipated the changing political environment when she decided, in 2023, to move her lab from Stanford University to the University of Toronto, where she sought the greater stability of climate science funding in Canada. "I was pretty confident that Trump was going to win reelection, and I knew I would want to leave the country as a climate scientist," she says.

Despite the political uncertainty, some physicists are still looking for ways to contribute to climate science. Levi Schult, a 26-year-old Ph.D. student at Vanderbilt University in Tennessee who studies gravitational waves, grew up aware of the vulnerability of New Orleans to rising seas and coastal flooding. "It feels so daunting and pressing of an issue," Schult says. She is now considering how to apply her modeling skills to climate science.

Condensed matter physics, too, has surprising connections to climate science. Marston found that Earth's oceans and atmosphere can support flow patterns that are mathematically analogous to electron motion in an exotic state of matter known as a topological insulator. "There's a wave equation in both cases," he says. Electrons in a topological insulator follow the Schrödinger equation, whereas Earth's ocean dynamics follow classical wave equations under the influence of Earth's rotation.

In a topological insulator, electrons flow on the material's edges or surfaces, while the bulk remains insulating. Those edge currents are robust: They can persist in the presence of defects or disorder that would normally scatter electrons. This edge transport can make topological insulators a useful analogy for certain wave patterns in Earth's oceans and atmosphere.

On Earth's surface, the oceans support several types of giant equatorial waves, such as Kelvin waves and Yanai waves, whose wavelengths can extend for thousands of kilometers. Such waves, according to Marston, are mathematical analogues of the edge currents found in certain topological insulators in which an applied magnetic field deflects electrons. Instead of a magnetic force, it's the Coriolis force that deflects fluid motion on Earth's surface. Because the Coriolis force vanishes at the equator, the equator can be thought of as "the boundary between two topological insulators," Marston says. The result is Kelvin and Yanai waves that can travel long distances with little distortion.



"A lot of climate scientists self-identify as physicists," says Brad Marston. Credit: Ariel Green

The NASA-ISRO Synthetic Aperture Radar (NISAR) team deploys the satellite's radar antenna reflector in August 2025. NISAR is designed to collect data on changes to Earth's land and ice surfaces. Credit: NASA/JPL-Caltech

Now Marston is working with Brown University undergraduate Leopold Li to look for signatures of topologically protected waves in the Madden-Julian oscillation, a large-scale pattern of rainfall that circles the tropics every 30 to 60 days and that can affect monsoons in Asia and Australia and the timing of El Niño, among other things. Li is building a simple computational model to try to elucidate the mechanisms driving the oscillation. This impactful phenomenon isn't accurately captured by current weather and climate models.

"Statistical mechanics gives you a formal language to describe accurately what a tipping point is," Lucarini says.

While climate science's societal relevance appeals to Li, his primary motivation is understanding the scientific phenomenon itself. "It just so happens [that] many of the most fascinating problems that I've encountered in my life are geophysical in nature," Li says.

Statistical mechanics concepts can also apply to climate science. Lucarini studies climate tipping points — thresholds beyond which a system abruptly shifts from one equilibrium state into another. Similar transitions occur throughout physics, from magnets losing their magnetization to water changing phase. "Statistical mechanics gives you a formal language to describe accurately what a tipping point is," Lucarini says.

Earth's climate appears to have undergone such transitions before. Drawing on both paleoclimatic records and theoretical models, researchers have found indications that Earth's past climate has tipped between different stable configurations, Lucarini says. A dramatic example is Earth's "snowball" state, a period between 717 and 635 million years ago when ice may have covered nearly the entire planet. Geologic evidence of glaciers at the tropics, together with climate simulations, supports the idea that Earth entered — and eventually escaped — this globally frozen state.

If Earth's climate has tipped between stable states in the past, the question is whether it could do so again. Lucarini studies potential tipping points associated with rising carbon dioxide levels. One prominent candidate is the Atlantic Meridional Overturning Circulation, an ocean current that brings warm water from the tropics to northern Europe and returns cold water southward toward Antarctica. Evidence suggests that this current is slowing down, and some researchers worry that a major weakening could trigger drastic changes, including the cooling of currently fertile regions of northern Europe and shifts in tropical precipitation cycles.

The politicization of climate science can make the field look unusually contentious and uncertain compared to other scientific disciplines. Mohammad Ashraf Modares, a graduate student in O'Neill's group, thinks that the public discussions of climate science have unfairly demonized the associated uncertainties, treating them as weaknesses rather than normal features of the scientific method. "The uncertainties in climate studies seem normal compared to any kind of science," he says.

But physics is only one piece of the climate puzzle, and cross-disciplinary work can be difficult to communicate across research communities: Marston, for example, has had to choose between publishing in journals aimed at atmospheric scientists and those read by condensed-matter physicists, even when both audiences would find the work interesting.

To Marston, our planet's atmosphere and oceans command a sense of wonder comparable to that evoked by astronomy. Images from the JWST observatory "lead to this greater appreciation for our place in the universe," he says. Climate physics could achieve something similar by offering people "an appreciation for the amazing beauty of the climate system," he says. And that sense of marvel may prove more powerful in shaping human behavior than facts and warnings alone.

Sophia Chen is a writer based in Columbus, Ohio. This article was reprinted from APS' Physics Magazine.

American Physical Society expands membership plan options

On June 29, APS rolled out new flexibility in membership plan options, as well as a program of accessible pricing for less-resourced countries.

The two membership plan options will replace the current, single-membership model. This expansion is designed to provide increased flexibility for APS members.

Both membership plans, including the new Basic membership plan, include: access to APS News and Physics Magazine, unit membership options, access to APS Fellowship, and the opportunity to vote in the APS general election. The Full membership plan's expanded benefits include additional resources to keep members connected to the physics community: access to Physics Today, access to APS mentorship resources, and discounts on APS meetings.

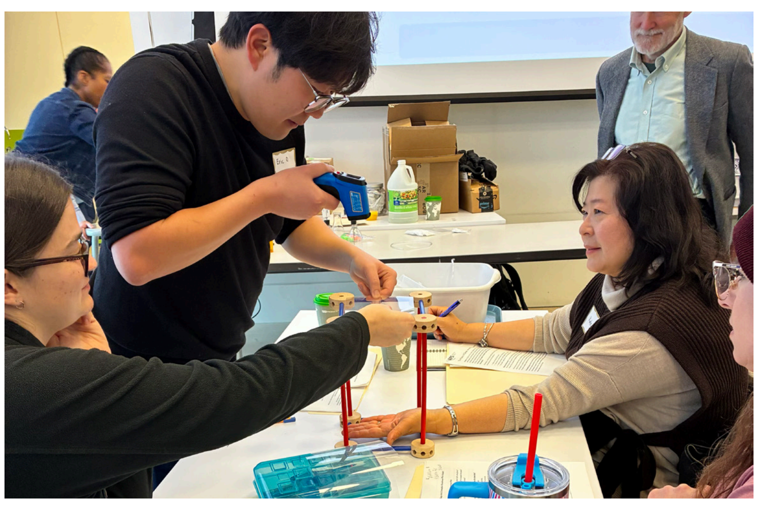
"Physicists need access to different resources at each stage of their careers," said Cortney Bougher, APS director of membership. "The new APS membership model will connect members with the APS offerings they choose to utilize in order to stay connected to the physics community. This change helps them get what they want out of their membership."

Current APS members will remain part of the Full membership plan, offering expanded benefits, until their renewal date. At renewal, they'll choose how they'd like to continue their membership.

APS also now offers discounted, accessible pricing on both membership plans for physicists and students in lower-income and lower-middle-income countries, as defined by the World Bank. APS will offer membership discounted up to 90% for residents of eligible countries. Members must demonstrate residency in an eligible country during the membership join process.

"APS has a long-standing commitment to equitable access to science," said Bougher. "These new membership discounts complement APS meeting registration price accessibility and participation in Research4Life journal initiatives."

PhysicsQuest continued from page 2



A trio of teachers tinker with the PhysicsQuest experiments. Credit: APS

"Physicists know the physics better than a teacher, but teachers understand educational implementation and pedagogy and how these lessons will read in a classroom better," Schrode says.

Binninger, Fletcher, and Gady were three of the pilot teachers for the 2026 kit. They worked with APS staff and physicists to select and streamline the activities. Many physicists have good ideas, "but to actually put them into practice is a whole other concept," Binninger says. For example, physicists may overestimate the level of background knowledge students have or the availability of classroom equipment. Pilot teachers can identify such challenges and offer possible solutions early.

Many people, even parents, don't understand the full reality of today's classrooms, says Gady. "In one of my classes, I had 14 different languages." Helping all students learn takes flexibility and openness, which she found in the physicist developers. The process was collaborative planning "at its very best," she says. The teachers also helped identify safety concerns, adjust lesson sequencing, and brainstorm ways to present topics that resonate with students.

Based on their input, Schrode — a former high school physics teacher herself — then guides physicists in turning their outlines into PhysicsQuest lesson plans. She also works with a science supply store to source materials so that, come spring, pilot teachers can test lessons in their classrooms.

In one climate activity, created by researchers at Brown University, students put volcanic rocks and water in two sealed plastic bottles, one containing regular air and one carbon dioxide. As the basalt reacts with carbon dioxide, decreasing pressure causes the bottle to crumple inward. When Gady's students saw this during the pilot session last spring, they immediately wanted to test her rock collection. Then they went searching for more rocks outside, which they brought in and experimented with. To their delight, some of the rocks reacted with carbon dioxide.

These kinds of activities make her students feel smart, Gady says. "That's really important, because nobody's ever told them they were smart."

After teachers test the activities and submit suggestions, the APS team refines the lessons, prepares supporting online resources, and finalizes the materials list. Registration opens each August, and 750-1,000 kits are shipped to teachers in the fall. Teachers who miss out on the physical kits can always find the lessons and supporting resources on the APS website, including those from past kits. Registration is now open for the Physics of Climate kits.

Gady encourages all teachers to give PhysicsQuest a try. "Even if you only do one of the activities, it makes a difference in these kids' lives," she says.

Kendra Redmond is a writer based in Minnesota.

Troyer Q&A continued from page 3

ulate nature with computers. Of all fields, I found quantum physics the hardest, so I started my university studies with physics. But I kept my interests in materials, chemistry, and computing.

For my master's thesis, I was offered a topic where I could use a Cray X-MP supercomputer. It was clear that this was what I wanted to do. For years, my focus was then on using computers to solve physics problems. If you combine the best computers with new algorithms and interesting physics problems, you can make real and fast progress — finding new problems to solve with the new algorithms and new hardware.

In 1997, you moved to Japan for a postdoc, where you had access to a supercomputer. How have supercomputers changed since?

I moved for the people, the scientists, and the physics in Japan. On top of that, I had access to a machine that had a performance speed of 220 giga flop [1 billion calculations per second]. Today, the biggest supercomputer in the world is 10 million times faster. That machine in Japan — its power is like my cell phone today.

Plus, the machines have gotten even bigger. With the end of Moore's law, people started to get more performance by scaling out to more processors, more CPU cores, rather than making the processors faster. For example, the machine that I worked with in Japan had 1,024 cores. Currently, the fastest supercomputer has 11 million cores. So it's 10 million times faster, but it also has 10,000 times more CPU cores — these machines have really grown in size.

Pivoting from academia to Microsoft was a major mid-career transition. Say more.

As one evolves and goes through one's career and pivots and changes, one learns one's own strengths and passions, and then finds the right role over time. I've sometimes thought whether I should have done things differently. Should I have pivoted earlier, or not? But in the end, whatever I've done, I've learned new things, built up skills, and had experiences that prepared me for the next phase in my career. In hindsight, there's a strong story to be told that one could not have predicted.

You've been an active member of APS for more than 30 years. Why?

I first got involved with APS as a graduate student back in 1994, when I went to the March Meeting. My talk was on 'two-leg ladder models' — models of two coupled chains of strongly correlated electrons. And it was the first talk Monday morning. The audience was mostly empty. *[laughs]*

Even now that I've moved to a company to build quantum computers, APS still plays a big role for me. The journals are a reliable and well-respected venue for publishing results. Also, the meetings are for more than talks. I go to them for networking and finding top students and postdocs to fill our open positions. I like to engage with other physicists — innovative ideas come from academia.

You've been the recipient of several prominent awards. Why do awards matter?

In my career, the awards I received — like the gold medal at the International Chemistry Olympiad in 1986, the ETH medal for an outstanding doctoral thesis — helped with reputation, helped with building my career. Awards help because they are a form of confirmation. Just being able to mention the awards on one's CV helps a person's career.

What's the significance of APS offering a new award in computational physics?

As a computational physicist, one is always between the computational science community and the physics community. To make progress in that field, one has to be an expert in both computing and physics. The challenge is that one gets evaluated for careers only by their impact, for example, on physics. But that is a hard career, and it has been a challenge for many colleagues to get recognition in physics as a computational physicist.

Now, computing is becoming more important across all fields of science and engineering. So, to make progress in physics, we have to help get computation in physics recognized, and that's where a prize like this can help.

> **"To make progress in physics, we have to help get computation in physics recognized." — Troyer**

Why is the invited talk an important aspect of APS' new Charlotte Froese Fischer Award?

As a student, a postdoc, and a young faculty, the main impact of APS on my career was through networking at the meetings and invited talks. Invited talks are a sign of recognition, and they help with one's career. As part of the award, there's an invited talk for the recipient. Typically, one can only give one invited talk at an APS meeting. But if you have an award, it's possible to give two, the standard invited talk plus the award talk. That's the only way one can give two invited talks at one meeting — for twice the career impact.

What scientific questions might we be able to answer with supercomputers and AI that once would have been a dream?

Soon, we can simulate materials and chemicals very accurately, predictively. We can already do it in many cases. What's more, the dream is that with 'agentic AI,' I can just talk to a computer and ask it to do certain calculations. But really, I think most of the things we do now feel like a dream!

The Charlotte Froese Fischer Award was funded in part by a corporate match from Troyer's employer, Microsoft, one of many companies with donation matching programs.

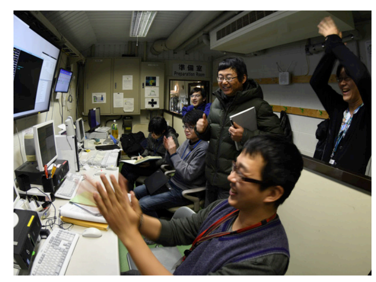
Liz Boatman is a materials scientist and science writer based in Minnesota.

Neutrinos continued from page 2

was tasked with leading the effort.

After sifting through thousands of atmospheric neutrino signals in the first two years of Super-K experiments, Kajita's team found that muon neutrinos arriving from the atmosphere above were much more abundant than muon neutrinos from Earth's interior below. The abundance of electron neutrinos, however, remained unchanged. These measurements finally gave them evidence to deduce that neutrinos changed flavor as they traveled. They published their findings in *Physical Review Letters* in August 1998.

Confirmation came a few years later. In 2000, scientists proved the existence of the last known neutrino flavor: tau. A year later, the Sudbury Neutrino Observatory, or SNO, in Canada — a Cherenkov detector filled with heavy water — was able to isolate solar neutrinos from the total neutrinos by measuring how they collided with deuterons. It showed that two-thirds of solar neutrinos went missing while the total neutrinos remained the same — confirming that neutrinos were oscillating. These oscillations meant that neutrinos possess mass and that their underlying mass states differ — a direct consequence of quantum mechanics. Takaaki, along with Arthur McDonald from SNO, went on to win the 2015 Nobel Prize in physics for their discoveries.



Researchers celebrate as Super-Kamiokande resumes data-taking following an upgrade in 2018-2019. Credit: Kamioka Observatory, ICRR (Institute for Cosmic Ray Research), The University of Tokyo

New physics is required to explain how neutrinos get their mass, tiny as it may be. The Standard Model requires that a particle and its antiparticle, if they have mass, must both have right-handed and left-handed versions — yet only left-handed neutrinos and right-handed antineutrinos have ever been observed. Other questions also remain unanswered: How do the masses of the different neutrino types compare to one another? Do neutrinos and antineutrinos oscillate at different rates, and could it help explain the universe's matter-antimatter asymmetry? Next-generation projects like Hyper-Kamiokande and DUNE aim to answer these questions. But for now, Super-K continues to investigate these chameleon-like particles.

Nyla Husain is the science communications manager at APS.

Fireworks continued from page 1

and the color is dim. If it's a little too high, the gas-phase compounds start decomposing and other emissions wash out the blue light. The narrow range is hard to hit given the high temperatures at play. Even today, you can judge the quality of a fireworks display by the purity and brightness of its blue effects.

plays aren't just the byproducts of explosions. Like colors, the sounds have also been engineered for entertainment. Large shells and tightly wrapped fireworks containing flash powder, which burns much more quickly than gunpowder, are used to produce reverberating booms. Layering boom upon boom also builds

Some colors are harder to produce than others; blue is particularly difficult.

3. The core elements of fireworks are the same now as they were hundreds of years ago.

By the 16th century, the main components of today's aerial fireworks were in place: lift systems such as mortars and rockets that could propel fireworks into the sky, fuses, bursting charges (the center explosive in a shell), and additives that enhanced light and color.

As alchemy transitioned into chemistry and industrialization and automation took root over the next few centuries, fireworks became more stable and predictable. Novel displays relied more on engineering than craft as combustion was better understood and color additives became more predictable and refined.

The fireworks displays of the late 1800s would look and sound familiar to audiences today, although they lacked the speed and precision of computer timing and automated ignition. Colors and sounds are more vivid now, fireworks produce less smoke, and shells burst into more shapes — achieved by patterning stars around the bursting charge at the center of the shell — but the key components have long been in place.

4. Today, sounds are engineered for show.

The characteristic booms and crackles of modern fireworks dis-

drama, as seen in many grand finales.

The whistling of a climbing rocket is another technique for building anticipation. To create the sound, a special "whistling" mixture is densely pressed into one end of a long, narrow tube or rocket. Above the packed powder is an empty cavity with a small opening at the top. The mixture, which burns inward from the cavity, has a burn rate that oscillates thousands of times per second. This excites the tube's resonance, generating the distinctive "phweeee" sound. Listen closely and you can hear the pitch decrease as the empty cavity lengthens.

Another fan favorite is the crackling that often accompanies fireworks when they rain down from the sky. This is the sound of many tiny explosions. Crackling fireworks contain encapsulated micro-particles or granules that rupture when heated, producing flashes of light and popping sounds. The abundance of these reactions is key to this soundscape.

As colorful bursts and thunderous booms fill the sky this season, consider the stories behind the spectacle: centuries of discovery and innovation by people seeking to understand — and celebrate — their world.

Kendra Redmond is a writer based in Minnesota.

IUPAP continued from page 5

national physicists who are facing a political environment that makes it challenging for them to even come to the United States."

IUPAP serves as an ideal forum for U.S. and international scientists to exchange ideas. The Union has 20 active commissions covering subfields from astrophysics to condensed matter. Each commission helps facilitate the free exchange of ideas across borders by participating in IUPAP's general assembly, organizing global conferences, and offering research awards.

IUPAP also hosts working groups on societal issues like climate change and women in physics. Most recently, the U.S. has proposed a working group on artificial intelligence and machine learning to guide the usage of emerging technologies in physics research.

"These commissions and working groups provide scientists a valuable window into physics research across the world," says APS CEO Jonathan Bagger. "Physics needs such connections to advance science for the benefit of all."

IUPAP's membership has expanded well beyond its 13 founding countries to nearly 60 country and territorial members. West Germany joined the Union in 1954, followed by East Germany in 1960 — a major shift in membership approach. The Union not only accepted a country it had excluded for decades, but also embraced nations on both sides of the major conflict at the time, the Cold War.

Today, IUPAP allows scientists to look beyond geopolitical tensions to advance the field. Fifty-two territories count themselves as members, including countries facing significant U.S. restrictions, like China and Iran. The U.S.'s participation signifies that even in times of conflict, fundamental science transcends borders.

APS hopes to carry that spirit forward as it leads the U.S. delegation's next chapter. "One of our values as an organization is fostering collaboration," says Flatten. "Physics is a global effort."

Corey Feuer is the APS member advocacy specialist.

Science Policy continued from page 1

rules, students who need more time to complete their programs will have to apply and pay for a formal extension of stay from U.S. Citizenship and Immigration Services, or leave the country and obtain a new visa abroad before returning, neither of which is guaranteed.

A 2025 report by AIP's statistics team found that about 97% of international students in physics and astronomy take more than four years to complete their Ph.D., with a median duration of 6 years for domestic and international students. The NSF's 2024 Survey of Earned Doctorates reports that the median time to complete a Ph.D. program across all disciplines is 5.7 years.

After March 18, 2027, students on F-1 visas who seek to transition into optional practical training will have to apply for a separate extension of stay and work authorization, which was not previously required. OPT allows graduates to work in a field related to their studies for up to one year, or three years if enrolled in certain STEM programs.

The final rule also shortens the grace period after completion of a program. Instead of having 60 days to depart the United States or change status after graduation, F-1 students will generally have just 30 days. The regulation will also prevent undergraduate students from changing programs or switching majors during the first year of their studies. Graduate students will be prohibited from changing programs or switching majors altogether. Students who complete a degree in the U.S. will not be allowed to pursue another degree in the U.S. at the same or lower education level. For example, a Ph.D. degree holder could not obtain an F-1 visa for another Ph.D. or any lower-level degree.

White House calls for science funding shake-up

The U.S. research enterprise too heavily centers on elite research institutions, and fails individual researchers with bold ideas, suggests the White House Office of Science and Technology in a new report. The office recommends sweeping changes to where federal funding is spent and how it should be awarded.

Released on July 21, the "Science: A New Golden Age" report seeks to update Vannevar Bush's landmark 1945 report "Science: The Endless Frontier" for the modern era. In the report, OSTP Director Michael Kratsios argues that today's scientific landscape — shaped by AI, global competition, and private-sector investment — requires a fundamental redesign of how the federal government funds research.

OSTP Director Michael Kratsios speaking at a House Science Committee hearing.
Credit: House Science Committee

OSTP published the report the day before Kratsios appeared before the House Science Committee to answer questions about the Trump administration's science policy agenda and research funding priorities for the next fiscal year. While Republicans on the committee broadly welcomed the administration's focus on innovation, AI, and research security, Democrats on the committee were highly critical of the administration's approach, noting major disruptions to research grants and questioning whether OSTP is improperly influencing NSF research decisions by redirecting funding and overriding the agency's award decisions. Kratsios denied any OSTP involvement in reviewing individual NSF grants, despite Rep. George Whitesides (D-CA) stating that his office had received information to the contrary.

Key recommendations in the report include prioritizing individual scientists over "a narrow set of legacy institutions," with greater support for other kinds of research institutions such as startups, independent research organizations, and NSF's recently launched X-Labs initiative, which supports research teams from a wide variety of organizations. The report also recommends more experimental funding approaches, including "golden tickets" that would let technical reviewers at individual agencies recommend "unconventional proposals that may not pass consensus-driven review panels" — a model that the report says is being piloted at NSF's Technology, Innovation and Partnerships Directorate.

Trump proposes defunding National Academies

On July 19, President Donald Trump posted on Truth Social ordering officials to consider suspending or debarring the National Academies of Science, Engineering, and Medicine from federal funding, the latest in a string of criticism

from Republican leaders targeting NASEM's work on climate-related science.

Trump's post came days after NASEM released a report on extreme event attribution science, a relatively new area of science that assesses the extent to which climate change influences an individual weather or climate event. The committee that put together the report has experienced intense scrutiny, as have other areas of NASEM's work related to climate science.

Republicans on the House Science Committee are pressing NASEM to provide information on the attribution committee that NASEM has said is confidential. They argued in a July 15 letter that oversight of NASEM is a matter of national security because NASEM is "one of the most trusted and respected providers" of science that agencies rely upon. They expressed interest in legislative reforms "with respect to the Academies as a whole."

Trump's Truth Social post took aim at the climate science chapter in the Reference Manual on Scientific Evidence, the main scientific resource for federal judges, which is co-authored by NASEM and the Federal Judicial Center. Separately, the chair of the House Oversight and Government Reform Committee criticized NASEM last year for its decision to study whether current evidence supports the since-rescinded endangerment finding.

House Science Committee Ranking Member Zoe Lofgren (D-CA) issued a statement on July 16 saying climate skeptics, "MAGA Republicans," and the president "have spent weeks building an opposition campaign against this very report because they feared what it would say." She accused them of protecting "big polluters at the expense of their own constituents."

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Jack Stillman continued from page 5

Stillman says. "My advisor recommended that I apply for a travel grant from APS." He applied — and received it.

"I'll never forget flying into Colorado, the endless parallel streets," he says. "I'd never been east of California."

Highlights from the meeting include NASA's exhibitor booth and a visit to the National Institute of Standards and Technology (NIST). He recalls the tungsten cube that NASA staff let him hold. "It was a model of a gold cube that's actually in a satellite, the laser interferometer space antenna" — an experiment designed to better understand gravity.

The cube "was so dense that it felt like it had its own gravity. I'll never forget that," he says. "Small experiences like that really matter."

But the highlight was his visit to NIST in Boulder, where Stillman was able to get up close and personal with the lab's atomic clock. "My dad is a clock and watch repairman," he says. "I'm a clock guy's son, and I got to see the most accurate clock in the world."

In 2019, after college, Stillman set his sights on an applied physics master's degree from the University of Oregon, but COVID disrupted the program. Instead, he began tutoring students via Zoom from home in Humboldt. Before long, a local school in need of a long-term physics substitute quickly learned of Stillman's background and offered him a position.

He's now in his fourth year as a high school educator, fully credentialed in math and physics. "It sounds like next year I'll be teaching the physics class, a couple of math classes, and hopefully an electronics elective," he says.

Although he isn't active in research at the moment, he still keeps up with APS activities. "I love the periodicals," like *APS News*, he says. "I put the magazines out for my students ... [it's important] for students to have exposure to the physics world."

Soon to finish a master's degree in education, Stillman is once more thinking about pursuing graduate school for physics. He thinks attending more APS meetings in the future could help him explore his options. Plus, he says, "getting back into the science community would feel much more daunting without the years of continued direct contact from APS."

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

THE BACK PAGE

The White House's damaging proposal on grants received tens of thousands of public comments. Read six of them.

The proposal would dramatically undermine American research, but scientists are speaking up.

Foreword from the *APS News* editor

On May 29, 2026, the White House Office of Management and Budget (OMB) released a proposed rule that would dramatically change how federal grants are dispersed and how science is conducted in the United States.

Titled "Regulation for Federal Financial Assistance," the rule would give political appointees the power to override peer review and terminate active grants at any time. It would impose sweeping restrictions on international collaborations, cutting U.S. scientists off from partnerships with researchers in many countries. It would make conference attendance much more difficult, and publication costs largely unallowable, under federal awards. It would undermine programs that broaden participation in science and support the next generation of researchers.

Together, these changes would insert political control deep into the federal research enterprise, undermining the independence and rigor that have made America a global leader in science.

Despite the rule's sweeping scope, the White House allowed only a 45-day window for public comment. Scientists responded in force: More than 150,000 comments have been posted to the federal docket.

APS partnered with more than 30 organizations to mobilize the scientific community in opposition to the White House's proposal. APS members and non-members alike were able to submit public comments by July 13, either signed or anonymous, to the federal docket through APS' user-friendly portal. More than 4,700 comments were submitted.

The excerpts below — from just a handful of the public comments submitted by APS members and scientists from across the country — reveal what is at stake.

— Taryn MacKinney

Tamara Rivera.

John Mather.

Deirdre Shoemaker.

David Ballentyne.

Mel Sabella.

Iain Stewart.

Rivera: "Fewer talented students ... would have pathways into research careers."

"I participate in STEM outreach, mentoring, and educational programs that help students learn about science careers and research opportunities. If these efforts were halted, students would lose valuable opportunities for scientific engagement, mentorship, and career development, weakening efforts to build a skilled and diverse future STEM workforce.

As a post-baccalaureate researcher at Yale University, I was supported by the National Science Foundation Research Experiences for Recent Graduates (NSF-REP) program. The purpose of this program was to provide research opportunities, mentorship, and professional development for recent graduates preparing for careers in science. As a first-generation, low-income student, this support was instrumental in helping me gain advanced research experience and successfully transition into a Ph.D. program. A grant like this could be vulnerable if programs designed to broaden participation in STEM or support workforce development were viewed as inconsistent with changing political priorities. Had this funding not existed, I would have lost access to research training, mentorship, and career development opportunities that were critical to my advancement as a scientist.

The broader consequence of terminating programs like NSF-REP is that fewer talented students, particularly those from historically underrepresented or economically disadvantaged backgrounds, would have pathways into research careers. This would weaken the future scientific workforce and reduce opportunities for individuals who have the potential to make significant contributions to science but may lack access to traditional research networks and resources."

Tamara Rivera, fourth-year Ph.D. candidate in marine science at the University of Texas Marine Science Institute

Mather, Nobel laureate: "Historically, peer review protects the public from attempts to corrupt."

If political appointees can override peer review, my Nobel-winning work measuring the Big Bang could easily have been rejected, since some ideologies and religions say we don't need that information. When the Nobel was announced, a political appointee at my agency indeed said the Big Bang was only a theory. Historically, peer review protects the public from attempts to corrupt the selection through back-channel influence or overt bribery. If political appointees can choose incompetent teams that support the political party in power at the moment, then taxpayer funds are wasted and the products are not obtained.

If my work can be terminated for political reasons, then loyalty to the political party in power at the moment is more important than the work I was chosen to do. That's not a good way to get results. It's a way to corrupt the entire system of science, which is ideally the self-correcting search for truth.

John Mather, senior astrophysicist at NASA Goddard Space Flight Center

Shoemaker: "Collaborations strengthen — not diminish — American scientific leadership."

"I am concerned about provisions that could discourage or complicate responsible international scientific collaboration. My own research depends on partnerships among U.S. universities and international collaborators. As a member of NASA's Laser Interferometer Space Antenna (LISA) Science Team, I help develop the U.S. scientific program for LISA, an ambitious international mission in which NASA and ESA each contribute unique capabilities toward a common scientific goal. This partnership enables the United States to participate in a groundbreaking observatory that no single nation could realistically undertake alone while maintaining appropriate oversight, security, and accountability.

Likewise, the historic first detection of gravitational waves and the emergence of multi-messenger astronomy were possible only through sustained international cooperation. These collaborations strengthen — not diminish — American scientific leadership by allowing U.S. researchers to lead major discoveries, train the next generation of scientists, and maximize the scientific return on federal investments. Policies that unnecessarily impede responsible international collaboration would reduce the competitiveness of U.S. research and diminish our ability to attract and retain the world's best scientific talent.

The technology we develop to lead in space-based gravitational wave astronomy will change the U.S.'s future. Don't let us lose our powerful edge out of fear."

Deirdre Shoemaker, physics professor at the University of Texas at Austin

Ballantyne: "One of the main research areas in my own career started from seeing a talk at a conference."

"Attending conferences is crucial for scientists to exchange ideas and teach each other about the latest findings in a research area. Many of the most important breakthroughs in physics were catalyzed at conferences where scientists could gather and discuss research questions.

One of the main research areas in my own career started from seeing a talk at a conference and then meeting the speaker afterwards. That conversation started a collaboration and research direction that continues to that day. Without the flexibility to attend several conferences, that conversation would never have happened which may ultimately have led to me having to abandon my career.

Simply speaking, scientific advances in the U.S. will halt if scientists are unable to publish or be able to access the scientific literature. Scientific knowledge has been disseminated by publications for centuries, and is the fundamental 'deliverable' for scientists. New research and discoveries can only be done by building on the knowledge of the scientific community.

I have published eight papers in academic journals in the last year. Two of those papers were led by young Ph.D. students publishing their first papers. These papers are crucial for the students to complete their degrees and enter the workforce. The Ph.D. students also help teach undergraduate classes. Shrinking scientific research by not providing support for publication costs will cause colleges to cut costs by reducing undergraduate enrollment and/or raising tuition.

Eliminating support for publication costs and conference attendance will significantly reduce the scientific enterprise in the country, forcing scientists to move to other countries in order to continue their work."

David Ballantyne, physics professor and associate chair for academic programs, Georgia Institute of Technology

Sabella: "Intellectual merit is a cornerstone of review."

"I am deeply concerned about the ability to override peer reviews by political appointees with little understanding of my area of research, and the possibility of circumventing the hard, rigorous work of peers who spend a great deal of time conducting these reviews. Having been a peer reviewer in the past, I know the amount of time it takes for this work. Intellectual merit is a cornerstone of review — the decision should not be left to political appointees without expertise.

The amount of resources and investment PIs dedicate to these projects is significant, and timelines are in place to accomplish the substantial work. The work will certainly suffer if there is the threat of termination at any time due to the whims of political appointees for any reason. Termination, and even the threat of termination, will limit scientific discovery and project outcomes. This is not the way contract work is done. Contracts and timelines need to be honored if the project proposal is being followed."

Mel Sabella, physics professor at Chicago State University

Stewart: "Cutting off U.S. scientists from those around the world will limit the information we have access to, and thus the science we can do."

"I am involved in scientific collaborations with people who are currently professors or senior researchers in Austria, Spain, Germany, the Netherlands, Switzerland, and Korea. In the past I have collaborated with scientists in China and Canada. These collaborations have led to publications in top journals and major advances in the field.

Science is a worldwide enterprise. Cutting off U.S. scientists from those around the world will limit the information we have access to, and thus the science we can do, putting us at a disadvantage to those in other countries. This exact approach led to a decline in science in Russia, in particular, with a large migration of scientists after the end of the Cold War. Many international collaborations involve multi-billion dollar construction projects, including particle accelerators and satellites for astronomy. These are necessarily funded by many countries and require international engagement of U.S. scientists who would otherwise be left out of new discoveries.

Bans on collaboration and travel to 'covered foreign countries' such as China, would ensure that U.S. scientists lose access to international research advances that may be critical for the future. In particular, as research has become more international, conferences are often hosted in different countries each year, and cutting off U.S. scientists from participation for conferences in China would be detrimental.

Rules that limit U.S. scientists from keeping up with the strongest science in the field by engaging with researchers from around the world, will weaken the U.S. enterprise and economy."

Iain Stewart, physics professor at the Massachusetts Institute of Technology.

These individuals' comments are their own. They do not speak on behalf of their institutions, and their positions do not necessarily reflect those of their institutions or APS.