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APS NEWS

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HONORS

2021 Nobel Prize in Physics Awarded for Research in Complex Systems

The Royal Swedish Academy of Sciences has announced the recipients of the 2021 Nobel Prize in Physics, which has been awarded for ground-breaking models of the hidden rules that govern complex systems, including predictions of human impact on Earth's climate. The recipients are: Syukuro Manabe (Princeton University), Klaus Hasselmann (Max Planck Institute for Meteorology), and Giorgio Parisi (Sapienza University of Rome).

One half of the Nobel Prize in Physics is awarded jointly to Manabe, a Japanese American climatologist, and Hasselmann, a German oceanographer, "for the physical modelling of Earth's climate, quantifying variability and reliably predicting global warming." The other half is awarded to Parisi, an Italian theoretical physicist, "for the discovery of the interplay of disorder and fluctuations in physical systems from atomic to planetary scales." Together, their work uses simple theories to explain how random, disordered, and complex phenomena arise and change over time.

"This prize in physics reflects the deep connections of our field to delving into mysteries that shroud the laws that determine the environment of our home, planet Earth," said APS President S. James Gates, Jr. "The citation of the award clearly shows our discipline's efforts to establish deep scientific knowledge behind such challenges as global climate change, pollution, and similar processes in complex systems. For with such knowledge, science and physics once more

2021 Physics Nobel Laureates. Pictured from left to right: Syukuro Manabe, Klaus Hasselmann, and Giorgio Parisi CREDIT: © NIKLAS ELMEHED, NOBEL MEDIA

NOBEL CONTINUED ON PAGE 6

JOURNALS

Physical Review X Celebrates 10 Years of High-Quality, Open Access Publishing

Open access journal articles now account for at least 30 percent of all research papers. This growth has been driven in part by multi-disciplinary "mega-journals," which collectively publish more than 50,000 articles per year. Their high volume and low selectivity approach serves some needs of some researchers at some moments, but such titles are not suitable in many cases.

"More and more researchers appreciate the value of open access publications, but people are really drowning in information and wanted something that would select what was most relevant and important," says Jorge Pullin, a theoretical physicist at Louisiana State University, who set out to create a multidisciplinary physics journal to meet those needs and became the first lead editor of PRX.

In 2011, APS launched *Physical Review X* (PRX) with a goal to publish high-quality research in all areas of pure, applied, and interdisciplinary physics. Over the past 10 years, PRX has gained a reverberant reputation as a highly selective, open access journal that exemplifies APS's tradition of publishing high-impact science and serving the needs of the broad and diverse community that cuts across physics as well as related disciplines.

"PRX currently publishes about 250 papers per year, covering all areas of physics. This is a very small number to select, but sets the highest standard of what's important and what's impactful

PRX CONTINUED ON PAGE 7

ETHICS

Confronting Inappropriate Behavior and Harassment in Physics

BY SUSAN BLESSING

This month's Back Page article is horrifying. For most of us, it is easy to say "that doesn't happen here" because the author hasn't named people, places, or her field. However, it could be happening at your institution, or mine.

Tales of not being able to go to HR and of not being heard by supervisors are all too common—these are difficult issues to deal with, and people shy away from confronting others about their inappropriate behavior, even when they are witnesses.

People also shy away from "making a fuss" about unacceptable behavior directed at them and frequently remove themselves from the situation—which could mean leaving graduate school or the work that they love. But losing valuable talent isn't the way we should think about this; the bigger issue is the human one: How we treat others is a direct reflection on us, as individuals, as mentors and supervisors, as representatives of our organizations, and as representatives of physics. It shouldn't be difficult to control ourselves and treat people with the respect they deserve. We should not excuse behavior because of rank within

Susan Blessing

ETHICS CONTINUED ON PAGE 3

GOVERNMENT AFFAIRS

Congressional Fellow Uses Scientific Expertise to Move Legislation Forward

BY TAWANDA W. JOHNSON

Following his recent APS Congressional Science Fellowship, David Somers reflected on how he used his scientific expertise to help move bills forward within the legislative process.

"My fellowship was exciting, and I view the work I did as laying a foundation for legislation that would make a positive impact on society," said Somers, who earned his PhD in physics from the University of Maryland at College Park.

As a fellow in the office of US Senator Chris Coons (D-DE) during the past year, Somers drafted language and secured support for the Industrial Finance Corporation Act.

The act would establish the Industrial Finance Corporation of the United States and use a one-time appropriation from Congress to finance investments in high-tech manufacturing to promote innovation and create jobs through domestic production. In addition to Sen. Coons, the bill was sponsored by US Sens. Amy Klobuchar (D-MN); Chris Van Hollen (D-MD); Raphael Warnock (D-GA); Gary Peters (D-MI); Michael Bennet (D-CO); and Mark Warner (D-VA).

"There are a lot of great innovations that flow from our research and development ecosystem, but many hit that valley of death. That means it's difficult to translate a viable product into a viable company with meaningful sales. The Industrial Finance Corporation Act would help address that problem by providing financing to scale up manufacturing of products that benefit our economy and support our industrial priorities," said Somers, who added that the APS Congressional Science Fellowship enabled him to work on projects he found "extremely interesting."

Sponsored by APS under the umbrella of the American Association for the Advancement of Science (AAAS) Science & Technology Fellowships, the aim of the Congressional Science Fellowships is to provide a public service by making available individuals with scientific knowledge and skills to members of Congress, few of whom have technical backgrounds. In turn, the program enables scientists to broaden their experience through direct involvement with the policymaking process.

Fellowships are for one year, typically running from September to August. Following a two-week orientation in Washington, DC, sponsored by AAAS, incoming fellows become acquainted with their new work environment. After interviews on Capitol Hill, fellows choose a congressional office where they would like to serve.

David Somers

In addition to the Industrial Finance Corporation Act, Somers used his scientific background to help move forward the bipartisan National Manufacturing Guard Act of 2021. The bipartisan legislation would invest \$1 billion over five years in the ability of the US government to respond to future supply chain emergencies. Besides Sen. Coons, the bill is sponsored by US Sens. Marco Rubio (R-FL); Maggie Hassan (D-NH); and John Cornyn (R-TX). An identical bill has been introduced in the House.

"My role was to build out details of the proposal and continue to 'beat the drum' about the impact that this bill would have in strengthening the US supply chain that has been strained during the coronavirus pandemic," said Somers.

FELLOW CONTINUED ON PAGE 4

MEETINGS

Muon Colliders Hold a Key to Unraveling New Physics

BY SOPHIA CHEN

As the discovery of the Higgs boson approaches its 10-year anniversary, physicists are busy building on its legacy. Although it was a tour de force, the experimental confirmation left many mysteries still unsolved. To find a way forward, physicists gathered virtually for a symposium at the 2021 APS April Meeting to discuss the potential for a muon collider—an ambitious new machine that could help answer many questions.

The symposium featured both a US perspective and a European one. The current flurry of activity has arisen from two formal processes in each respective region by which the particle physics community sets its priorities for the next decade. In the US, the process is known as Snowmass, named for the former location of the gathering, and organized by the APS Division of Particles and Fields. In Europe, the process is known as the European Strategy for Particle Physics.

Many researchers are excited about the machine's potential for new physics. "The muons are calling, and we must go," said Nathaniel Craig of the University of California, Santa Barbara, whose talk opened the symposium.

Possible New Physics

Craig explained how a muon collider is a good probe of electroweak symmetry—how the electromagnetic and weak forces are the same force at short distances, a bedrock of the Standard Model. At larger distances, the Higgs boson breaks the symmetry, but researchers still don't know how. "Does the symmetry break in the way that the Standard Model predicted, or in a more complicated way?" Craig asks. For example, the muon collider could investigate whether multiple Higgs bosons exist to break the symmetry, beyond the one discovered in 2012.

The muon collider could also probe the nature of dark matter. One method would be to precisely compare the energy of the Higgs boson to its decay products, says Isobel Ojalvo of Princeton University. If energy is missing, it could correspond to dark matter.

Another big question is why particles come in different varieties known as flavors. The muon itself is a flavor of charged lepton, a category that also includes electrons. Generally speaking, using a different flavor of elementary particle in collisions could reveal something new about the categories, says Craig.

But first, the community needs to agree on the machine's specifications. Broadly, the vision for the machine is a ring-shaped facility that is much more compact than proposed proton colliders for studying comparable physics. Researchers have estimated that a muon collider requires only a 10-kilometer circumference to study the same energy regime as a 100-kilometer proton collider, such as the proposed Future Circular Collider at CERN. In addition, a muon collider would only require 10 to 20 TeV to achieve elementary particle collisions comparable to a 100-kilometer proton collider at 100 TeV.

Another possibility is to build a "Higgs factory"—an electron-positron collider for precisely characterizing those particles—concurrently with a lower-energy muon collider in two different locations. The technology for the muon collider isn't out of reach, according to Ojalvo. "If the US community decided that this was important, we could build a 1 to 5 TeV muon collider on a 10 to 15-year timeline," she says.

However, a muon collider could also serve the role of a Higgs factory. The muon beam is surrounded by virtual particles such as W and Z bosons, which collide to form Higgs bosons at a high rate, says Craig. These processes are also predicted to produce "beyond the standard model" particles. Although not as "clean" as an electron-positron collision, compared to a proton collider muon collisions produce Higgs bosons in a relatively clean environment, which allows for the reconstruction of the collisions to measure Higgs properties.

A muon collider also offers an advantage over ring-shaped electron-positron colliders such as the proposed FCC-ee at CERN. Electrons and positrons that travel in a curved path lose a lot of energy because they emit so-called synchrotron radiation. Muons, which are approximately 200 times heavier than an electron, would produce synchrotron radiation at a rate of

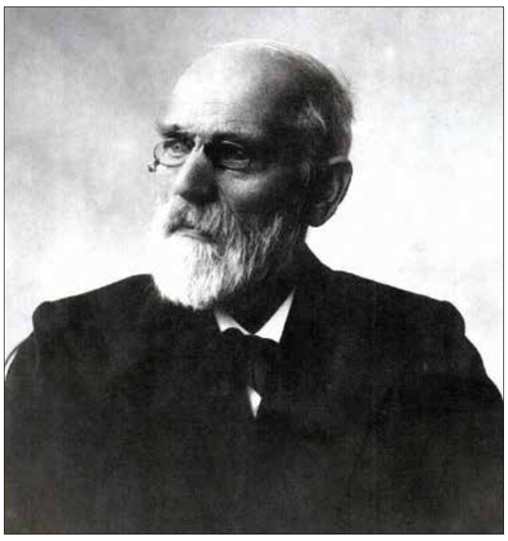
MUON CONTINUED ON PAGE 7

THIS MONTH IN

Physics History

November 23, 1837: Birth of Johannes van der Waals, a Self-Made Man and the Father of Modern Molecular Science

BY ABIGAIL DOVE



Johannes Diderik van der Waals CREDIT: WIKICOMMONS

At the start of his *Lectures in Physics*, Richard Feynman famously asked what single piece of scientific knowledge the human race should preserve for posterity. His answer was that all matter is composed of atoms. While this may seem obvious—in fact, the notion of atoms dates back to the ancient Greeks—the existence of atoms was a hotly contested issue until well into the twentieth century. Providing forceful and convincing evidence for a molecular view of the world was Johannes Diderik van der Waals, a Dutch school teacher whose knowledge of physics was largely self-taught, but who would go on to become the father of modern molecular science.

The future Nobel laureate was born on November 23, 1837 in Leiden, the Netherlands as the first of ten children in a carpenter's family of extremely modest means. At the time, girls and working-class boys did not have access to a rigorous secondary education. As such, van der Waals' early education consisted only of reading, writing, and basic arithmetic, with little to no exposure to the natural sciences.

Van der Waals left school at the age of 14 to work as a primary school teacher, eventually becoming the director of a primary school by age 24. Hungry for more knowledge, he attended lectures in mathematics, physics, and astronomy at the local Leiden University in his spare time but was repeatedly denied enrollment as a full-time student given entrance requirements that mandated knowledge of Latin. Following sweeping educational reforms that expanded the Dutch secondary education system, van der Waals dedicated himself to the goal of becoming a secondary school teacher, ultimately working as a physics teacher for over a decade.

Van der Waals' world opened when a further change in Dutch education policy lifted the Latin requirement for university admission. Van der Waals quickly passed the qualification exams in physics and mathematics and began doctoral studies at Leiden University. By 1873, at the age of 36, he finally obtained his doctoral degree.

Van der Waals' thesis, "On the Continuity of the Gas and Liquid State," established the foundations of modern thermodynamics and would eventually lead to the 1910 Nobel Prize in Physics. In it, he proposed a unified model to describe the properties of both gases and liquids in what would become known as van der Waals equation: $(P + a/V^2)(V - b) = RT$, where *P*, *V*, and *T* are the pressure, volume, and temperature of a substance and *a* and *b* are constants.

The significance of van der Waal's work lies in adapting the Ideal Gas Law (PV = nRT) to accommodate molecules and intermolecular forces—an insight that was even more visionary given that the very existence of molecules was a hotly contested issue at the time, let alone the idea of atoms interacting and exerting force on one another. In his honor, the weak attractive forces that have since been demonstrated to act between molecules are now termed van der Waals forces.

"There can be no doubt that the name of van der Waals will soon be among the foremost in molecular science," noted James Clerk Maxwell, a giant in the thermodynamics field, in a prescient review of van der Waal's thesis in *Nature*. Despite this early praise, recognition of van der Waal's achievement came slowly, largely because the work was first published only in Dutch. It took until 1877, when van der Waal's findings were summarized in the widely read German language journal *Annalen der Physik*, for the physics community to fully grasp the revolutionary nature of this work, triggering a flurry of research activity on the molecular physics of liquids and gases.

With this wider recognition, van der Waals left his posting as a physics teacher to accept the first professorship in physics at the newly founded University of Amsterdam. After being excluded from the world of academia for so long, van der Waals—along with close colleagues Henry van't Hoff (the eventual winner of the first Nobel Prize in Chemistry) and Hugo de Vries (a pioneering geneticist)—would eventually lead the new university to prominence during an unfolding golden age of Dutch science.

HISTORY CONTINUED ON PAGE 5

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Staff Science Writer .... Leah Poffenberger
Contributing Correspondents .... Sophia Chen and Alaina G. Levine
Design and Production .... Leanne Poteet

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ETHICS CONTINUED FROM PAGE 1

the community, research output, grant-getting, or accolades.

On April 10, 2019, APS Council adopted APS Statement 19.1 - Guidelines on Ethics, and Section III directly addresses APS's stance on harassment, treatment of subordinates, and code of conduct for meetings. I hope that it is not necessary to say that nothing described in this month's Back Page is acceptable behavior. APS has increased its focus on ethics, especially on ethical behavior since everyone understands that falsification of data and plagiarism are wrong. We should already be in a place where behavior that resembles anything like that described in the Back Page article is considered at least as wrong.

Do your part to make us better. Familiarize yourself with the APS Guidelines on Ethics; the work of the APS Ethics Committee, which includes training materials; and the many resources available from the Committee on the Status of Women in Physics and the Committee on Minorities.

Physics is done by people and the people are the most important part. We should all behave that way.

The author is a member of the Ethics Committee, appointed to represent the Committee on the Status of Women in Physics.

PROFILES IN VERSATILITY

Carolyn "Cam" Brinkworth Seeks Out New Ways to Build an Inclusive Science Atmosphere

BY ALAINA G. LEVINE

Growing up, Carolyn "Cam" Brinkworth wanted to be part of something bigger than herself. Inspired by a love of both data and Data of *Star Trek: The Next Generation*, Brinkworth saw science as a crucial mechanism to advance humanity. "The value of service to a greater good was something that really spoke to me," Brinkworth says. "Working for NASA one day was the most amazing example I could imagine of that kind of work." With that goal in mind, Brinkworth grew up, studied physics in school, and got her PhD. At the brink of achieving traditional success as a scientist, she realized there was something missing in the scientific ecosystem: in the relentless pursuit of discovery some of the greatest minds were being ignored. So she changed course, and made it her continuing mission to make science inclusive for all.

Brinkworth is the Chief Diversity, Equity, and Inclusion (DEI) Officer at the University Corporation for Atmospheric Research (UCAR) in Boulder, where she strives to cultivate an ecosystem that celebrates each person's worth and individual voice. A native of the UK, she received her undergrad degree in physics and astrophysics from the University of Leicester and, at first, intended to be a physics teacher. But "I didn't feel like I was done learning," she says, and at the last minute, she decided to go to grad school. She matriculated at the University of Southampton and began assisting her advisor in commissioning a new high-speed camera designed to measure evolution rates in binary stars.

"I thought this was the coolest thing ever," she says. By her second year, she saw an advertisement for a 6-month internship position with the Spitzer Space Telescope at Caltech and the Jet Propulsion Laboratory (JPL) and decided to try for it. Brinkworth landed the fellowship and made the trip across the pond. "It was a breath of fresh air," she says. "Spitzer had just launched, and everyone was buzzing with hopefulness and excitement about what Spitzer was going to do." Her PI offered her a postdoc even before she finished her PhD, "which made my defense slightly less nerve-wracking," she jokes.

Brinkworth enjoyed the work, but there was something missing. "My postdoc was successful, I got grants. I knew I was good at it, but not the best at it. I always felt I wasn't contributing anything unique, that anyone else could have looked at my data and written the paper," she says.

There was something gnawing at her spirit. "[My work] felt removed from people," she says. "It felt very narrow, with not a lot of impact on human beings, and that nothing I could discover here could make a difference in human lives." Brinkworth had always been drawn to outreach and had been active in public engagement and in leadership roles throughout graduate school and in her postdoc, too. Suddenly, she realized: "The only thing that prevented me from doing more outreach was the research."

This was a dramatic moment for her. It crystalized that her talents, curiosity, and spark were better served by positively impacting others. As her postdoc concluded, she remained at Caltech, taking a job as a staff scientist with the Infrared Processing and Analytics Center (IPAC). A year later she formally joined the education and outreach team, later transitioning to a role as the Education and Outreach Scientist for Spitzer.

"This was a dream job," she says. "The creativity, to work with a creative team all of whom cared about the science we were doing and helping people understand it." Brinkworth worked on various aspects of public affairs, such as writing scripts for education videos, interfacing between the press officer and scientists, and organizing public events. The whole team had free range to be creative with their outreach projects, from arranging for a fire station basement to be filled with smoke so they could demonstrate how an IR camera worked, to creating videos with celebrities like Neil Patrick Harris and Cameron Diaz. Brinkworth gained new skills, and she felt supported in a way she had not experienced before. "The director built a team based on trust and psychological safety—everything brought to the team by any member was considered," she says. "I felt such a safe space to explore, and I was blown away by this team. He taught me how to be a good manager."

> "I'm fascinated by the people in science and how I can help make science better for all of us."

In this nurturing environment, Brinkworth blossomed. In her nine years here, she took on a variety of projects and eventually was named Deputy Lead of Public Affairs for IPAC. But still, she wondered—what's it all for? In the mid-2010s, a "perfect storm" of cascading events propelled her in a new direction.

In 2008, Proposition 8, a bill supporting a ban on gay marriage in the California state constitution, was passed. Although later overturned in court, it shook Brinkworth. "I'm gay, and I started to see with Prop 8 a lot of political football being played with gay kids and the rise in suicide of LGBT youth," she says. It prompted her to get involved in the Trevor Project, a non-profit that supports LGBTQ+ kids. She gave workshops at schools on suicide prevention and LGBTQ+ issues. "This was my first experience as an activist."

At the same time, Brinkworth craved additional scholarship and a credible qualification in education.

Carolyn "Cam" Brinkworth

While working for Caltech, she went back to grad school for a master's in education with a focus on building safer spaces for LGBT+ people in STEM departments. "I took classes at Claremont Graduate University on social and racial justice, and I got more and more angry," she says.

Emboldened to take action, in 2014, she landed a newly-created position as the Director of Diversity, Education & Outreach at the National Center for Atmospheric Research (NCAR). She and her team launched extensive training programs for the organization on gender and gender identity, bystander intervention, racism, unconscious bias, and other topics. "We felt that we skimmed this subject, so then we created another course on race and racism, including the history of NCAR and how it fits in with the system," she says. With these initiatives, "we saw significant improvements in awareness and bystander interventions," she says.

In 2017, Brinkworth was promoted to Chief Diversity, Equity & Inclusion Officer at UCAR, the parent organization of NCAR. The new role meant more responsibility and more potential impact. She's especially proud of her involvement in Rising Voices, a program at UCAR-NCAR that facilitates conversations between indigenous and non-indigenous communities especially in terms of climate and weather-related topics. The efforts culminated this year in an exciting collaboration with Haskell Indian Nations University, a major tribal college in Kansas.

Brinkworth is just getting started. She is concentrating on improving demographics, ensuring workplace inclusivity, decreasing racism and sexism in science, and designing metrics to collect and mine data to improve more. The job has revealed to her how much impact she can have as an advocate for science and, more importantly, the citizens of science. "I went into science because I thought it was cool and I was fascinated to learn how the universe worked, but what I really found is that I'm fascinated by the people in science and how I can help make science better for all of us," she says. "I think I always wanted to have impact. I have people email me years later and say, 'you don't remember me but here's the impact you had.'...it's humbling and gratifying and makes the hard days worth it."

Adds Brinkworth: "The mission of NCAR is literally to save the

BRINKWORTH CONTINUED ON PAGE 5

FELLOW CONTINUED FROM PAGE 1

The same could be said for his involvement in the FORWARD (Furthering Our Recovery With American Research and Development) Act—bipartisan legislation that would expand tax support for American companies that invest in research and development (R&D) of new products and technologies. The Senate bill is sponsored by Coons as well as US Sens. Steve Daines (R-MT); Catherine Cortez Masto (D-NV); Todd Young (R-IN); and Maggie Hassan (D-NH). Additionally, a companion bill has been introduced in the House.

"This bill would improve access to an expanded R&D tax credit," he said. The R&D tax credit enables businesses to reduce their tax liabilities if they invest in research and development.

Somers remarked that his Capitol Hill experience is serving him well in his career journey, which now involves working as a project leader with the Boston Consulting Group.

"Learning the intricacies of the legislative process and working with a diverse array of stakeholders will certainly be beneficial in my new role," he said.

Mark Elsesser, Director of Government Affairs, said he was not surprised to hear that Somers made a positive impact during his fellowship year.

"There are many skills that STEM students develop during the course of their PhD that set them up for success on Capitol Hill. APS's congressional science fellows use their technical background, analytic ability and communication skills to help inform policy decisions," he said.

Added Francis Slakey, Chief Government Affairs Officer, "The APS Congressional Science Fellowship is a crucial program for the Society, and we are examining ways to make it even more impactful through the creation of a more diverse pool of candidates."

To learn more about the APS Congressional Science Fellowship, visit the website: aps.org/policy/fellowships/congressional.cfm

The author is APS Senior Public Relations Manager.

INDUSTRIAL

Carlos Gutierrez Shares What it's Like to be an Energy Researcher at a National Laboratory

Physicists who work in the energy sector address a wide range of challenging issues—from developing novel ways to store energy on the grid to researching renewable sources to replace fossil fuels. Dan Pisano, Director of Industrial Engagement, spoke with physicist Carlos Gutierrez, R&D Manager in the Nanoscale Sciences Department at Sandia National Laboratory, about his career in the energy field.

Pisano: What inspired you to become an energy researcher?

Gutierrez: Energy R&D caught my attention when I was in middle school in 1973, when the OPEC (Organization of the Petroleum Exporting Countries) oil embargo led to fuel shortages and sky-high prices throughout much of the decade, impacting the world economy and national security. Solutions required the development of new materials and materials science understanding for energy conservation and production. Additionally, materials and nuclear physics seemed to be a critical aspect of this interdisciplinary inquiry.

What is a typical work day like for you?

My day usually involves responsibilities for the activities in 20 research labs with diverse materials science activities, setting the overall research direction for my department. I am responsible for making sure that work is done safely and observing lab activities, so part of my day is spent in my department's labs. I help teams procure new R&D equipment and get updates on more than 60 department research projects to ensure that adequate progress is being made and to facilitate the solutions to obstacles. I represent team R&D activities as needed in internal/external meetings, review internal and external R&D proposals, and engage in R&D strategy planning for the department.

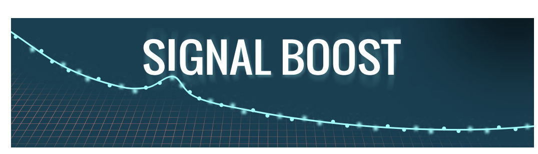
As a national lab employee, do you interact with academia and commercial entities that work on energy production, distribution, and storage?

Yes, Sandia National Labs (like many other Department of Energy Labs) is encouraged to partner with academia and industry in these areas. We have expertise and resources that complement those at universities and industries targeting problems of national and world importance. Since we cannot compete with industry, we are engaged as "honest brokers" who help provide honest and unbiased technical appraisals of R&D solutions that help improve the result at the end. We have non-disclosure mechanisms that enable fruitful trustworthy collaborations. Our scientists can even take a leave of absence to pursue an idea in industry, and return later if desired to tackle a new problem.

Carlos Gutierrez

How has APS supported the dissemination of your work?

The APS March Meeting is very important, especially relevant focused sessions and invited sessions organized by GERA (Topical Group on Energy Research and Applications), FIAP (Forum on Industrial and Applied Physics) etc. I think that *PRX Energy* is a promising new dissemination forum for the community.



Signal Boost is a monthly email video newsletter alerting APS members to policy issues and identifying opportunities to get involved. Past issues are available at go.aps.org/2nr298D. **Join Our Mailing List: visit the sign-up page at go.aps.org/2nqGtJP.**

FYI: SCIENCE POLICY NEWS FROM AIP

Biden Fills Out President's Council of Advisors on Science and Technology

BY MITCH AMBROSE

President Biden named the membership of the President's Council of Advisors on Science and Technology (PCAST) earlier this fall, with significant representation from the physical and biomedical sciences and in areas such as climate, energy, and information technology. Many of the members are leaders in the scientific community and industry, and several have held high-ranking positions in national laboratories or previous Democratic administrations

PCAST is reconstituted under every new president and consists of experts from outside the administration. Earlier in the year, Biden appointed Caltech bioengineer and Nobel Prize-winner Frances Arnold and MIT planetary geophysicist Maria Zuber as the co-chairs of his council, and Presidential Science Advisor Eric Lander serves ex officio as a third co-chair.

Among the new members is former Defense Secretary Ash Carter, who trained as a physicist and oversaw the beginnings of the Pentagon's push to accelerate the development and deployment of new defense technologies. Among the other Obama-era officials on the council include former astronaut and National Oceanic and Atmospheric Administration head Kathy Sullivan, former Commerce Secretary Penny Pritzker, and former Agriculture Department Chief Scientist Cathie Woteki.

Other physicists on the council include National High Magnetic Field Lab Chief Scientist Laura Greene, an expert in quantum materials and the 2017 APS President, and Saul Perlmutter, an astrophysicist at Lawrence Berkeley National Lab and UC Berkeley. Perlmutter won a share of the 2011 Nobel Prize in Physics for his work demonstrating the accelerating expansion of the universe.

In addition, University of Texas at Austin professor Bill Press is a physicist, though much of his current work is in computer science and computational biology. He previously served as vice chair of PCAST during the Obama administration, deputy director of Los Alamos National Lab, and chair of the JASON defense advisory panel.

Among the engineers on the council is Dan Arvizu, who directed the National Renewable Energy Lab from 2005 to 2015 and currently is chancellor of the New Mexico State University System. Others include Caltech aeronautical engineer John Dabiri, who specializes in wind energy and is currently chair of the APS Division of Fluid Dynamics; Texas A&M University nuclear engineer Mark Adams, an expert in nuclear security; John Banovetz, chief technology officer of the chemical engineering company 3M; Paula Hammond, head of MIT's chemical engineering department; and Andrea Goldsmith, dean of the engineering school at Princeton University.

Experts in climate change on the council include UC Berkeley carbon cycle scientist Inez Fung,

FYI CONTINUED ON PAGE 7

Next-Generation Fellowship Supports New Voices within Nuclear Weapons Policy Field

BY TAWANDA W. JOHNSON

To strengthen diversity and the inclusion of many viewpoints in the nuclear weapons policy field, the Physicists Coalition for Nuclear Threat Reduction launched its inaugural Next-Generation Fellowship this year.

The coalition is an initiative based at Princeton University's Program on Science and Global Security and supported by APS and the Carnegie Corporation. It seeks to educate and mobilize a national network of physical scientists interested in being informed advocates to policymakers and the public on the nuclear weapon threat and opportunities for its reduction.

The Next-Generation Fellowship strives to diversify and strengthen participation of graduate students, postdocs, and early-career physical scientists and engineers, especially women and members from underrepresented groups, in reducing the threat of nuclear weapons. The fellowship also provides its participants an opportunity to work with senior mentors on a guided study; learn from practitioners about how the nuclear policy process works; and get hands-on training and experience in how to engage as advocates on nuclear weapon policy issues with Congress.

Sebastien Philippe, associate research scholar at Princeton's Program on Science and Global Security who chaired the 2021 fellowship selection committee, said the committee had a hard time choosing the first cohort of fellows from a group of "strong and diverse applicants, including graduate students, post-docs and young faculty."

"Despite the logistical challenges of launching this initiative during the pandemic, we have been very pleased with the success of the 2021 cohort of fellows," he said.

The fellowship has been a valuable experience for Matt Caplan, nuclear astrophysicist and professor of physics at Illinois State University.

"My background is in science and education, so the emphasis that the fellowship places on policy has all been new to me. I think few young scientists have opportunities to peer into the workings of the federal government, and even fewer have been put in a position where they can directly advocate for new legislation," he said.

Caplan added, "Over the fellowship year, I've done a little bit of work on a number of topics, but I keep coming back to the humanitarian crisis that unfolds after a nuclear attack, and I am currently authoring an essay about the consequences of a limited nuclear strike on a modern city that is intended for publication in the Bulletin of the Atomic Scientists."

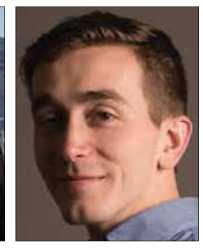
Katherine Quinn said the fellowship has been "a wonderful, eye-opening experience."

"I highly value the connections I've made with the other fellows and members of the coalition. Through our monthly fellowship meetings, I've learned from the projects of the other fellows, especially given the breadth of interests," said Quinn, a theoretical physicist working as an Associate Research Fellow at Princeton's Center for the Physics of Biological Function.

Matt Caplan

Bárbara Cruvinel Santiago

Katherine Quinn



Alan Kaptanoglu

"The coalition-sponsored training—a boot camp on nuclear policy, meeting with experts for small presentations and personalized conversations—have proven invaluable in my understanding not only of nuclear threat reduction, but policy and advocacy at the federal level," she adds.

Quinn is exploring the history of climate science and modeling nuclear war scenarios to understand the impact on national and international policy as part of her fellowship experience.

"I am also connecting modern advances in nuclear winter modeling to our current understanding of climate refugee migration to better understand the full impact of different global and regional nuclear conflicts, to bring the full consequences of nuclear war back to the public consciousness by placing it in modern contexts," she said.

Being a Next-Generation Fellow is exceeding the expectations of Bárbara Cruvinel Santiago, a physics PhD student at Columbia University.

"I came in with a budding interest in policy in general and not knowing much about nuclear security policy at all. Now, I feel like I went through a super steep learning curve, and I'm actively considering pursuing a career in science policy after I graduate with my PhD," she said.

Cruvinel Santiago is working on a project to analyze how Brazilian nuclear policy has evolved since the 1950s and why the country's nuclear policy took such a dramatic turn in the last few years.

"A good part of my project is focused on Brazil's role in the Treaty on the Prohibition of Nuclear Weapons (TPNW)—the first country to sign it. It also addresses how Brazil would benefit from finally ratifying it, which it never did after President Jair Bolsonaro and his allies took over the executive and legislative branch," explained Cruvinel Santiago.

Alan Kaptanoglu said his experience with the fellowship has been "very positive."

"The organizers and mentors are excited to have younger scientists engage on nuclear weapons issues, and the training resources, including our participation in the George Washington University Nuclear Bootcamp— a week of lectures from experts across every nuclear domain— have been very educational," said Kaptanoglu, a physics PhD student at the University of Washington.

Understanding how the military communicates its policy on nuclear deterrence is the theme of Kaptanoglu's fellowship project.

"In the public discourse on nuclear weapons, the voice of the defense establishment— the military, government, think-tanks, and industry—is large and influential," he said. "That voice is, in part, formed by the messaging from the defense leadership to the defense establishment itself. Unfortunately, much of the messaging is limited, so service members may not be exposed to the full range of views on US nuclear deterrence."

Zia Mian, a founder of the coalition who served on the fellowship's selection committee and as a mentor, said the experience is aimed at providing young scientists today the means for effectively participating in the long struggle against nuclear weapons in which earlier generations of scientists have played historic roles.

"Even before the United States became the first country to make weapons, scientists, especially physicists, were speaking up on the urgent need to confront and end the new threat to humankind," said Mian, Co-Director of Princeton's Program on Science and Global Security. "Today, with nine countries having nuclear weapons, and a renewed nuclear arms race getting underway that will cast a shadow over the rest of this century, physicists again need to ask what they can do to understand and reduce nuclear dangers."

Regarding the next cohort of fellows, Philippe explained, "We are looking for the next generation of physicists and leaders to advocate for a more secure and just world at a moment when renewed technological and nuclear arms racing between great powers is bringing us back to the nuclear brink. There is no better time for early-career scientists to take action and make a difference."

Mark Elsesser, Director of Government Affairs, said he was thrilled to have APS support the coalition's fellowship whose goals align with several of the Society's core values, including "diversity, inclusion, and respect."

"The Society was eager to publicize the opportunity to its members, and the Government Affairs team will continue to assist with the program through administrative support, providing the fellows advocacy training, and facilitating meetings between the fellows and Congress," he said.

The 2022 Next-Generation Fellowship application is now open, and the deadline for individuals to apply is November 30, 2021. Details can be found on the coalition's website: aps.org/policy/nuclear.

The author is APS Senior Public Relations Manager. Charlotte Selton, APS Special Projects Organizer, contributed to this article.

HISTORY CONTINUED FROM PAGE 2

Van der Waals' subsequent achievements included the Law of Corresponding States—a theory that served as the foundation for the liquification of hydrogen and helium and the ensuing discovery of superconductivity in 1911—an early theory of capillary action, and a theory of binary mixtures, which has had a lasting impact on chemical engineering and geochemistry. Van der Waals also anticipated the importance of cluster chemistry and physics, topics which have become active areas of research only within recent decades.

Despite these accomplishments, van der Waals was famously modest. This is perhaps most evident in the opening turn of his Nobel Prize lecture: "Now that I am privileged to appear before this distinguished gathering to speak of my theoretical studies on the nature of gases and liquids, I must overcome my diffidence to talk about myself and my own work."

Van der Waals was also deeply private about his personal life. Tragedy struck van der Waals' family in 1881 when his wife, Anna Magdalena Smit, died suddenly from tuberculosis at the age of only 34. In the aftermath, van der Waals was left so shaken that he did not publish any papers for over a decade. He never remarried and went on to live a quiet life surrounded by his four children, Anne Madeline (who ran the household), Jacqueline Elisabeth (a well-known poet), Johanna Diderica (a teacher), and Johannes Diderik Jr. (who followed in his father's professional footsteps as a physics professor). "Fame changed neither his behavior nor his habits," remarked one of his students.

Van der Waals died on March 8, 1923 at the age of 85, his life a powerful example of persistence in the face of adversity.

"It will be perfectly clear that in all my studies I was quite convinced of the real existence of molecules, that I never regarded them as figments of my imagination," van der Waals once remarked. "But when I began my studies, I had the feeling that I was almost alone in holding that view."

The author is a freelance writer in Stockholm, Sweden.

Further Reading:

"Johannes Diderik van der Waals Biographical." NobelPrize.org

Onnes, H. "Prof. J. D. van der Waals," *Nature* ***111***, 609-610 (1923).

BRINKWORTH CONTINUED FROM PAGE 3

planet: 'science with and for society,' but fulfilling that mission is impossible without a diverse workforce in an environment of inclusion, belonging, and psychological safety. I feel like I'm in the best place I can be to use my talents to serve the greater good. I want people to understand it is not only possible to be a great scientist while also being kind and inclusive, it's necessary. Technical ability is not good enough. To be a good scientist, you have to be more than just good at science— you have to be a good human being."

NOBEL CONTINUED FROM PAGE 1

can be shown to be the 'survival instinct' of our species. This is the work of physics done on a grand scale for all of humanity."

Added Gates, "In the case of the American recipient, Prof. Manabe, his is part of the historical tapestry delineating how physicists born in other nations continue to enrich the science of this nation."

The Nobel Committee cited 17 papers in journals published by APS in their announcement, including six authored by Parisi: five in *Physical Review Letters*, and one in *Reviews of Modern Physics*. This marks the 11th consecutive year that a *PRL* article co-authored by one of the recipients has been cited in the Scientific Background on the Physics or Chemistry award.

"The *Physical Review* journals are among the most-trusted in physics, and their consistent citations by the Nobel Committee demonstrate the important role they play in advancing scientific discovery and research dissemination," said Jeff Lewandowski, APS Director of Publishing.

Manabe and Hasselmann share half of the award for separate but complementary research that provides a solid, physics-based understanding of the Earth's climate, a complex system of vital importance to humankind.

In the 1960s, Manabe led the development of climate models that laid the foundation for today's models. He also demonstrated the relationship between increased atmospheric carbon dioxide and increased temperatures on the Earth's surface. His research built on the work of fellow Nobel Laureate Svante Arrhenius, who studied the greenhouse gas effect 70 years earlier with a focus on radiation balance. Manabe's models were the first to explore the relationship between radiation and the vertical transport of air masses due to convection, while also incorporating the heat contributed by the water cycle. Using this model, Manabe was able to show that carbon dioxide is responsible for an increase in the Earth's temperature, not changes in solar radiation.

About 10 years later, Hasselmann also developed a critical model, which links weather and climate, showing that climate changes, unlike weather, can be reliably predicted. Taking into account the chaotic nature of weather and variable fluctuations that influence climate, such as wind strength or melting ice sheets, Hasselmann created a stochastic model for predicting climate variations. He would also go on to develop methods to identify climate "fingerprints" of both natural phenomena and human activities. His methods have been used to demonstrate that human emissions of carbon dioxide— not natural causes—have caused the increased temperature in the atmosphere.

Parisi receives the other half of the Nobel Prize for finding hidden patterns underlying seemingly random phenomena. Around 1980, he made crucial discoveries about spin glasses, a type of metal alloy with radical magnetic properties. Parisi developed a physical and mathematical model that solved a puzzle about how frustrated spins could coexist in the material. The structures he discovered in spin glasses were so fundamental that they shaped research in many fields, from biology to machine learning. He earned the 2016 Lars Onsager Prize from APS for applying spin glass ideas to computational problems.

"Glass is very familiar in nature, and also a complex object that we normally see but we don't recognize as complex," said Parisi by phone during the Nobel announcement in Stockholm.

Parisi's work on disorder and complexity extends beyond spin glasses to include systems such as periodically recurring ice ages and patterns in flying starlings. Some of his current research analyzes big data from the COVID-19 pandemic. For his findings in elementary particle physics, quantum field theory, and statistical mechanics, Parisi also received the 2005 Dannie Heineman Prize for Mathematical Physics, jointly awarded by APS and the American Institute of Physics.

"APS congratulates the 2021 Nobel Laureates for their outstanding contributions to our understanding of complex systems," said APS CEO Jonathan Bagger. "This year's prize demonstrates the fundamental role of physics in addressing some of the most pressing problems of our time."

The Nobel Prize, first awarded in 1901, is widely considered the highest honor in science, economics, and literature. The 2021 Nobel Laureates will be awarded medals separately in their home countries, and they will receive 10 million Swedish kronor (approximately $US 1.15 million), half of which goes to Parisi, and the other half to Manabe and Hasselmann. The traditional Nobel Prize banquet will not take place in 2021 due to the COVID-19 pandemic.

The following articles have been made free-to-read by APS:

Articles Cited by the Nobel Committee

G. Parisi, Infinite Number of Order Parameters for Spin-Glasses, Phys. Rev. Lett. 43, 1754 (1979).

Giorgio Parisi, Order Parameter for Spin-Glasses, Phys. Rev. Lett. **50**, 1946 (1983).

M. Mézard, G. Parisi, N. Sourlas, G. Toulouse, and M. Virasoro, Nature of the Spin-Glass Phase, Phys. Rev. Lett. **52**, 1156 (1984).

Giorgio Parisi and Francesco Zamponi, Mean-field theory of hard sphere glasses and jamming, Rev. Mod. Phys. **82**, 789 (2010).

Patrick Charbonneau, Eric I. Corwin, Giorgio Parisi, and Francesco Zamponi, Universal Microstructure and Mechanical Stability of Jammed Packings, Phys. Rev. Lett. **109**, 205501 (2012).

Paolo Rissone, Eric I. Corwin, and Giorgio Parisi, Long-Range Anomalous Decay of the Correlation in Jammed Packings, Phys. Rev. Lett. **127**, 038001 (2021).

Related Articles

J.S. Wettlaufer, Editorial: Climate Science: An Invitation for Physicists, Phys. Rev. Lett. **116**, 150002 (2016).

PROGRAMS

STEP UP Summit Empowers Educators to Inspire the Next Generation of Scientists

BY LEAH POFFENBERGER

For many students, their high school physics experience will determine their attitudes about physics. This is particularly true for young women, as a 2017 paper shows that most women physics majors report becoming interested in physics—including as a career—in high school. The goal of the STEP UP program is to reach students during this formative experience and use researched-backed lesson plans to change cultural ideas about physicists and inspire more women to enter the field.

STEP UP is a national community of physics teachers, researchers, and professional societies dedicated to empowering teachers, creating cultural change, and inspiring young women to pursue physics in college. A July 17 STEP UP summit brought this community together virtually, along with nearly 200 new members: the first-ever cohort of STEP UP Advocates, a group of teachers committed to deploying STEP UP lessons in their classrooms.

The Summit gave new Advocates an opportunity to learn best practices for applying STEP UP's curriculum, comprised of lesson plans on *Careers in Physics*, *Women in Physics*, and *Everyday Actions* for reducing marginalization in the classroom. Attendees spent much of the day in small group workshops with STEP UP Ambassadors—educators who have been involved in training and supported implementation of STEP UP in classrooms around the country—to build confidence in carrying STEP UP's message to their students.

"I enjoyed gathering with other high school physics teachers who are preparing to implement the STEP UP lessons in their classes this upcoming school year," said Catherine Garland, a teacher at Uncommon Charter High School in Brooklyn and a STEP UP Ambassador. "It was so helpful to hear different ways of implementing the lessons, work through questions as a group, and practice delivering different parts of each lesson. Spending time with other teachers who are equally committed to helping students shift their own physics identities is always energizing and inspiring!"

Highlights of the conference included the opening session, where Zahra Hazari, the Principal Investigator of the STEP UP grant, shared the motivations behind the program: disrupting inherent bias in the world of physics. She also presented research-based evidence for STEP UP's ability to change student perspectives about who can do physics. Gabriela Gonzales (Louisiana State University, LIGO) also spoke in a plenary at the end of the day, and shared her work at LIGO and the search for gravitational waves. She emphasized that the people doing the work at LIGO were all ages and types of people. "We don't all look like grey-haired men. There are young people who are [at LIGO] doing the science—that's how you should imagine a physicist," she said.

As a key motivational point of the day, attendees were able to hear from former STEP UP students, in the forms of letters or video messages, sharing what STEP UP's lesson plans meant to them. One of those students, Adriana De Cardona, is currently majoring in biochemistry with a minor in physics at Florida International University and credits some of her success in STEM to the confidence she built in her high school physics teacher's classroom. Her teacher, Andres Torres, is a STEP UP Ambassador who brought the STEP UP lesson plans to life.

"Mr. Torres was an amazing teacher. A lot of students seem to give up on classes senior year, but I would show up to physics class, and all I wanted to do was learn more," said De Cardona. "The [*Careers in Physics* lesson] really hooked me—seeing all the things that physics applies to in the real world and how it can take you literally anywhere."

De Cardoza also enjoyed the Women in Physics lessons, which gave her role models and more motivation to learn about physics. Torres' inclusive classroom also helped her male counterparts in class to confront their own biases about who belongs in science.

"Mr. Torres cares about his students. He pushed for diversity in the classroom in the way of who gets to participate," said De Cardona. "He wanted girls to get into science. A lot of time [girls might not participate] because there's a bias from the teacher or the professor who thinks the girls aren't into it. It was a very inclusive classroom."

After a day online at the STEP UP Summit, the new STEP UP Advocates dispersed to bring the same lesson plans and hopefully the same results to classrooms across the country. Garland urges other teachers who want to get involved to jump in.

"The lesson plans and materials provided by STEP UP are backed by research! We know that they help to shift student physics identities so that more students can see themselves as 'physics people,'" said Garland. "STEP UP provides support for any teachers implementing the lessons—we have Ambassadors who are ready to help in all parts of the country and in Canada, too!"

For more information, and to download the free materials appropriate for students in middle school through intro college courses, go to STEPUPphysics.org/curriculum.

PRX CONTINUED FROM PAGE 1

while ensuring topically and geographically diverse coverage," says Ling Miao, Managing Editor of PRX. "One [role of PRX] is to disseminate the best, cutting-edge knowledge to a broad audience."

The APS Editor in Chief at the time, Gene Sprouse, tasked Pullin and Miao with developing editorial standards for the new journal.

"We reached out to the community, and we asked for advice from the founding Editorial Board. What we heard was loud and clear," says Pullin, who served as lead editor of PRX until 2016.

As authors, researchers had expressed a need for small journals that offered high editorial standards and high visibility for their own work, and as readers, they strongly indicated that what they needed from an open-access journal was selectivity based on reliable and consistent scholarly standards.

"APS's dedication to meeting the needs of the research communities it serves is reflected in the fact that, year after year, PRX ranks first in Impact Factor among fully open access journals in the Physics, Multidisciplinary category," says APS Director of Publishing Jeff Lewandowski. "Our recent launch of a new set of highly-selective open access journals—including *PRX Quantum*, *PRX Energy*, and more to follow—also speaks to just how much researchers appreciate and value the PRX model, as well as to APS's continued commitment to serving the changing needs of researchers. These new titles are inspired by and named after PRX, and will complement the original."

Supported by countless authors, referees, and readers, as well as an engaged editorial board of distinguished scientists, all from across the globe, PRX has continued to grow in submissions, quality, impact, and visibility.

"Some of the top players of physics are sending their papers to PRX, and the editorial team has expanded," says Pullin. "PRX has established itself as the premier open access venue for innovative physics research with long-term impact."

In March 2016, Pullin passed PRX's lead editor baton on to Cristina Marchetti (University of California, Santa Barbara) and Jean-Michel Raimond (Sorbonne Université). "Our role has been pretty easy because the goals were set, we had in mind what we wanted to be," says Raimond."We hope PRX will continue to become more impactful."

PRX complements *Physical Review Letters* (PRL), APS's long-standing flagship title, by offering authors more flexibility to choose which venue is most appropriate for their publishing needs.

"While PRL typically publishes reports of influential developments in physics in the form of short letters—around four pages—PRX allows for longer articles, without a length limit," says APS Editor in Chief Michael Thoennessen. "Its online-only model allows PRX to offer flexibility on length and format to its authors that they can, and do, use to best communicate their work to both broad audiences and specialists in their field. It also presents a top-quality fully open access option for authors who prefer or are required to publish under that model."

A hallmark of PRX is a focus on truly innovative research, the editors say, regardless of whether that research is particularly eye-catching or flashy.

"PRX has proved that there are many varieties of papers that can make a big impact in physics, or in science more broadly" says Miao. "Impact can mean making people think about what they might do differently, or inspiring them to see a different piece of the physics world, or providing them incredibly important and innovative tools to solve new problems, or giving them food for thought."

While PRX has grown steadily in visibility and citations performance—now with an impact factor of 15.762—and continues to be a top-tier journal in the *Physical Review* family, the hope for the next ten years is to see it continue to play its unique and important role that is highly valued by the community.

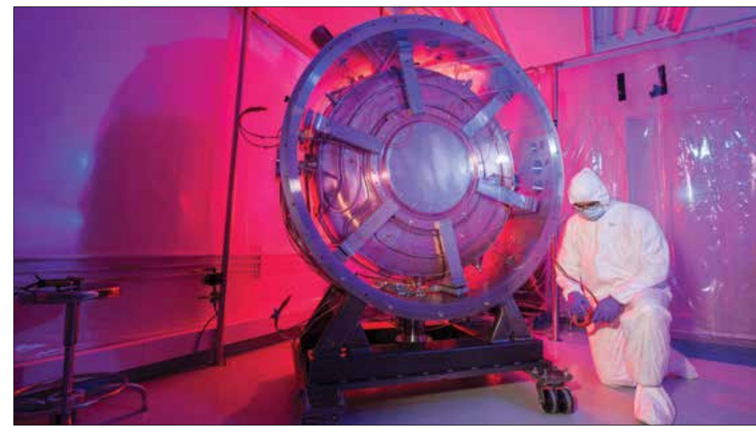
"PRX is the best open access journal covering all of physics, and it can become even better," says Raimond.

PRX has grown steadily in visibility and citations performance—now with an impact factor of 15.762.

Top Ten Most-Cited Papers Published in PRX

1. ***Experimental Discovery of Weyl Semimetal TaAs.*** B.Q. Lv, H.M. Weng, B.B. Fu, X.P. Wang, H. Miao, J. Ma, P. Richard, X.C. Huang, L.X. Zhao, G.F. Chen, Z. Fang, X. Dai, T. Qian, and H. Ding. Phys. Rev. X **5**, 031013 – Published 31 July 2015
2. ***Weyl Semimetal Phase in Noncentrosymmetric Transition-Metal Monophosphides.*** Hongming Weng, Chen Fang, Zhong Fang, B. Andrei Bernevig, and Xi Dai. Phys. Rev. X **5**, 011029 – Published 17 March 2015
3. ***GWTC-1: A Gravitational-Wave Transient Catalog of Compact Binary Mergers Observed by LIGO and Virgo during the First and Second Observing Runs.*** B.P. Abbott *et al.* (LIGO Scientific Collaboration and Virgo Collaboration). Phys. Rev. X **9**, 031040 – Published 4 September 2019.
4. ***Observation of the Chiral-Anomaly-Induced Negative Magnetoresistance in 3D Weyl Semimetal TaAs.*** Xiaochun Huang, Lingxiao Zhao, Yujia Long, Peipei Wang, Dong Chen, Zhanhai Yang, Hui Liang, Mianqi Xue, Hongming Weng, Zhong Fang, Xi Dai, and Genfu Chen.Phys. Rev. X **5**, 031023 – Published 24 August 2015.
5. ***Binary Black Hole Mergers in the First Advanced LIGO Observing Run.*** B.P. Abbott *et al.* (LIGO Scientific Collaboration and Virgo Collaboration). Phys. Rev. X **6**, 041015 – Published 21 October 2016; Erratum Phys. Rev. X **8**, 039903 (2018).
6. ***Anomalous Edge States and the Bulk-Edge Correspondence for Periodically Driven Two-Dimensional Systems.*** Mark S. Rudner, Netanel H. Lindner, Erez Berg, and Michael Levin. Phys. Rev. X **3**, 031005 – Published 23 July 2013
7. ***Periodically Driven Quantum Systems: Effective Hamiltonians and Engineered Gauge Fields.*** N. Goldman and J. Dalibard. Phys. Rev. X **4**, 031027 – Published 18 August 2014; Erratum Phys. Rev. X **5**, 029902 (2015)
8. ***Properties of the Binary Neutron Star Merger GW170817.*** B.P. Abbott *et al.* (LIGO Scientific Collaboration and Virgo Collaboration). Phys. Rev. X **9**, 011001 – Published 2 January 2019
9. ***Mathematical Formulation of Multilayer Networks.*** Manlio De Domenico, Albert Solé-Ribalta, Emanuele Cozzo, Mikko Kivelä, Yamir Moreno, Mason A. Porter, Sergio Gómez, and Alex Arenas. Phys. Rev. X **3**, 041022 – Published 4 December 2013
10. ***Computational Study of Metal Contacts to Monolayer Transition-Metal Dichalcogenide Semiconductors.*** Jiahao Kang, Wei Liu, Deblina Sarkar, Debdeep Jena, and Kaustav Banerjee. Phys. Rev. X **4**, 031005 – Published 14 July 2014

MUON CONTINUED FROM PAGE 2



A proposed muon collider would use technology developed by the UK-based Muon Ionization Cooling Experiment (MICE) collaboration, whose experiment is pictured here. CREDIT: REIDAR HAHN, FERMILAB

about 1,600,000,000 times less, as power losses decrease as mass to the fourth power.

If the community chooses to build electron-positron colliders such as the International Linear Collider in Japan or the Circular Electron-Positron Collider in China, the community could build the muon collider at CERN after experiments end at the LHC, says CERN's Daniel Schulte, who also leads the Europe-based International Muon Collider Collaboration. Alternatively, they could build the Higgs factory at CERN, followed by a muon collider, says Craig.

Craig thinks the US would make an excellent host site for the muon collider. Physicists there developed several crucial pieces of muon collider technology through the country's Muon Accelerator Program, which ran from 2010 to 2017. The collider could also fit in the footprint of US national labs such as Fermilab in Illinois, says Craig.

"There's been a long-standing tradition of having colliders both in Europe and the US," says Ojalvo. "I think that there are enough people to work on both machines."

Muonic Challenges

To create a source of muons, you smash protons into a target to produce pions, which decay to produce muons. Then, to form the muons into a beam, you have to remove the particles' motion in all directions except in the direction of the beam, known as "cooling." The production and cooling of muons, along with their subsequent acceleration and collisions all need to occur within the particle's mean lifetime of 2.2 microseconds.

Several technical hurdles arise from the muon's short lifetime. One issue is developing magnets that can ramp up magnetic field quickly, so that the muons can get up to speed before they decay. Another challenge is to create a cost-effective and compact muon cooling system, says Schulte. Researchers are building upon the work of a UK-based collaboration known as the International Muon Ionization Cooling Experiment (MICE). The muons are cooled as they ionize atoms in liquid hydrogen.

In addition, researchers are studying how to extract signals from collision data. To that end, Ojalvo works on simulations of muon collisions to understand the background noise of the muon beam and its decay products. Ojalvo has found that during data analysis, they can remove a significant amount of noise if their detector can measure the timing of collisions with the precision of tens of picoseconds, in addition to measuring the particles' positions and energies.

And of course, there's the matter of fundraising. With other proposed colliders' price tags in the billions of dollars, researchers will need to make the case to their governments for a similarly expensive machine. Ojalvo is optimistic: "Whenever I talk to Congress for lobbying, you hear a lot of support for fundamental science research," she says. She points out that these projects produce societal benefit beyond physics to educate thousands of students in science and engineering.

Schulte anticipates that the muon collider will offer a cost-effective and energy-efficient method for studying high energy physics compared to other types of colliders. While the community still needs to further develop muon collider technology, he says, "it has potential to push the field much further in the long run."

FYI CONTINUED FROM PAGE 4

Princeton University ecologist Steve Pacala, and Frances Colón, who served as deputy science adviser to the secretary of state during the Obama administration.

Among the remaining members, four are from the biomedical sector, four are from the information technology sector, two are social scientists, and one is a mathematician.

In a video announcing his appointments, Biden observed that his council is the "most diverse PCAST in history," saying, "For the first time, immigrants and people of color, including Black, Hispanic, and Asian Americans, make up more than one third of its members." He also noted it is the first time that the co-chairs are women and that half the council's members are women.

In another video featuring the three PCAST co-chairs, Zuber indicated the council's agenda will be shaped by questions that Biden posed to Lander after selecting him as science adviser.

"The president wants us to look at what we've learned from the pandemic and how that can help us with other global challenges. He's asked us to think about the challenges associated with climate change. He's asked us how all Americans can benefit from discoveries in science and technology," she remarked.

The author is the Director of FYI.

THE BACK PAGE

One Woman's Struggle with Harassment in Physics

EDITOR'S NOTE: THE NAME OF THE AUTHOR OF THIS ESSAY HAS BEEN WITHHELD AT HER REQUEST.

From my earliest years, I have wanted to be a researcher in science, especially physics. I worked hard at this, earning a doctorate equivalent degree in engineering with a thesis on a complex analytical system solved with numerical coding, and one in physics with an experimental thesis performed in the US. An organization soon hired me on a term contract at a very low salary. Even after obtaining tenure, my salary was always at the extreme low end of the spectrum. On the surface, all seemed to be going well with my career, but after 20 years in research, I was diagnosed with Post-Traumatic Stress Disorder (PTSD) thanks to the harassment and toxic environments I experienced along the way.

I had been tasked with establishing a research lab in a field that was new for me. I was alone in the US, without family or husband. I was logging in long hours to come up to speed and start designing specialized experimental setups. I needed to focus. Instead, in my first few months on the job, I had to face an older married colleague who was blatantly chasing me around and stalking me to friends' houses. As much as I was trying to be kind to him, I did not reciprocate his advances and soon thereafter rumors flew around the office that I was a marriage wrecker. The head of my subdivision believed the rumors and badmouthed me from then on.

While I was dealing with that, the division head would often stop at my open office and make loud compliments of various kinds to me that everybody heard. Unfortunately, during my very first conference away, the division head dragged me out of the venue and drove us on the highway, with the pretext of calming down from some heated discussions. He left the main road, took an unpaved trail, and stopped in the middle of some vegetation. There he made some attempts at hugging and kissing me. As terrified as I was, I rejected him as politely as I could and somehow convinced him to drive back. This did not prevent him from doing the same in a limo and in my open office on a weekend.

That is when I reached the peak of my frustration and powerlessness. Going to the Human Resources (HR) department was not an option, as previous victims who had complained had been transferred somewhere else and never heard from again. On every occasion, until he finally stopped, I reiterated that I was not interested and that this whole thing was bad for everybody involved. But yet again, it was too late, as everybody was convinced that I was his lover and an opportunist. Thank God, my direct supervisor appreciated my work, and a tenure-track position was opened for me to apply. I got it thanks in part to enthusiastic letters from the community. However, I later learned that my subdivision head had thrown away half a dozen letters that had been personally addressed to him.

In the following years, while supervising graduate students, I kept adding innovative experimental setups to my lab and pioneered collaborative grants with industry. I was able to hire people and eventually was directing a group in addition to managing my lab. Nevertheless, the organization officially assigned my lab and my de-facto group to a younger male colleague. Only when he left the lab did I become an official group leader. Approaching ten years of experience, I had high-impact results, more than 150 peer-reviewed publications, had given dozens of talks, had established international collaborations, and my lab had received international recognition. Yet even after being awarded scientific prizes, the organization completely ignored me: no internal mention or honors, no initiative to propose me for external awards, no consideration for relevant internal or external committees' membership, no promotion to roles of increased responsibility, and so on.

After expanding our research and obtaining another record achievement, instead of finally being given more responsibility, my group was transferred under a person with friends in the right places, somebody who spent most of his time trying to destroy the know-how we had systematically acquired. He fought as hard as he could against my overdue promotion, micromanaged our safety procedures, and rated me as barely "sufficient" in my performance review the year that I was elected as an APS Fellow. He attempted to blame an accident outside of my lab on my group, which was cleared after a lengthy review. When I pushed back, I received a reprimand for "inappropriate behavior."

Despite my past and present division management having done all that they could to see me leave, I will not leave. I should not be the one to leave. I have invested decades of my life in this organization, which I love, and I have established meaningful relationships with most of the people that I have worked with during the years. I take most pride from my group members, who had the courage to stand up for me when I stood up for them, the brilliant students that keep my neurons alive and dancing, and several of my kind and extraordinary collaborators. I now also have a wonderful family and children. However, when I was diagnosed with PTSD, I realized that this environment of unethical behavior had significantly affected my health. I was not born a victim and can only see myself as a warrior. I will always get back up again to take another hit. But by remaining, one engenders change. Therefore, I intend to use myself as a compelling case for positive change. I am negotiating with my institution not only to get personal reparations but also to change their antiquated HR procedures, which are still geared towards victim-blaming rather than victim protection because HR takes instructions from the division heads. I have told them that I will never stop fighting.

> **"Going to the Human Resources (HR) department was not an option, as previous victims who had complained had been transferred somewhere else and never heard from again."**

When the next division head was appointed, I had great hopes. After all, what could be worse than what I had already experienced? After getting rid of the aforementioned subdivision head, he surrounded himself with former students and close associates, and only cared about his own area of research. Having worked in this same area for a few years, I was looking forward to his contribution and expert advice in my work. However, when I asked for a meeting to show him our results, he barely looked at my data and immediately stated that they were junk and could not be compared in quality with those obtained by his group. As soon as I tried to ask about his criteria for quality, he threw me out of his office. My technique was later adopted by foreign industry through a collaborative agreement, and I am trying to bring it back to the US.

When that division head left, I do not recall that any opening was published, or I would have applied. Then, all of a sudden, a friend and collaborator of the former division head moved in to take the position. This individual had been tasked with paving the way for top management's associates to climb the ladder as fast as possible, and everything started revolving around this goal. This included giving one resounding title after another to each crony, proposing them for as many awards and important committees as possible, staging workshops or discussions to make them shine, and the like. This also included frequent promotion of the research results of the lab director's cronies at any opportunity, both inside and especially outside of the organization. Favored younger researchers were promoted at a much faster rate than even the best in the whole history of the organization, sometimes going from PhD graduate to senior tenured positions and division heads in a few years. Everybody else, including me, did not exist or were considered encumbrances and were passed over for any kind of recognition.

Very little attention was paid to important achievements by other groups, including mine, that served the organization's mission. Some important breakthroughs within the core areas of the organization were completely ignored as much more scope-limited attainments of the cronies were allowed to shine without competition. This clearly had negative consequences on the funding of these other mission-related areas and most of all on the organization's mission and reputation. During this time, a young scientist from our division committed suicide. He had often complained about working too hard compared to his rewards. In addition to such blatant favoritism causing extensive demoralization in the organization, it also made people scared to stand up during discussions. The cronies were de-facto given the authority to shame people into silence, and our organization has become one where lack of scientific debate is not only accepted but encouraged. As expected, several good scientists including numerous women left the institution.

During these struggles, the sexual harassment continued. I was approached with sexual advances both inside and outside my organization by well-established scientists who were looking for a lover. For instance, I had a disturbing groping experience with a Nobel prize winner in my cafeteria. We had met because I was hoping for his support of the scientific research that had been boycotted by my organization, but he apparently wanted something in exchange for reading my papers. Needless to say, I never heard from him again. In my experience and that of many others, harassment is not just a feature of a toxic workplace—many such cases occur at workshops and conferences by individuals in the community from other organizations. I was fortunate that in none of these events I crossed paths with violent people, and I could always escape physically unscathed. However, the negative consequences on my psyche, work, and career have compounded during my whole professional life with endless daily verbal microaggressions, both of sexual but also of non-sexual nature. This is also due to the surprising attention to superficial appearances by many scientists. I pursued the physical sciences to nourish my passion for facts and truth, hoping to have sufficient depth and skills for it. Nevertheless, even in an allegedly scientific community, I so often found myself being judged superficially.

Thanks to APS, I am not alone in my battle. By accepting me with appreciation and open arms, this Society was critical to my self-esteem. Never had I felt more inclusively accepted as a working professional. I did not need any special connections, just the willingness to participate and serve its noble mission. Under the relatively new APS ethics enterprise (see *APS News*, April 2021), cases like mine are heard and examined to possibly establish a future safety network for defenseless scholars of any gender and race. Ideally, the ethics initiative will accomplish this and offer solutions for all.

The Back Page is a forum for member commentary and opinion. The views expressed are not necessarily those of APS.

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