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# APS NEWS

A PUBLICATION OF THE AMERICAN PHYSICAL SOCIETY

GOVERNMENT AFFAIRS

## US Monitoring of Methane Emissions is Falling Short, Report from APS, Optica Finds

BY TAWANDA W. JOHNSON

The United States is not effectively monitoring methane emissions from oil and gas operations, but the federal government could take specific actions to remedy the situation, according to a new joint report by the American Physical Society (APS) Panel on Public Affairs and Optica (formerly OSA), Advancing Optics and Photonics Worldwide.

"Current methane monitoring under-estimates emissions from oil and gas by several times what it should be, and in order to fulfill any pledge to address climate change, the United States would need to consider a wide range of options to address the issue," said William Collins, co-chair of the report, professor-in-residence at UC-Berkeley, and Director of the Climate and Ecosystem Sciences Division at Lawrence Berkeley National Laboratory.

"Developing methods for accurately measuring methane emissions is a global challenge. The Optica and APS communities are well-positioned to solve this challenge and enable the success of future monitoring efforts," said Michelle Bailey, an author of the report, Research Chemist at the National Institute of Standards and Technology, and member of the Optica Public Affairs Council.

Gas burns from a flare stack at a petroleum refinery in Port Arthur, Texas.

The atmospheric concentration of methane has more than doubled since the start of the Industrial Revolution. Colorless, odorless, and flammable, methane is the second most abundant greenhouse

METHANE CONTINUED ON PAGE 6

EDUCATION

## International Teaching Can Transform Physics

BY SULTANA NAHAR

Despite the enduring challenges of the COVID-19 pandemic, the crisis spurred teaching innovations that could help students around the world access physics—a lesson I learned firsthand last fall, when people from nearly a dozen countries participated in my course on astrophysics and spectroscopy.

I'm an astronomy professor at the Ohio State University (OSU), but my involvement in physics extends beyond borders. For more than a decade, I've advocated for stronger support of physics in nations whose scientists are underrepresented in the field—nations like Egypt, Pakistan, and Bangladesh, where I'm from. My goals have been to invite more people into physics; teach them the skills they need to conduct research, which is still not taught extensively in many developing countries; and grow

TEACHING CONTINUED ON PAGE 7

Participants of Dr. Nahar's online course called in from four continents, including from (shown left to right) Bangladesh, Egypt, Ethiopia, India, Mexico, Morocco, Pakistan, Palestine, Saudi Arabia, and the United Arab Emirates.

## I'm the New Editor of *APS News*, and I'm Excited for What Comes Next

BY TARYN MACKINNEY

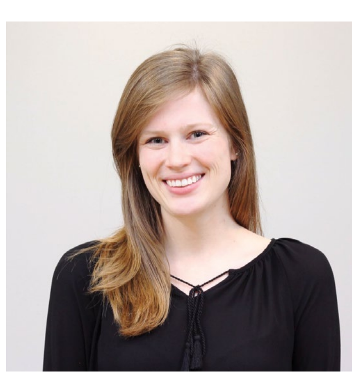
Hello, everyone! Happy June. My name is Taryn, and I'm thrilled to be the new Editor of *APS News*. I'm taking the reins from David Voss, who was Editor for nearly eight years and led with skill and dedication. I'll do my best to fill these big shoes.

My job is to help tell the stories of physicists, who spend their careers improving the field they love—making it better known, better taught, and better studied, and nudging it a little closer to the next big question, the next big answer.

In other words, my job is to help you tell your story.

For years, I honed my skills in science storytelling at Atlantic Media and then at the nonprofit Union of Concerned Scientists, where I researched, wrote, and edited stories on everything from chemical policy to climate change, the US Census to the science of masks.

Now, I'm excited to become the Editor of the preeminent physics society publication—the voice of physics. This is an incredible community of passionate people, doing groundbreaking work across the nation and around the world. I'm looking forward to sharing their stories—your stories—with you, and with new audiences, too.



Taryn MacKinney

And I'm excited to dig into all the questions, big and small, new and old, that inspire newcomers and experts alike. How do

EDITOR CONTINUED ON PAGE 7

## Celebrating 50th Anniversary of First African-American Woman to Earn Physics PhD

BY DONNELL WALTON

In 1972, Willie Hobbs Moore became the first African-American woman to receive a PhD in physics in the United States. On the 50th anniversary of this historic moment, we celebrate her, and I remember my personal, albeit brief, friendship with her.

Willie Hobbs Moore was born in Atlantic City, New Jersey, on May 23, 1934, to Bessie and William Hobbs. In 1954, the same year that the Supreme Court struck down school segregation in *Brown v. Board of Education*, she boarded a train for Ann Arbor, where she studied electrical engineering at the University of Michigan (UMich)—the only Black woman undergraduate in the program. She earned her bachelor's degree in 1958 and her master's in 1961. She worked as an engineer at several companies before she returned to the University of Michigan to pursue her PhD.

In 1972, Dr. Hobbs Moore made history when she received her doctorate in physics.

For five years afterward, Dr. Hobbs Moore worked as a lecturer and research scientist at UMich. She published more than a dozen papers on protein spectroscopy in prestigious journals, including the *Journal of Applied Physics*, *Journal of Chemical Physics*, and *Journal of Molecular Spectroscopy*.

In 1977, Dr. Hobbs Moore joined Ford Motor Company as an assembly engineer. She went on to help the company expand its use of Japanese methods of quality engineering and manufacturing. This work proved critical to boosting Ford's competitiveness during Japan's domination of the automobile market. She eventually became an executive at the company.

Dr. Willie Hobbs Moore CREDIT: THE UNIVERSITY OF MICHIGAN

But her passions extended far beyond work. Dr. Hobbs Moore was involved in community science and math programs and was a member of The Links, Inc., a service organization for Black women, and Delta Sigma Theta, a historically Black, service-oriented sorority founded in 1913. She and her husband, Sidney Moore, who taught at the University of Michigan Neuropsychiatric Institute, had two children, Dorian Moore, MD, and Christopher Moore, RN, and three grandchildren.

I first met Dr. Hobbs Moore in 1992 at the Saturday Academy for African American Students, a community STEM tutoring program for which we both volunteered. When I approached her, she was tutoring a student in trigonometry; she was so focused that she didn't even look up. But when she came to find me at the end of the session, we connected quickly. We

HOBBS MOORE CONTINUED ON PAGE 6

GOVERNMENT AFFAIRS

# ‘I had no idea when I would see my family again’: Scientists of Chinese Descent Recount Stories of Unjust Arrests

BY TAWANDA W. JOHNSON

Xiaoxing Xi, a Temple University physics professor, was thrust into a nightmare in the early-morning hours of May 21, 2015, after FBI agents pounded on the door of his home.

“They pointed their guns at my wife and two daughters and ordered them to walk out of their bedrooms with their hands raised,” he recalled. “When they took me away, I had no idea when I would see them again.”

Xi, along with Anming Hu, associate professor in the Department of Mechanical, Aerospace, and Biomedical Engineering at the University of Tennessee-Knoxville, and Gang Chen, the Carl Richard Soderberg Professor of Power Engineering at the Massachusetts Institute of Technology, recounted heart-wrenching stories about their unjust prosecutions by the federal government during an April 18 webinar sponsored by APS, Asian rights’ groups, and other scientific organizations. The wrongful arrests have devastated their personal and professional lives, harmed the nation’s ability to recruit the best and brightest talent, and hurt international scientific collaborations.

“It is my hope that listening to the experiences of speakers in today’s webinar will provide the motivation for us all to advocate and support members of our community,” said APS President Frances Hellman.

After Xi was taken to an FBI office, he was fingerprinted and had a mugshot and DNA sample taken, he said. Then, at a Marshal Service jail, he was ordered to strip naked so that an officer could inspect him for hidden possessions—a humiliating ordeal.

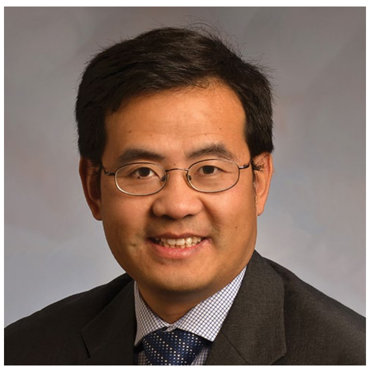
Hours later, Xi was charged with sharing US technology amounting to trade secrets with China.

“I said immediately, ‘that’s absurd,’” he recalled.

Xi’s name quickly circulated online, where he was labeled a Chinese spy. He faced the possibility of up to 80 years in prison and a $1 million fine.

Four months later, charges were dropped against Xi when leading scientific experts signed affidavits stating that he had not shared trade secrets with China.

Dr. Xiaoxing Xi
CREDIT: TEMPLE UNIVERSITY



Dr. Anming Hu
CREDIT: UNIVERSITY OF TENNESSEE-KNOXVILLE

Dr. Gang Chen
CREDIT: MASSACHUSETTS INSTITUTE OF TECHNOLOGY

His communications with Chinese colleagues represented routine academic collaboration, experts agreed.

But the damage was done. The debacle delayed his research, endangered his funding, and seriously harmed his reputation. “If I don’t have a chance to clear my name, and try to repair my

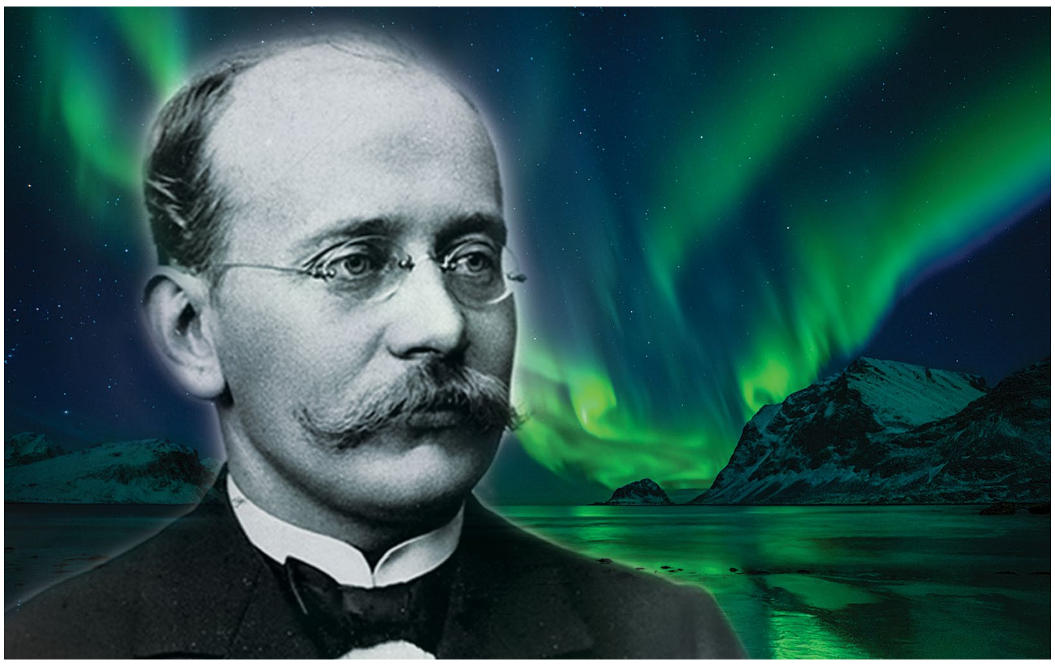
CHINESE CONTINUED ON PAGE 4

THIS MONTH IN

# Physics History

## June 15, 1917: Death of Kristian Birkeland, King of the Northern Lights

BY ABIGAIL EISENSTADT



Kristian Birkeland. His face now adorns the Norwegian 200-kroner banknote, but he died decades before he was recognized for his work.

Physicist Kristian Birkeland was the first man to describe how charged particles from the Sun interact with Earth’s magnetism to create dazzling phenomena like the aurora borealis. But he did so at a cost, sacrificing money, community, and health in fervent pursuit of his goal: understanding the northern lights.

Born in 1867 in present-day Oslo, Norway, Birkeland’s passion for electromagnetism grew serious in his teens under the mentorship of a math teacher. At age 18, he published his first research paper. A few years later, he became the youngest faculty member in sciences and mathematics at what was then Norway’s only university—today’s University of Oslo.

But his academic career was just the start of his story. Birkeland had always been interested in auroras, the dazzling, colored lights that snake across the sky, especially in the Arctic and Antarctic. For thousands of years, cultures around the world had built myths about the auroras—some Indigenous people of northern Europe, like the Sámi, saw the lights as the souls of the dead—but scientists had no idea what caused them, and the harsh conditions of the far north deterred most researchers from studying them.

Until Birkeland. In 1899, he launched the first of many research expeditions to study auroras. In the depth of winter, he led a team through the Arctic Circle to map auroras and snowstorms, looking for patterns. The work was grueling and the environment brutal; two people died on the expedition. But Birkeland survived and returned home with reams of data.

After a flurry of analysis, Birkeland established a connection between polar electromagnetic currents and the aurora borealis. He published his theory, seeking international scientific recognition—especially from England’s most prestigious scientific institution, the Royal Society, whose validation could rocket his career to new heights. But the Society vehemently opposed his theory. One of their past presidents, the revered thermodynamics expert Lord Kelvin, had declared in 1892 that there was no relationship between sunspots and geomagnetism. The Royal Society took Lord Kelvin’s word as doctrine. Birkeland would fight for the rest of his career to gain British recognition for his auroral theories.

After his first expedition, Birkeland began planning a second one, but money was tight. The Norwegian government, which had backed his first trip, had grown frustrated with his shoddy bookkeeping, so Birkeland had to raise his own funds. He decided to invent what he thought would be a lucrative tool: a mechanism that could turn currents on and off quickly at hydroelectric power plants in Norway’s fjords. His design was well-planned but poorly executed: The mechanism exploded in testing.

Undeterred, Birkeland repurposed his switch mechanism into an electromagnetic cannon, or coilgun, that used electricity-powered coils to shoot missiles, an innovation that Birkeland thought could revolutionize warfare. It attracted

HISTORY CONTINUED ON PAGE 5

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INTERVIEWS

# Scientists Don't Belong on Pedestals: Interview With Science Historian Patricia Fara

BY SOPHIA CHEN

The past is messy. Politicians, movies, and schoolteachers might have you believe that events unfolded one way, but the truth is far more complex and contradictory, as Patricia Fara well knows.

"Every person who goes back can fish out a completely different set of facts and tell a completely different story," said Fara, a historian of science at Cambridge University in the UK.

This applies not only to wars and political movements, but also to the lives of scientists, along with their discoveries. Fara has spent her career unearthing new ways of viewing scientific history, and she has written about women's contributions to science dating back to the Enlightenment period. Her writing often emphasizes the contributions of translators, teachers, and technicians—previously unrecognized people whose work was crucial to the global development of science.

Raised in the London suburbs by her mother, a housewife trained as a nurse, and her father, who was a lawyer, Fara studied physics at Oxford University in the sixties. Sexism in the field was direct and rampant. Men dominated her physics classes, she said, and instructors and students alike parroted messages about female inferiority. After graduating in 1969, Fara left the field to work in computer programming. "I learned very rapidly that I should never, ever reveal to anybody that I had a degree in physics from Oxford, because nobody—neither men nor women—would talk to me, because they'd regard me as completely abnormal," she said.

Fara made a career of producing educational videos on statistics and computing before pivoting to historical scholarship at age 40. In 1993, she earned a PhD in History of Science from Imperial College

Dr. Patricia Fara
CREDIT: DOROTHY LIVINGSTON

London and joined Cambridge University's Department of History and Philosophy of Science that same year. She has written more than 10 books, including *Science: A Four Thousand Year History* and *A Lab of One's Own: Science and Suffrage in The First World War*, and co-authored several more.

Fara, the 2022 recipient of the Abraham Pais Prize for History of Physics, spoke to *APS News* about her work and the role of science history in today's world.

*This interview has been edited for length and clarity.*

**How do you choose subjects of study?**

My first popular book was about Isaac Newton [*Newton, The Making of Genius*, 2002]. That was a definite programmatic decision. It was in response to people who kept asking me to lecture on gender studies during my PhD and afterward because I was a woman. Gender studies was relatively new; it was regarded as a woman's subject, and it didn't have the importance that it does now. I got so angry about it that I decided I was going to take the most masculine case I possibly could. And that was Isaac Newton.

FARA CONTINUED ON PAGE 7

CAREERS

# How to Network After Conferences

BY ALAINA G. LEVINE

Now that you've gone to the March and April Meetings, you're probably wondering what to do with the contacts you acquired and conversations you had. The business cards you amassed will seem like an inconvenience if they sit on your desk for the next five years, accumulating muons, but take heed: There is value to be extracted from those chats and cards.

After all, networking is not a one-time deal—it's about crafting mutually beneficial partnerships over time and investing in the relationship for the long haul. The first point of contact—meeting someone at a mixer, chatting after their presentation, or introducing yourself while in line for coffee—sets the tone for the relationship, but it doesn't end there. Here are a few ideas to engage in mindful, strategic post-conference networking to grow your newfound alliances into a long-term win-win:

Attendees at the APS 2022 March Meeting.

- Follow up as soon as you can. Based on what you discussed at the conference, send an email to thank the person for meeting with you. If they had a request, like sharing with them your CV or a recent paper, do so.
- Request a follow-up Zoom or phone appointment "to continue the conversation." Ask for 15 or 20 minutes to discuss X further and "explore the potential to collaborate." The key is to keep the dialogue going, flowing, and growing to nurture the relationship.
- Organize your contacts. If you haven't used a formal system to manage your contacts, now is the time to do it. You don't need a fancy piece of software—a Google Doc might be right up your alley—as long as the system you choose aligns with how you collect and process information. Include the basics, like a person's name, position, organization, and email, but also include contextual reminders you might forget later, like the event at which you met, what you discussed, or the research they're conducting that's relevant to your interests.
- Connect on LinkedIn, which is specifically designed for networking and appropriate self-promotion. If you don't have a LinkedIn profile, create one! Start by pasting parts of your CV, such as education and experience, and expand from there. Consider posting a copy of your paper or poster to showcase your work and help others.
- Check in within the year. Rather than waiting until 2023, touch base with your new contacts a few months from now and perhaps again before the end of the year. Check-ins are easy: Email them with new information about you ("I am so honored I won the Nobel Prize"), new information about them ("Congrats on your paper in Phys Rev A"), something of value to them ("I wanted to share this paper I read about leptons"), and/or a yes or no question ("Your talk on analyzing magnetic behavior in X materials was so interesting. Have you ever utilized the Z method?").
- Attend your next March and April Meeting with even more confidence and joy—after all, you'll know people attending. Put a note in your calendar, about a month before the next event, to check in with your contacts, and invite them for lunch or coffee at the 2023 Meetings and beyond.

Happy networking!

*Alaina G. Levine is a professional speaker, writer, and STEM career coach. This article builds on content that has appeared in her other work, including her columns, speeches, and book, Networking for Nerds (Wiley, 2015).*



MEMBERSHIP UNITS

# From Great Plains to Alaska, Physicists in the Northwest Section Prepare for June Meeting in Canada

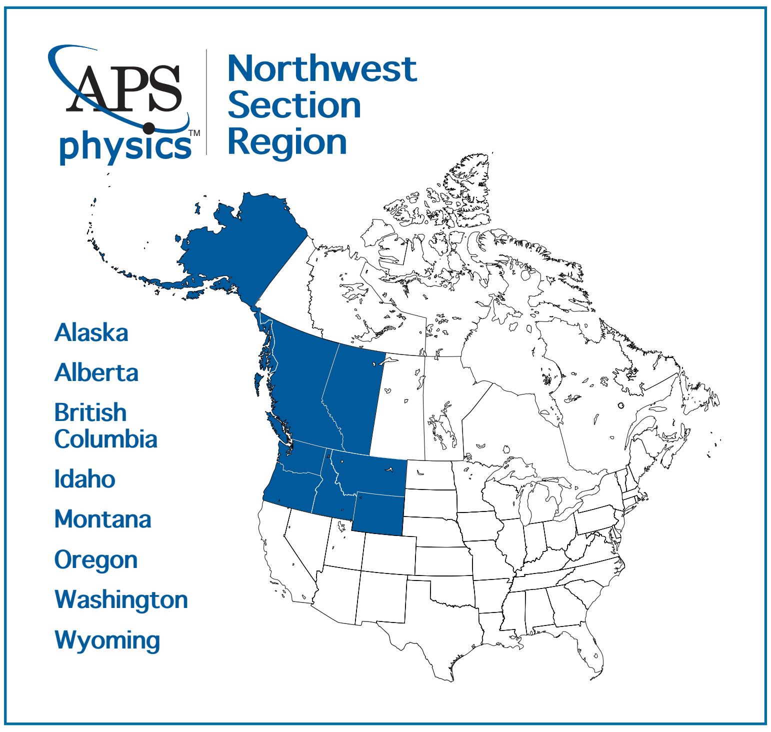
BY ABIGAIL DOVE

Stretching across the northwestern edge of the continent, the Northwest Section (NWS) is a hub for 1,200 APS members in Washington, Oregon, Idaho, Montana, Wyoming, Alaska, and western Canada.

Geographical sections are important to APS. They help APS diffuse the knowledge of physics at a regional level, and they let physicists connect in their own neighborhoods. They can also foster connections between nearby laboratories, companies, and schools, from small liberal arts colleges to large research universities.

Established in 1998, NWS is by far the largest of APS's 10 geographical sections in terms of land area, covering three time zones and almost two million square miles from the Great Plains to the Pacific Northwest to Alaska. It's also the only geographical section that extends internationally, with members in the Canadian provinces of Alberta and British Colombia.

Fittingly for such a vast region, the section spans a wide range




of physics research. One of the largest universities in the region, the University of Washington, has robust programs in nuclear physics and high energy physics. Meanwhile, smaller colleges in the Northwest boast a rich tradition of atomic, molecular, and optics physics research; optics research in particular is popular in undergraduate classes. The region is

NWS CONTINUED ON PAGE 6

ETHICS

# The APS Ethics Committee's Work in 2021

BY NAN PHINNEY AND JEANETTE RUSSO

The American Physical Society sets high standards for ethical behavior and professional integrity for all APS staff and members. Since 2018, the APS Ethics Committee—comprised of 12 APS members with diverse backgrounds—has overseen the implementation of ethics policies for APS, updated the community on best practices, and organized educational events and materials related to ethics.

As the committee's Chair and staff advisor, we've seen firsthand that the physics community is not immune to misbehavior. In 2021, APS received about 60 complaints, ranging from suspected plagiarism, concerns about journal rejections and appeals, and code-of-conduct breaches at APS meetings. These incidents were reported by APS members, journal authors, meeting attendees, and APS staff.

For each complaint, the APS ombudsperson, relevant APS staff, or the full Ethics Committee reviewed and responded. For some, the APS ombudsperson—an independent legal expert, external to APS—led a successful mediation. For others, the Ethics Committee reviewed complaints and chose an appropriate course of action, sometimes recommending new policy. In three cases, the professional conduct disclosure policy uncovered potential misconduct

ETHICS CONTINUED ON PAGE 6

Attendees at the APS 2022 March Meeting.

CHINESE CONTINUED FROM PAGE 2

reputation, then it's damaged," he told *APS News* in 2015.

Xi has filed a lawsuit to hold the government accountable for his wrongful arrest and prosecution.

Hu recalled his own harrowing experience. On Feb. 27, 2020, he awoke to heavy knocking on his front door.

"I was still in my pajamas when eight FBI agents burst into my house and arrested me," said Hu, who was charged with defrauding NASA and hiding his employment with a Chinese university. Hu was acquitted of all charges in September 2021.

He may have been acquitted, he said, but the experience "is part of a broad pattern of racial profiling and targeting of scientists of Asian descent."

Chen, who endured similar experiences, said he was grateful that APS spoke up on his behalf. He was arrested on Jan 14, 2021, after federal agents stormed into his home and accused him of concealing affiliations with China in his applications for nearly $2.9 million in grants from the US Department of Energy.

"APS was the only professional society that openly questioned my arrest, and I'm proud to be [an APS] Fellow," Chen said.

The unjust arrests of many scientists of Chinese descent, including Hu and Chen, are linked to the China Initiative, which began in 2018. The former federal program, which aimed to root out Chinese espionage, sowed fear among some APS members and curtailed legitimate collaboration. APS was a leading voice in calling for reforms to the initiative, holding community events to highlight the policy's negative impacts and launching a grassroots campaign to call for change and raise awareness with Congress. APS leadership also met with FBI staff and US Department of Justice officials to push for change.

APS has also been a strong supporter of impacted scientists. In March 2021, APS wrote to Attorney General Merrick Garland in support of Chen and earlier this year filed an amicus brief on behalf of Xi. And APS continues its broader work to make the US more welcoming for scientists.

Past APS President Phil Bucksbaum, who participated in the webinar, said APS is committed to speaking up and supporting scientists who are unjustly prosecuted.

"We're not dropping the ball," he said. "When we speak up about this harm and overreach, we can be heard and make a difference."

Chief External Affairs Officer Francis Slakey pointed to data indicating how urgent these issues are for international scientists.

"In an APS survey of international graduate students and scientists who chose not to come to the US, nearly half of them said it was because they perceive the US is unwelcoming," he said. "And for those who did come to the US, nearly half said the federal government's response to research security makes them less likely to stay long term."

*Listen to the webinar at go.aps.org/TheirWordsWebinar.*

*Tawanda W. Johnson is APS Senior Public Relations Manager.*

MEETINGS

# March Meeting Brings Physics Fiesta to Chicago School

BY MEREDITH FORE

The annual APS March Meeting brings thousands of physicists together in one city—but this year, a group of physicists brought their enthusiasm for physics into the community. "It's not what Chicago can do for APS, it's what APS can do for Chicago," quipped Brian Schwartz of the City University of New York, invoking the classic Kennedy quote. The idea: A Physics Fiesta, hosted at Chicago's Eric Solorio Academy High School.

Schwartz and Smitha Vishveshwara, of the University of Illinois Urbana-Champaign, have experience bringing cultural events to APS meetings: In previous years, they had organized physics-related theater performances for attendees of the March and April Meetings. But before physicists descended upon Chicago for the 2022 March Meeting, they and collaborator Shireen Adenwalla of the University of Nebraska–Lincoln—all physicists and APS members themselves—wanted to shake things up. Instead of bringing culture and art to the physics meeting, what if APS, working with local physicists, brought science education and physicists into the Chicago community?

Young participants at Physics Fiesta, an APS March Meeting community event.

CREDIT: ERIC SOLORIO ACADEMY HIGH SCHOOL

Russell Ceballos and Patrick McQuillan, local physicists of the Chicago Quantum Exchange, pitched Solorio as an ideal venue for the event. Solorio, which has a student population that's over 95% Latinx and over 90% low-income, is one of Chicago's top public high schools. The after-school Physics Fiesta invited local students and their families to a "night of science," featuring physics demonstrations, science-themed Latin dance performances, a rap battle, and opportunities to meet physicists.

When the day came, the weather was typical for March in Chicago—

FIESTA CONTINUED ON PAGE 5

FYI: SCIENCE POLICY NEWS FROM AIP

# Biological Physics Should Be a Distinct Discipline, National Academies' Report Says

BY MITCH AMBROSE

This spring, the National Academies of Sciences, Engineering, and Medicine published a blueprint for cementing biological physics as a discrete field of physics, on par with disciplines such as astrophysics and condensed matter physics, rather than merely an application of physics techniques to biology. The report, assembled by a 13-member committee chaired by Princeton University physicist William Bialek, argues that the field now warrants more focused attention from funders and educators.

The report is the first-ever "decadal survey" of biological physics, an influential exercise the National Academies uses to recommend ten-year strategies for major fields of science.

Biological physics is a deeply diverse field. New technologies and scientific advances have made it possible to "find the physics" in ever-more complex living systems, "ranging from the folding of proteins to the flocking of birds, from the internal mechanics of cells to the collective dynamics of neurons in the brain," the report says.

This breadth is a strength of biological physics, but also a challenge: The field's funding sources are scattered across federal agencies, and the field sometimes lacks a clear home within them, the committee concluded.

For instance, the National Institutes of Health (NIH) allocated about $60 million annually for biophysics research over the past decade, but the grants came from 75 of the roughly 200 study sections the agency uses to review applications—a big number, according to the committee. This fragmentation has forced researchers to define their work "in relation to the communities represented by the study sections, thus working against the emergence of biological physics as a field of physics," the committee found. To remedy this, it recommends that NIH form study sections devoted to the full breadth of biological physics.

The Department of Energy (DOE) could also do more to embrace the field, the committee argues. The DOE currently supports a broad portfolio of research and facilities that are directly relevant to biological physics, such as X-ray and neutron sources used to characterize protein structure. However, DOE is constrained by its formal mission, sometimes making it difficult for the agency to justify facility investments based on their relevance to biological physics, the committee wrote. Accordingly, the report calls for Congress to expand the agency's mission to explicitly include partnering with the NIH and the National Science Foundation (NSF) to construct research infrastructure for biological physics.

The NSF was the only agency the committee found to have a program dedicated to the full breadth of biological physics. For two decades, the NSF has had a "Physics of Living Systems" program that funds diverse research, from single-cell dynamics to the collective behavior of animal populations. But the program is still relatively small, spending only a fifth of what the NIH does on biological physics, the report notes.

And no matter the agency, budgets for biological physics are tight, the committee argued, hovering "dangerously close to the minimum needed for the health of the field."

Funding isn't the only challenge: Many physics degree programs lack biophysics education. The committee noted that many physics undergraduates never encounter the subject, despite its value in demonstrating physics' relevance to present-day problems.

"Typical core physics curricula today hardly require undergraduates to learn anything that happened after 1950, while modern biology and computer science focus on ideas and results from after 1950," the committee writes. "Should we be surprised, then, to hear people speak of physics as the science of the past, while biology and computing are the sciences of the future?"

*Mitch Ambrose is the director of FYI. Published by the American Institute of Physics since 1989, FYI is a trusted source of science policy news that is read by congressional staff, federal agency heads, and leading figures in the scientific community. Sign up for free FYI emails at aip.org/fyi.*

HONORS

# APS 2022 Distinguished Lecturer, Sufi Zafar, Says Physicists Should Explore New Fields

BY DANIEL PISANO

Sufi Zafar, physicist and researcher at IBM's T.J. Watson Research Center, received the APS Distinguished Lecturer Award for 2022. *APS News* spoke to her about her unique career path, and what advice she'd give to other physicists.

The award—sponsored by APS's Committee on Careers and Professional Development (CCPD) and the Forum on Industrial and Applied Physics (FIAP)—honors physicists in non-academic careers for significant contributions to physics, and for their ability to give engaging lectures to both experts and non-experts.

Early in her career at IBM, Zafar became interested in biosensors and wanted to learn more. "I taught myself basic biology by mainly using free educational resources available on the internet," she says. When she had questions, she would reach out to friends and acquaintances. As her knowledge expanded, so did her reading: She began devouring research papers, searching for opportunities to collaborate.

It wasn't easy. "The first collaboration was difficult," Zafar says. She approached several researchers in her free time before finding some who would work with her, but it paid off with two published papers, in 2004 and 2008.

"[This collaboration] helped me identify unmet needs in life sciences that could be addressed by physics and engineering principles and semiconductor technology," she says. It also helped her launch her first biosensing device research project.

A stock photo of a biosensor implant. Dr. Zafar's work on biosensors started more than a decade ago, after she taught herself basic biology online.

Since then, Zafar has become a leader in interdisciplinary research in biosensors, device and material physics, data modeling, and nanofabrication. Her biosensor work has achieved commercial success, too: "I focused on devices with design, materials, and fabrication compatible with semiconductor technology. This compatibility allows biosensing devices to be cost-effectively manufactured in a semiconductor foundry." Those early, deliberate considerations were vital for what happened next: "We were approached by NanoDx Inc for commercialization rights of HfO2 finFET biosensing devices," she explains.

Throughout her career, she says, her background in physics has been "invaluable" as she navigated new fields, like biology.

All told, Zafar has contributed to 79 top-tiered journal publications (she is first author for 25) and filed 84 patents. She has received prestigious awards and honors, including IBM Outstanding Technical Achievement Awards (2013, 2018), IBM Master Inventor Award (2017), IBM Outstanding Innovation Award (2021) Senior IEEE Member (2014) and American Physical Society Fellow (2009).

For Zafar, the important thing is to keep learning. She advises other physicists to go outside their current areas: "It opens opportunities to work on problems that are not only interesting, but can play an essential role in addressing urgent global issues, such as climate change, healthcare, and food security."

And better still, says Zafar, it's enjoyable: "I've also found learning a new area to be a fun process."

*Daniel Pisano is APS Director of Industrial Engagement.*

FIESTA CONTINUED FROM PAGE 4

rainy, windy, near-freezing—but that didn't stop 500 students and parents from filling the Solorio auditorium-gymnasium.

"I think it was one of the highest attended events that we've had," said Laura Vaca, STEM Program Manager at Solorio. "We saw students and parents from the community, from other neighborhood schools. It was a really, really good crowd."

Attendees visited booths manned by physics professors, postdocs, and graduate students, who distinguished themselves with large, comical hats styled after the periodic table. Several booths, organized by scientific institutions across the state, led demonstrations. At one booth, participants stood on carts and tossed balls back and forth, demonstrating conservation of momentum when both the catcher and thrower rolled away from each other. In a center-of-mass experiment, Schwartz had children and parents try to get up from sitting in a chair without putting their feet under it and leaning forward—an impossible task. Another booth demonstrated a superconducting track, above which an ultra-cold, fast-moving puck appeared to float, a quirk of quantum mechanics.

Another booth allowed students to "speed-network" with physicists, including a Solorio physics teacher. Students took turns quizzing these experts about their careers and research.

"One of them asked me, 'what's the best life advice you got?'" Vishveshwara said. "Tough question! I replied that it took a long time to realize this, but no matter what people tell you and how they try to shape you, just be yourself, and allow your passion and love to come through. And I could see their eyes light up."

Stage performances were another highlight of the evening. Professor Lyrical, the stage name of Peter Plourde of the University of the District of Columbia, performed a STEM-themed rap; Physics Van, a traveling science performance group from the University of Illinois Urbana-Champaign, performed a skit with Star Wars characters that used lasers to burst balloons; Solorio's Mexican Folkloric Dance Group, Los Alebrijes, built on the light theme with a traditional Mexican dance in which dancers balanced lit candles atop their heads; and Solorio's Latin Jazz band provided lively entertainment.

Alexa Uribe, a Solorio senior who performed in Los Alebrijes, said she was very impressed with the student and community turnout. "The audience's enthusiasm and interest radiated throughout the entire gymnasium," she said.

For the Physics Fiesta's finale, everyone feasted on Chicago deep dish pizza, tamales, and traditional Mexican drinks like horchata and agua de jamaica.

"Many of the families came up to me to thank me at the end of the night," said Victor Iturralde, principal of Solorio. "I could really see the excitement in the young people. I thought to myself, I think we're planting real seeds here. I'm totally confident that there are kids who are going to go into the sciences because of this event, because of the seeds that were planted."

Encouraged by the success of Physics Fiesta, Adenwalla, Schwartz, and Vishveshwara said they are looking forward to working with more APS members and units to plan similar community-based outreach events at future APS Meetings, including next year's, which is slated to take place in Nevada.

"Watch out, Las Vegas!" said Schwartz.

*The event was supported by the APS Forum on Outreach and Engaging the Public, chaired by Adenwalla, and the Division of Condensed Matter Physics, chaired by Vishveshwara.*

*Meredith Fore is a science writer for the Chicago Quantum Exchange.*

HISTORY CONTINUED FROM PAGE 2

enough attention from investors that he was able to finance another Arctic trip in 1902.

The expedition helped Birkeland understand how Earth's polar electric currents, called auroral electrojets, cross paths with electricity that moves vertically along geomagnetic field line currents. The latter are called Birkeland currents today, and they bridge Earth's magnetosphere and ionosphere. The expedition also helped him conceptualize how sunspots—solar regions with cooler temperatures caused by fluctuations in the Sun's magnetic field—stimulate auroras. In 1908, Birkeland published these theories in a book titled *The Norwegian Aurora Polaris Expedition, 1902-1903*.

After the expedition, Birkeland—eager to fund his next trip—continued to rally investors for his electromagnetic cannon. But in 1903, the gun violently malfunctioned during a public demonstration, spewing flames in a deafening crack. "It was the most dramatic incident in my life," Birkeland said later.

Birkeland's ardor for the cannon faded, but not before he realized he could repurpose the invention for another, stranger use: fertilizer. Global populations were exploding, but there was not enough natural saltpeter fertilizer—vital to the world's agricultural needs—to go around.

To solve this, Birkeland suspected components from his cannon's design could be repurposed to produce nitric acid for artificial fertilizer. He wanted to build a furnace to test the plan, but he needed money. He shared his idea with an industrialist named Sam Eyde, who agreed to gather investments and let Birkeland use his waterfall properties to test the furnace.

But the partnership was doomed. Once Birkeland finessed the nitrogen fixation method today called the Birkeland–Eyde process, Eyde—eager to solidify his own wealth and prestige—began excluding Birkeland from their new company, nowadays known as Norsk Hydro. Birkeland had a nervous breakdown. The doctor prescribed him the barbiturate veronal, to which became Birkeland became addicted—and which would, only a few years later, claim his life.

Relegated to the edges of the fertilizer company, Birkeland used the proceeds he did manage to secure to return to auroral research. This time, he wanted to bring auroras into the laboratory by building a terrella, a small magnetic ball representing the Earth, first pioneered in the 1600s to model geomagnetism. Birkeland's terrella mimicked how the Sun's solar winds were triggering electromagnetic storms. Convinced the project would force the global scientific community to accept his research, Birkland held a public lecture in 1913, but it made no impact in England.

Dismayed, Birkeland left for Egypt to find and study another auroral event: the Zodiacal Light, an eerie, triangular patch of white light that can appear on the horizon during sunrise and sunset. He suspected that the Zodiacal Light was evidence of charged electrons from the Sun, and he wanted to calculate how these electrons, today called cathode rays, reached Earth.

His research went well for a time, but when World War I broke out, his expat community returned to Europe. Birkeland remained in Africa, growing increasingly isolated and paranoid. His dependency on veronal skyrocketed. In a last-ditch effort to find reprieve, he traveled to Tokyo to reconnect with an old colleague, but his mental and physical health spiraled. On June 15, 1917, he took a dose of veronal 20 times the amount he was prescribed and died in his hotel room alone. It's not known whether the overdose was accidental.

At the time of his death, Birkeland was still seeking international recognition for his discoveries. But it would be another 50 years before that validation came. In 1967, a United States Navy space probe finally recorded observations of Birkeland's solar winds and electromagnetic interactions, confirming the theories that Birkeland had developed so many years before. Today, he is celebrated as a pioneer in atmospheric electromagnetism, a contribution perhaps best summed up by the nickname given to him by his alma matter, the University of Oslo: "King of the Northern Lights."

*Abigail Eisenstadt is a science writer at the American Association for the Advancement of Science.*

**Further Reading:**

Jago, Lucy. *The Northern Lights: The True Story of the Man Who Unlocked the Secrets of the Aurora Borealis.* New York, New York: Alfred A. Knopf, 2001.

Brown, Bruce. "The Shining: The Mysterious Power of the Northern Lights." *The New York Times*, December 12, 1982.

"The King of Northern Lights." *Apollon.* University of Oslo.

NWS CONTINUED FROM PAGE 3

also home to TRIUMF, Canada's premier particle accelerator, located in Vancouver.

As is typical for APS geographical sections, most of NWS's activity centers on its annual meeting. Each meeting typically draws 100 to 150 participants and features a slate of talks by leaders in different fields, along with presentations and a poster session.

For NWS Chair Andrew Dawes, a professor at Pacific University in Oregon, the NWS Annual Meeting has personal significance: It was the first physics conference he ever attended as an undergraduate. He described the NWS Annual Meeting as an excellent way to hear updates from a broad range of physics fields and compare notes with other researchers in the region.

"I've discovered a lot of great connections that I wouldn't have necessarily made at bigger meetings," he explained. "As a professor at a smaller college, it is so valuable to see what's happening at similarly sized and scaled institutions. The NWS Annual Meeting is accessible to smaller institutions, so we can see what types of research work, what types of programs work, and how different departments are thriving and growing."

The meetings are also accessible to a wider range of people, given the lower costs associated with regional travel. To this end, the executive committee changes the meeting location from year to year, choosing host institutions in different areas in the region to encourage participation.

Still, Dawes acknowledged that traveling to the meetings can be a challenge for many in such a large region, and the executive committee must strike a difficult balance between the main hubs in Seattle, Portland, and Vancouver and smaller hubs in Idaho, Wyoming, Montana, and Alberta.

"On the surface, the sheer size of this section might make things seem slightly less 'regional,' but in the northwest, we're used to things being spread out," he explained.

NWS's 2022 Meeting is fast-approaching, scheduled for June 3-5 at Thompson Rivers University in Kamloops, British Columbia—a four-hour drive northeast of Vancouver.

For those on the fence about attending, the meeting location may be a draw. Kamloops is a nature-lover's dream, with an extensive network of hiking and mountain-biking trails and more than 100 lakes in the area for kayaking and fishing. Kamloops is also home to a thriving scene of local wineries and microbreweries, perfect for after-conference socializing.

The meeting website promises "a breadth of physics presentations, from subatomic to cosmic." Plenary sessions will cover the latest updates from the TRIUMF particle accelerator, new data from the Canadian Hydrogen Intensity Mapping Experiment (CHIME), and discussions on nuclear astrophysics, low temperature physics, and atomic interferometry. Dawes highlighted an additional session that will bring together physics department chairs from several institutions to discuss ongoing challenges in higher education—namely, demographic change and dips in enrollment from the COVID-19 pandemic.

Students make up more than 30% of NWS's ranks, and the Annual Meetings are designed to be extremely student-friendly. The meetings enable students to present their research outside their own schools, often for the first time, and the wide range of fields represented at the meetings can help students learn to tailor their talks to a broad audience—a vital skill. Students who attend also get plenty of opportunities for career development. This includes careers outside academia, paths that are often unfamiliar to young scientists.

Overall, NWS stands out as a lively and inclusive geographical section, offering members—especially students—professional development, learning opportunities, and community. Visit the NWS website to learn more.

*Abigail Dove is a freelance writer in Stockholm, Sweden.*

ETHICS CONTINUED FROM PAGE 4

by a candidate for an APS honor or appointment; one of those candidates was disqualified.

Also in late 2021, the committee, for the first time, received requests for revocation—in other words, appeals for individuals who don't meet expectations of ethical behavior to be stripped of APS honors, leadership positions, or membership. The committee is reviewing these requests now.

Much work remains. For example, the committee must clarify policies regarding people who *enable* unethical behaviors in others, as well as clarify penalties for people who have violated standards but whose actions don't warrant a revocation. The committee must develop clearer procedures for handling misconduct and ensure that members know these procedures.

This is difficult work. Committee discussions can be tough and uncomfortable, and gray areas abound. On multiple occasions, the committee has had to navigate uncharted territory, relying heavily on the expertise of the APS ombudsperson. We are listening and learning.

But it's also vital work. After all, APS's ethical guidelines reflect the Society's enduring goals: to promote truthfulness and respect and ensure that the physics community is welcoming to all.

*If you believe you have witnessed or experienced an ethics violation, review the APS Guidelines on Ethics at www.aps.org/policy/statements/19_1.cfm. To report a breach of APS ethics standards at an APS event, visit aps.ethicspoint.com; to report another form of ethics violation, email ethics@aps.org.*

*Nan Phinney is Chair of the APS Ethics Committee. Jeanette Russo is APS Corporate Secretary.*



METHANE CONTINUED FROM PAGE 1

gas generated by human activities, and its 100-year global warming potential is more than 30 times greater than carbon dioxide's. Because methane remains in the atmosphere for about a decade—compared to centuries for carbon dioxide—actions taken today would have a significant positive impact in the short term.

The APS-Optica report assesses the current state of monitoring US methane emissions from oil and gas operations, which account for roughly 30% of US human-caused methane emissions. It also offers recommendations to inform investments in research to improve the nation's detection capabilities and strengthen monitoring policies throughout the US. APS and Optica partnered on the study for more than a year, leveraging their scientific communities' expertise in remote sensing, modeling, and monitoring of greenhouse gasses from a variety of space-, air-, and land-based platforms. The report's authors include experts from several national laboratories and universities. Independent experts also reviewed the study before its publication.

The study concludes that the US is not effectively monitoring methane emissions, in part because there are no calibration standards that would enable the comparison of methane emissions data collected from different technologies. The report's authors also maintain that a large portion of the total emitted methane from oil and gas operations originates from a small number of sources, including leaks. Quickly identifying and mitigating large leaks could potentially reduce the costs of producing oil and gas while significantly reducing emissions. For methane emission regulation to be most effective, it should target the small portion of leaks that are major emitters, the report states.

To support emerging national and international efforts to reduce methane emissions, the report offers seven recommendations that address methane emissions detection, reliable and systematized data and models to support mitigation measures, and effective regulation.

Among the recommendations, APS and Optica identified two crucial first steps toward addressing climate change. The organizations urge the federal government to:

- Establish national facilities for testing new technologies and intercalibrating methane measurements that would support a tiered and federated observational network.
- Establish a unified national database of observations of methane concentrations and emissions, open to the international climate community, to help monitor progress toward emission reduction targets.

*Tawanda W. Johnson is APS Senior Public Relations Manager.*



HOBBS MOORE CONTINUED FROM PAGE 1

spoke about educating kids in STEM fields; the latest physics research, especially optics; and the history of Black physicists. I mentioned our efforts to increase the number of Black PhDs at UMich and elsewhere, and she told me that UMich and Princeton were among the top producers of Black physics PhDs in the 1950s and 1960s. Willie had a natural way of providing context and perspective.

Over the next couple of years, we would catch up at and after the Saturday Academy. But in early 1994, Dr. Hobbs Moore stopped volunteering. I didn't know why; all I knew was that I missed our conversations.

As I learned later, she was losing her 24-year-long battle with cancer. On March 14, 1994, she passed away in her Ann Arbor home. She was only 59 years old. Her death was a profound loss for science, and for the communities she cared about so much. I remember so well her wit, wisdom, and warmth; our times together remain some of the most memorable experiences of my life.

The following year, the National Conference of Black Physics Students awarded Dr. Hobbs Moore the inaugural Edward Bouchet Pioneer award, given to distinguished physicists in honor of Dr. Bouchet, the first African American PhD physicist in the US.

This year, in commemoration of the 50th anniversary of Dr. Hobbs Moore receiving her PhD, I organized a symposium at the APS March Meeting addressing the topics we discussed at the Saturday Academy all those years ago. The symposium was sponsored by the National Society of Black Physicists, African-American Women in Physics, and APS Committees on the Status of Women in Physics and the Committee on Minorities.

After a welcome address from APS Past-President Dr. S. James Gates, a roster of exemplars spoke. The founder and CEO of the organization African-American Women in Physics, Dr. Jami Valentine, discussed the history and current status of Black women in physics. Dr. Gerceida Jones from New York University spoke on her STEM education efforts for Black and Brown youth in New York City. Dr. Nadya Mason from the University of Illinois Urbana-Champagne introduced her group's latest superconductivity research.

> "In early 1994, Dr. Hobbs Moore stopped volunteering. . . . As I learned later, she was losing her 24-year-old battle with cancer."

The session concluded with a panel discussion on representation in physics. The discussion was nuanced and memorable, moving the conversation beyond merely discrimination, or "bias against," to include the shortcomings of in-group favoritism, or "bias for."

I also shared what I learned from her daughter, Dr. Dorian Moore, a few months ago—that to her children, Dr. Hobbs Moore referred to me as their brother, and that she talked about me the day she passed away. She hadn't wanted to tell me about her illness because she didn't want to distract me from my studies. To me, this was a sign of her deep, enduring care for those around her.

After the webinar, I posted a recording of the event on LinkedIn. Don Coleman, the former associate provost at Howard University and a good friend of mine, noted that Dr. Hobbs Moore had tutored him when he was an engineering student at the University of Michigan. He recalled that she taught from the fundamentals, and always made him feel as though she were merely reminding him of what he already knew, rather than teaching him unfamiliar things. Don said he wasn't surprised that Dr. Hobbs Moore pursued a physics PhD, given her mastery and depth of knowledge.

One of the most insightful questions that arose during the symposium was whether Dr. Hobbs Moore considered herself a pioneer. She and I never discussed this. But in the middle of a battle, does an extraordinary soldier stop to think about whether they're a hero? I imagine they believe their actions are part of their duty. And Dr. Hobbs Moore had many duties: She was a physicist, researcher, and executive as much as she was a teacher, community leader, and advocate.

Perhaps most importantly, she was a mentor, a lifelong learner, and—to me and so many others—a friend. My life has been made richer by my encounters with Dr. Hobbs Moore, and I hope her story and legacy have enriched your life, too.

*Dr. Donnell Walton is director of the Corning Technology Center Silicon Valley.*

FARA CONTINUED FROM PAGE 3

**I had not thought of Isaac Newton as particularly masculine. Why do you call him that?**

As far as I was concerned, he was the furthest removed from anything to do with women. There were few women in his life. He was dedicated to physics and maths, which are very masculine subjects. I don't think any other woman has ever written a book about him.

I used to give lectures after I wrote that book. Instead of a straight biography, it was an account of how he became so famous, and how his reputation shifted over the centuries. There would be a clutch of elderly men in the audience who would stick their hands up and say something patronizing: "Well, dear, you don't quite understand gravity," or whatever it was. I just glared at them and said, "Yes, I do. I have a degree from Oxford in physics." It was extremely satisfying, because it shut them up.

**Sometimes the most-repeated stories about scientists may not even be historical fact, such as Newton discovering gravity when he saw the apple fall from the tree. Why are these stories so popular?**

Particularly in Europe and the Americas, they're foundational stories based on stories from the Bible and the mythological stories of the ancient Greeks. The same story gets reworked and retold for different people. The Newton story is the same story as James Watt inventing the steam engine when he watched a kettle boil, and they're both based on the archetype of Archimedes jumping out of his bath and shouting, "Eureka!" when he'd worked out how to find the volume of a crown. People grew up with these stories, and they're very comforting.

**In your book *Pandora's Breeches* (2004), you point out that women's stories suffer from similar pitfalls. What are the tempting feminine myths that we tend to repeat without solid evidence?**

A common story is victimization. We create these great women that were suppressed, and we forget to look at what the women were actually doing. One famous example is Rosalind Franklin. She emerges as the woman who was completely marginalized and badmouthed by Watson and Crick, who stole her photo of DNA and took all the glory for themselves. But you can tell a completely different story about her. She was only working on DNA for about a year and a half. After that, she was one of the founding mothers, if you like, of the science of virology. She was the first person to analyze the structure of the tobacco mosaic virus. She was working on the polio virus and various other viruses at the time that she died. Her work was continued by Aaron Klüg, who won the Nobel Prize. So presumably, she would have got the Nobel Prize if she hadn't died. It's a completely different version of her life, where she's a successful woman. But the trope is to write about women who fail.

Another good example is Dorothy Hodgkin, who is still the only British woman who has won a Nobel Prize for science. She's virtually unheard of in the UK. I think it's because she seems to have been a nice, hardworking, ordinary woman. She had three children, and she did absolutely amazing science. But that's not as dramatic as talking about Rosalind Franklin being totally subverted by Crick and Watson.

Also exciting to think about a question and express your point of view.

**What is your opinion about the word "genius?"**

It's the secular equivalent of saying that somebody is a saint. People were elevated to sainthood before because they carried out miracles. Their birthplace would be converted into a shrine. Isaac Newton's cottage where he was born in Lincolnshire has become a shrine for scientists who visit that place from all over the world. There's something special about the air because Isaac Newton breathed it. The apple tree in the garden is like a holy relic.

"We ought to confront the shortcomings. We have to face up to what human beings are like. Just because you produce a great scientific theory doesn't mean you're not a corrupt human being. People like Newton and Schrödinger don't belong up on a pedestal."

**What have you thought about the Hollywood treatment of the history of science?**

The women's appearances are always terribly important, where it's just not so for the men. There's always a romantic story involved. All the films about Marie Curie, for example, focus on her love affair with Pierre Curie, and they make her very beautiful. There was also a film about Mary Anning, the geologist, which I haven't seen. They made her have a lesbian love affair with the wife of another geologist. There's absolutely zero evidence of that.

**Do you think that scientists would benefit from learning history during their scientific training?**

Yes. It's really good for them to learn about the history of their subject, along with some aspects of philosophy, which will teach them about ethics. History also teaches them how to write and make persuasive arguments, which they need for writing papers and grant proposals.

It's also an opportunity not just to regurgitate facts, but to express opinions. Our questions don't necessarily have a right answer, as long as you can back up what you're saying. That's very important for students to learn. For example, I might ask the question, would Charles Darwin have formulated the theory of evolution by natural selection if he hadn't been on a voyage on the *Beagle* around the world? Nobody can know the answer to that question, but my students adopt one view or the other and are adamant that they're right. It's exciting to think about a question and express your point of view.

Many people like to think of great scientists of the past as qualitatively different from other people. That's something, for example, that Stephen Hawking tried to latch onto. He presented himself as a natural successor of Galileo and Newton. It's an attractive story, but it divorces science and scientists from ordinary society. Science is absolutely imbued with political and commercial and personal considerations. Scientists are just people. We need to recognize that, because otherwise, we have a completely artificial view of what scientific knowledge is all about.

**Recently, some journalists have publicized the unsavory personal lives of certain famous scientists. I'm thinking of Erwin Schrödinger, whose pedophilia was recently [featured in *The Irish Times*](), along with scientists who took money from Jeffrey Epstein. How do you make sense of stories like these?**

We ought to confront the shortcomings. We have to face up to what human beings are like. Just because you produce a great scientific theory doesn't mean you're not a corrupt human being. People like Newton and Schrödinger don't belong up on a pedestal. There's a phrase by the historian E.P. Thompson—"the condescension of posterity"—where it's very easy to think that we're absolutely perfect today. But what are people going to think in 100 years' time of the way we live?

*Sophia Chen is a writer based in Columbus, Ohio.*

TEACHING CONTINUED FROM PAGE 1

their confidence in the field. I've known for years that international collaboration is vital to these goals, but it wasn't until last fall that I grasped the enormous potential of online teaching in achieving this collaboration.

After pandemic-related delays, I began organizing a course with lectures on atomic astrophysics, complete with computational workshops, which would take place over three weekends in October 2021. The course would be supported by OSU's Indo-US STEM Education and Research Center and India's Aligarh Muslim University, and it would utilize the facilities of the Ohio Supercomputer Center.

I invited a few faculty members and students to attend the course, but news traveled fast, and before long, more than 100 people had signed up. They came from universities across the world—Bangladesh, Egypt, Ethiopia, India, Mexico, Morocco, Pakistan, Palestine, Saudi Arabia, the United Arab Emirates, and the United States.

From the very first day of the course, the attendees began connecting, despite being separated by thousands of miles. Participants found common interests and sought ways to help one another, even forming a WhatsApp group to discuss assignments and work out technical issues. Each session lasted four hours and ended at 4pm ET—3pm in Mexico, from where student Aldo Calderon was calling; 2am in Bangladesh, home of participant Mahbuba Aktary; and many time zones in between.

Better still, the online format enabled participation that might have otherwise been difficult for some participants. One participant, Dr. Rahla Nagma in India, listened to lectures while her two young children slept nearby; Habib Abdurrahman Arebu, a student from Addis Ababa University in Ethiopia, periodically battled internet issues but was undeterred. Both excelled on the exams.

Beyond diversity in national origin, language, and background, the participants brought a diversity of physics experience. Whether experimentalists or theorists, undergraduates or seasoned professors, all had unique expertise, and all sought to learn.

The lectures covered atomic and plasma physics (including computations in atomic structure and R-matrix method), astronomy, and spectroscopy, all complemented by hands-on computational workshops on research. There was plenty to learn, but the participants were eager, capable, and sincere. I was thrilled when they received their certificates.

It's hard to overstate the significance of opportunities like this, which would have seemed unthinkable just a few years ago. But now more than ever, the physics community has the tools it needs to support the best and brightest minds, no matter who they are or where they're from—to make physics education and research truly global.

To do my part, I've worked to expand the benefits of APS membership to international scientists. I teach internationally twice a year, and I've helped international participants of these courses, and students and faculty from 29 countries, to become APS members for free under the Matching Membership Program. When I served on APS's Forum on International Physics from 2012 to 2014, I successfully advocated for free membership for physicists in under-represented countries in Arab countries, Asia, and beyond.

But more must be done. I believe this October 2021 course can serve as an example of effective teaching and collaboration in the global physics community—a community that, like physicists' passion for their work, knows no borders.

*Dr. Sultana Nahar is a professor of astronomy at the Ohio State University, co-author of the textbook* Atomic Astrophysics and Spectroscopy, *creator of the NORAD-Atomic-Data, co-director of the STEM ER Center, and adjunct professor of physics at Aligarh Muslim University and Cairo University.*

EDITOR CONTINUED FROM PAGE 1

quantum computers work? What lies beyond the Standard Model? How do we make physics welcoming for everybody?

There's so much to learn, and I can't wait to dive in with you.

So what comes next for *APS News*? We'll start with some exciting changes. We'll grow the newsletter's digital presence to reach more people. We'll expand our pool of talented writers to tell the stories you want to read. We'll partner with you to publish your thoughts and opinions, so that more readers can engage.

We'll need your help. This publication is, after all, for you. What do you love to read? What stories do you hope to tell? We want to publish interesting ideas and fresh perspectives, and we need our readers to plant the seeds.

So when you send a letter to the Editor, I'll be on the other end, eager to work with and learn from you.

*Taryn MacKinney is the Editor of* APS News. *You can reach her and the* APS News *team at* [letters@aps.org]().

# THE BACK PAGE

## Physics in a Diverse World—or, a Spherical Cow Model of Physics Talent

BY HOWARD GEORGI

I suspect that many of you, when you think about diversity in physics, feel as I did for much of my life. We say to ourselves something like, "I am a good person and I would like to increase diversity in physics, but we face societal obstacles not of our own making and there is nothing I can do."

I don't want this article to sound judgmental, and I don't want to hold myself up as a role model. In fact, I'm embarrassed that it took me almost 45 years to realize that assuming there's nothing I can do is both morally untenable and bad for physics. For me, the epiphany came when I was chairman of the Harvard Physics Department in 1992, and it dealt with gender diversity.

By this time, I had been teaching at Harvard for over 15 years. Helen Quinn was at Harvard when I arrived as a postdoc, and we had many discussions about the dearth of women in physics. I knew it was a problem, but I didn't see how I could help. I thought my job as a physicist was just to do good physics, and I thought my job as a teacher was just to organize a subject in a deep and interesting way (which I enjoyed), come up with devilishly clever problems (which I also enjoyed), and give lectures (which I was never very good at). I was lucky to be at an institution where I could get away with this and where I had a stream of spectacular graduate students. Our high energy theory group in the 1980s included Shelly Glashow and Steve Weinberg, so we had our pick of students who wanted to do particle phenomenology, and many of them ended up working for me, including four amazing women: Sally Dawson, Ann Nelson, Lisa Randall, and Liz Simmons.

Ann Nelson's class in particular had a positive influence on the culture of the department. For example, they initiated a "Puppet Show" in which second-year students made anonymous fun of the faculty (represented by silly puppets) to give first-year students the real scoop about the department. This wonderful tradition is still going on. But the number of racial minorities in the applicant pool was still almost zero. And when the women graduate students tried to explain that there were real problems for women in physics, I still didn't get it.

Meanwhile, I was having a wonderful time teaching undergraduate courses, too. Many undergrads hung out in my office, and I got to know many of them well. Again, some of the women tried to explain how difficult the physics culture was for them, but it wasn't getting through my thick skull.

This changed when, in 1992, I saw data showing that the men who graduated in physics loved their time in the Harvard physics department, but the women hated it! And these were women who stuck it out and graduated, despite feeling like outcasts. Finally, I understood what the women had been saying. They were in an abusive relationship with the Harvard Physics Department. This was just not right.

> "Finally, I understood what the women had been saying. They were in an abusive relationship with the Harvard Physics Department."

So what's wrong with saying, "there is nothing I can do"? We do face societal obstacles, and we must do everything in our power to break them down. Many children who could become outstanding scientists cannot imagine careers as physicists, and far too many minority kids could not afford to pursue a physics career even if they dreamed of it. And it's an understatement to say that one of our major political parties is not trying to change this. I know many of you are working hard with outreach and teaching to chip away at this problem.

But we also put up a daunting obstacle of our own making. Perhaps subconsciously, we see physics as survival of the fittest, and we look for the apex predator who will fight their way to the top of the food chain. So in our teaching, admissions, and hiring, and most importantly in our own heads, we make ordered lists and search for "the best."

This isn't surprising. We're drawn to physics because we want real answers to real questions. We aren't satisfied unless our understanding is quantitative and expressible in the language of mathematics. And we submit our answers to the ultimate test—quantitative comparison with experiment. So naturally, we tend to quantify our thinking about physicists: If white male applicant A is higher on our ordered list than minority applicant B, we must choose A, and there's nothing we can do about diversity. But this is nonsense.

I am *not* suggesting naive affirmative action. Few things damage the cause of diversity more than choosing an applicant who is not outstanding. The first requirement for any candidate is that they must be able to do a great job. The trouble is that for physics, one doesn't know exactly what the job is, and the assumption that we can unambiguously order outstanding people makes no sense. We physicists should know better than anyone that there are quantitative questions that don't have answers, like which of two space-like separated events comes first.

Here, I want to talk to you established physicists out there. I know that each of you has incredible skills that you've worked hard to hone and use productively. But I also believe that each of you has a *different* cocktail of skills. I know there are some things I'm better at than other things; I see a similar diversity of skills in my students and colleagues. And looking back on my long career, I've had the privilege of collaborating with almost ninety amazing physicists, including dozens of winners of physics prizes. And I've gotten to know many people without actually collaborating (I shared an office for years with Ed Witten, a humbling experience). All these people are amazing intellects, but each is amazing in a unique way.

The conclusion I draw from years of physicist-watching is that if you want to quantify what makes a great physicist, you must use a space with many dimensions, a different dimension for each of the possible ways of thinking that may be important. I sometimes imagine a spherical cow model of physics talent in N dimensions where N is large and talent in each dimension increases from 0 at the origin to 1 at the boundary, the N-dimensional version of the positive octant of a sphere. This, I learned from Wikipedia, is called an "orthant." Each point in my N-dimensional orthant is a possible set of talents for physics. Great physicists are out near the boundary, far away from the origin. If we assume that the talents are uniformly distributed, you can see that in my spherical cow model, the fraction of possible physics talents within $\rho$ of the boundary grows N times $\rho$ for small $\rho$. If N is very large, as I think it is, then that means there's a lot of space near the boundary—so there are a huge number of ways of being a great physicist, including many ways we haven't seen yet. Diversity is critical to the future of physics, I believe, because it's imperative that we explore this vast space of physics talent, and that means encouraging people who are different and who think and act differently.

You can quibble about the details of my spherical cow orthant, but I'd be happy if this helps you recognize how damaging it is to rely on one-dimensional, ordered lists of people. Such a list represents only some arbitrary, one-dimensional projection from some higher dimensional space. This is why I think that working for diversity in physics isn't only a moral imperative—it's also the most useful approach for the field of physics.

So what can be done?

If you teach, you probably have to give grades, but I think you should give students sub-grades for several ways of excelling, and you should keep track of each separately. This makes it easier to encourage a diverse set of students and to explain that the final grade is a somewhat arbitrary combination. You should get to know your students as people and celebrate their uniqueness. Instead of forcing a younger colleague into a predetermined mold, encourage them to develop, be proud of, and effectively display their unique strengths. Sometimes this also means working to help your older colleagues accept new ways of thinking.

At the national level, you need to learn about the outstanding minority physicists in your own subfields. Invite them to give talks. Nominate them for prizes.

The most important thing you can do for diversity is to hire diverse faculty. I have seen this effect for women in my own department. We still have a long way to go, but our women faculty have made big changes to the department's culture and student morale. I look forward to the day when our department is equally diverse racially and culturally, which I believe will happen if we work harder to consider candidates as individuals with multiple skills rather than numbers in a ranked list.

Meanwhile, selection committees need to avoid overly rigid definitions of subfields, so they can search broadly. They need to avoid confusing aggressiveness or facileness with ability. They need to apply an appropriate implicit-bias factor for candidates who look like the selection committee and current department. They must look beyond the "old-boy network" and instead make a special effort to identify promising candidates who have not risen through the usual channels. None of this is easy.

There are certainly some rare super-super-stars who are so far out in the space of physics talent that they're clearly unique. If you find another Ann Nelson or Ed Witten, you should hire her independent of her minority status. But most candidates, like most of us, will just be "ordinary" good physicists who have a combination of skills that, with luck, will sometimes be the right skills to solve important problems.

While I care deeply about these issues, I know my own view is narrow, personal, and probably outdated in many ways, because the landscape changes with time. So let me close with a quote from a *Physics Today* article by Ann Nelson, my former student and an extraordinary scientist and person, whose passing was an incalculable loss to physics:

"If your career is established and you are not making an explicit and continual effort to encourage, mentor, and support all young physicists, to create a welcoming climate in your department, and to promote the hiring of diverse faculty members, you are part of the problem. This is a critical issue of civil rights in our field."

I've tried to argue here that this is more than a civil rights issue. It's the best way to ensure that physics will continue to be great.

So what is your assignment?

Your first job is to do great physics and enjoy it and communicate your excitement to the next generation. But you owe it to this field that we love to work to increase its diversity.

The most important thing is to keep at it! This is a job for optimists. Progress will always be slower than we'd like. But progress won't happen at all unless the good people who think that there's nothing they can do actually wake up—and start doing.

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