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APS NEWS

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MEETINGS

April Meeting: From Quarks to Cosmos via New York

BY DAVID BARNSTONE

The international scientific community will come together next month to explore a broad range of physics spanning astrophysics, particle physics, nuclear physics, and gravitation. Held online and in New York City from April 9 to 12, the 2022 APS April Meeting invites attendees to "bring [their] ideas" to the annual event representing 20 APS Units and Committees.

Among the nearly 200 planned sessions are talks by some of the world's leading scientists probing the fundamental forces and origins of the universe. They will present research on primordial black holes, gravitational waves, dark matter, physics beyond the standard model, and many other topics. Attendees won't want to miss a special session on the physics of the late Steven Weinberg (see APS News September 2021, *Steven Weinberg 1933–2021*) in addition to a variety of talks on neutrino physics and decarbonization strategies for addressing the climate crisis. Researchers will also discuss how to make the physics field more inclusive of people from diverse backgrounds.

The meeting will take place at the New York Marriott Marquis in the heart of Manhattan. A variety of travel and caregiver grants are available from APS Units. Those unable to travel to New York or who rather participate online will be able to take advantage of the meeting's virtual components, including live streaming of the invited talks. Contributed and focus session presenters are encouraged to upload a video of their talk to the virtual meeting platform. Poster presenters also have the option to upload a brief video presentation that will be made available to view by all registered participants. Both onsite and online attendees can keep up with the meeting on social media using the #apsapril hashtag.

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JOURNALS

Governance Changes Bolster APS's World-Renowned Journals

BY DAVID BARNSTONE

In late January, APS's elected leaders unanimously approved a new governance structure for APS's scientific publications. The new structure, which was developed in consultation with APS members, senior staff, and publishing professionals, is intended to strengthen and safeguard the excellence of the *Physical Review* journals and will be implemented in phases in the coming months.

"Our journals are among the best in the world, but their pre-eminence is at risk. Fierce competition, open access mandates, and other external pressures compelled us to carefully reconsider how we approach our editorial and publishing activities," says Philip Bucksbaum, the 2020 APS President and past chair of the Governance Committee.

At the direction of the APS Board of Directors, the Governance Committee developed a proposal to address these looming threats to the Society's journals. According to the committee, having the Editor in Chief (EIC) as both a senior staff position and a member of the Board hinders effective decision-making because it mixes scientific oversight with operations. Under the new structure, the EIC is an appointed, non-voting member of the Board, Council, and Board Executive Committee charged with overseeing the quality, relevance, scientific integrity, and editorial excellence of APS scientific publications, as well as the development and execution of APS's publishing strategy. Additionally, the EIC chairs and is advised by a restructured Committee on Scientific

JOURNALS CONTINUED ON PAGE 2

MEETINGS

Physicists Address Global Challenges at Leadership Meeting

BY DAVID BARNSTONE

International experts in physics and science policy met online January 27 for the APS Annual Leadership Meeting (ALM) to discuss the impact of research security concerns on the scientific enterprise, how to stem the flow of misinformation, and what it means to be a physicist. The Thursday sessions were free and open to the public as part of ALM, a forum for discussing the ways that the physics community can advance and diffuse the knowledge of and excitement in physics and ensure that all who want to practice physics find a welcoming and supportive environment.

The recordings are available to view online at leadership.aps.org. Highlights include:

- FBI Deputy Senior National Intelligence Officer Patrick Shiflett shared the agency's perspective on research security risks.
- PBS Science Correspondent Miles O'Brien moderated a panel discussion about barriers to international scientific collaboration.
- Researchers from industry and academia debated how to make physics more inclusive of nontraditional career paths.

In addition to the public sessions, APS members and leaders came together for the Annual Business Meeting as well as training for Unit officers and Board members. The ALM also included a full day of congressional visits (see the article *Teamwork Key to 2022 Congressional Visits Day* on page 1) and the debut of a short documentary film celebrating the recipients of the Society's highest honors (see the article *The 2022 APS Medal and Society Prize Ceremony* on page 7).

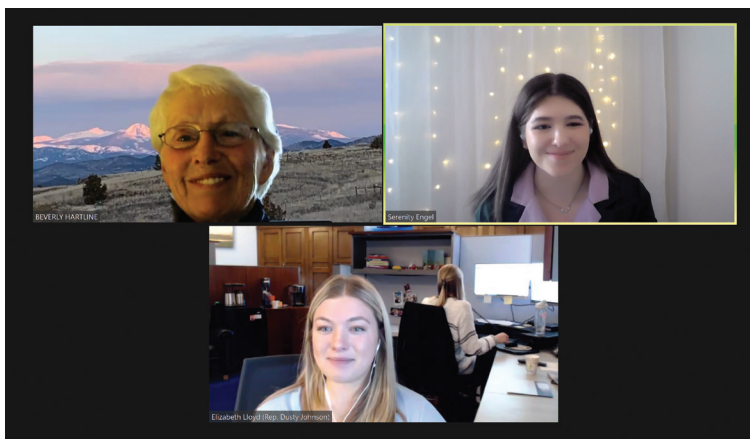
ADVOCACY

Teamwork Key to 2022 Congressional Visits Day

BY TAWANDA W. JOHNSON

If the 2022 virtual APS Congressional Visits Day (CVD) had a theme, it would likely be: "teamwork makes the dream work." That's because 69 APS members, with diverse expertise and backgrounds, worked especially well together while advocating for APS's science policy priorities during 103 meetings with congressional staff and three members of Congress.

"This year's CVD was a study in what great teamwork looks like. Some members were experienced in speaking with members of Congress, and others were brand new advocates," said Callie Pruett, APS Senior Strategist for Grassroots Advocacy. "Yet, everyone supported each other's advocacy and helped their teammates reach their full potential. I was thrilled with their enthusiasm. All in all, this CVD was one of our best ever."



APS members Beverly Hartline and Serenity Engel met with Elizabeth Lloyd, a congressional staffer in the office of US Representative Dusty Johnson (R-SD-At-Large District).

Similar to last year, to prepare for the event, APS developed concise and engaging information about the Society's science policy priorities. That content was featured on a widely praised user- and mobile-friendly website that was accessible by congressional staffers. APS members met with one another between meetings to ask questions, and provide real-time feedback to APS Government Affairs staff.

During their meetings, volunteers advocated for five science policy priorities, which were determined with input from APS members and leaders. They asked Congress to: complete the Fiscal Year 2022 appropriations, avoiding a full-year continuing resolution, and prioritize funding for key federal science agencies; support the "Keep STEM Talent Act," which would enable international STEM graduate students to both state their intent to stay in the US and pursue careers after graduation and provide them a path to a green card if they secure job offers from US employers after graduation; support appropriations matching the authorization levels for the National Science Foundation's Robert E. Noyce Teacher Scholarship program and champion legislation improving the program's effectiveness in recruiting and retaining qualified K–12 STEM teachers; develop a national strategy for measuring methane emissions and develop a national database of methane emissions observations; and require a realistic testing and assessment program for US Missile Defense systems, including the Ground-based Midcourse defense, to help improve the reliability of these systems.

As with all CVDs, volunteers use their own personal time away from their busy careers and other commitments to represent themselves (and not their institutions) as they advocate for crucial science policy issues.

"I'm thrilled to report that CVD 2022 was a great experience," said Robin Selinger, Speaker of the APS Council and physics professor at Kent State University.

"Our team's diversity was our strength, with graduate student

CVD CONTINUED ON PAGE 3

JOURNALS CONTINUED FROM PAGE 1

Publications (CSP), reporting to the Board and Council, which includes both active scientists and publishing professionals.

These changes required amendments to the APS *Constitution & Bylaws* and revisions to the associated *Policies & Procedures* of the APS Board and Council. APS members shared their perspectives during a comment period from December 1, 2021 through January 15, 2022. The Governance Committee carefully reviewed these comments which guided revisions to the proposal presented to the Board and Council. Specifically, the added stipulations raised by members ensure that the EIC maintains responsibility for the scientific integrity of the journals, that a majority of the seats on the CSP will be filled by members of the APS community, and that a newly established Council of Lead Editors will have an advisory role in the selection of the EIC. The revised governance language was approved by the Board and Council on January 29, 2022.

"The comments we received from APS members were crucial to this process. They ensure that the changes we are making reflect the needs of the scientific community we serve," says Bucksbaum. "I understand there is a sense that APS has become more business-oriented over the years. But the vitality of the journals depends on our ability to adapt to a changing publishing environment. And once this new structure is in place, we will be well-positioned to do so."

To support these changes, APS will hire a Chief Publications Officer (CPO) who will manage the operations of the entire journal portfolio. The CPO will assume the responsibilities of the outgoing senior staff positions of EIC and Publisher, including sales and marketing as well as the production and editorial processes. The CPO will not influence editorial decisions about individual manuscripts.

The CPO will report directly to the APS CEO, Jonathan Bagger, who explains these changes by analogy: The Treasurer is an elected member of the Board who oversees the financial affairs of the Society. The Chief Financial Officer is a senior staff member who manages and executes the day-to-day operations of the Society at the direction of the Board. Similarly, the new EIC position on the Board will set the direction for APS's publishing activities while the CPO will leverage their industry expertise to make that vision a reality.

"This new senior staff position will bring clarity and accountability to the APS publishing enterprise. They will also chair and be advised by a new Council of Lead Editors, bringing together leading scientists from the fields their journals serve," says Bagger.

"I believe so strongly in our society journals," says 2022 APS President Frances Hellman. "Modernizing the governance structure will leave us more nimble and able to continue to publish the preeminent journals in the world."

CAREERS 2022

CAREER PATHWAYS & ADVICE
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Download it at: go.aps.org/careers2022

THIS MONTH IN

Physics History

Women's History Month: Arianna Rosenbluth and the Metropolis Monte Carlo Algorithm

BY SOPHIA CHEN

March 6 marks the anniversary of the 1953 submission of the Metropolis Monte Carlo algorithm to the *Journal of Chemical Physics*.

The algorithm, devised to explore the capability of the earliest computers, spawned a whole class of data analysis techniques, known as Markov Chain Monte Carlo methods. Today, these methods have become a cornerstone of modern data science.

"Nearly every quantitative scientist in the entire world uses Markov Chain Monte Carlo, whether they know it or not," astronomer Benjamin Pope of the University of Queensland said. "It's completely revolutionized statistics and data analysis." People have used Markov Chain Monte Carlo methods in applications ranging from modeling exoplanet orbits to stock market assets to COVID-19.

Yet for years, the story behind the Metropolis algorithm remained "shrouded in mystery," as physicist James Gubernatis wrote in a 2003 article commemorating the algorithm's 50th anniversary. The paper's five authors, two of them women, pivoted away from the work soon after. Only one author, Marshall Rosenbluth, has given a detailed perspective on the algorithm's development.

The paper, titled "Equation of State Calculations by Fast Computing Machines," bears the names of Nicholas Metropolis, and two couples: Arianna and Marshall Rosenbluth, along with Augusta and Edward Teller. According to Marshall, he and Arianna did almost all the work. Edward provided a key insight, and Augusta seems to have participated in the programming only in the project's initial stages. Metropolis provided the computer but did not participate in any technical conversations.

Aside from her name on the paper, Arianna's crucial role went largely unacknowledged for years. She left her career not long after the article's publication, and she shared little about the algorithm before her death in 2020. This column highlights her contribution to the project.

In the early 1950s, in her early twenties, Arianna (pronounced "AIR-ee-anna") Rosenbluth worked as a physicist at Los Alamos National Laboratory in New Mexico. The facility, established in 1943 to develop the atomic bomb, had pivoted to support a new mission: containment of the USSR. In 1949, the Soviet Union performed their first test of an atomic bomb, spurring the United States to develop the first thermonuclear weapon, or hydrogen bomb, at Los Alamos.

Arriving at Los Alamos, Rosenbluth had a remarkable academic background. Born into a middle-class Texas family, Rosenbluth received her bachelor's degree in physics from Rice Institute (now Rice University) at age 18 and her PhD in physics from Harvard at age 21. At Harvard, she was a peer of Philip Anderson, as they both studied under the future Nobel Laureate John Van Vleck. (She also qualified for the 1944 and 1948 Olympics in fencing but did not compete.)

Arianna Rosenbluth
CREDIT: COURTESY OF THE ROSENBLUTH FAMILY

Rosenbluth, alongside her then-husband, Marshall, worked on the hydrogen bomb. "Both my parents were politically liberal, but I don't think they had regrets about the work they had done," said their son Alan Rosenbluth. "They believed in an approach that was bipartisan in those days—containing the Soviet Union and maintaining a strong defense as a deterrent."

Researchers had also begun using digital computers to bolster weapons development. Los Alamos hosted one such machine, the Mathematical Analyzer Numerical Integrator and Automatic Computer, or MANIAC. The MANIAC consisted of 1,024 vacuum tubes, and its memory consisted of a thousand 40-bit words. Beyond weapons development, Los Alamos scientists were simply curious how to make their new toy sing.

Arianna and Marshall proposed using the MANIAC to study how solids melt. They framed the problem as a collection of up to 224 rigid, two-dimensional disks, representing simplified molecules, in contact with a heat bath at a fixed temperature. The computer would predict the disks' equilibrium thermodynamic properties such as pressure and density.

HISTORY CONTINUED ON PAGE 4

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PUBLIC ENGAGEMENT

American Physical Society Takes On Scientific Misinformation

BY CATHERINE MEYERS

This article was originally published by FYI.

At the American Physical Society's Annual Leadership Meeting, held virtually on Jan. 27, APS CEO Jonathan Bagger introduced an initiative called the Science Trust Project that aims to leverage the Society's membership in addressing the spread of scientific misinformation. "This project is rooted in our mission to diffuse knowledge to the benefit of humanity, and it's also grounded in our values to uphold truth," he remarked.

Explaining the project's origins to the audience, Bagger said, "Many of you have asked APS to develop an activity to counter misinformation, a problem that's been exacerbated by the broad reach of the COVID-19 pandemic. And it's through your input and the input of numerous experts across the sciences that we have developed the Science Trust Project."

The project's co-leader, Callie Pruett, a senior strategist for grassroots advocacy at APS, told FYI that those calls from members built up throughout 2020 and 2021 in response to encounters with misinformation on social media and in their personal interactions. "I think that when you start seeing it in your own family, among your own friends, it really does reach that flash point where you say, 'I have to throw my hat in. I have to do something,'" she said.

Panel considers physicists' role

Bagger introduced the Science Trust Project at the conclusion of a panel discussion on the problem of misinformation, which was one of four themed panels organized for the meeting. At the start of the session, an audience poll showed that 95% of respondents are either "fairly" or "extremely" concerned about misinformation and disinformation. More than one-fifth reported being a target of misinformation or disinformation in their own work, and more than 80% felt they should play an active role in countering disinformation.

The worries and calls for action were echoed by the panelists.

"I think it's very bad," computer scientist Christo Wilson of Northeastern University said. "We don't actually understand the information ecosystem very much anymore. ... And then you throw in bad actors who are weaponizing that ecosystem for their own ends."

Neil Johnson, a George Washington University physicist who heads an initiative in complexity and data science, suggested physicists are well-positioned to

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Anisha Singh from Stanford, Bob McKeown from Jefferson Lab and Caltech, and me from Kent State in Ohio. Our most exciting meeting of the day was with Congressman Mike Garcia (R-CA-25th). Anisha was a highly effective advocate in her lead role in the meeting with the congressman who represents her home district. We left the meeting feeling hopeful that he will support at least one of the legislative initiatives she presented."

Selinger continued, "Bob was also a huge asset to our team. His experience as Deputy Director for Science at Jefferson Lab meant that he could well explain—from personal experience—the wasteful inefficiencies that arise when federal agencies operate under a continuing resolution. Plus, Bob was a very effective advocate on monitoring methane emissions, a topic he deftly connected to the historic success of air pollution monitoring in California."

Richard Spencer, a medical physicist at the National Institutes of Health and chair of the APS Topical Group on Medical Physics, said his team also worked well together.

"The CVD reminds us that, in addition to our research, we must also make ourselves heard regarding critical issues facing our profession and society. Including diverse voices allows us to speak even more powerfully, with a wide range of personal experiences and perspectives being put forward," Spencer said. "The newest members of the Maryland team this year, Kandice Tanner and Sally Zhang, exemplified this. As younger female foreign-born physicists, their stories and viewpoints were absolutely compelling to Jim Adams and me, but much more importantly to the congressional staff we met with throughout the day."

Zhang, Assistant Research Scientist at Johns Hopkins University and Secretary/Treasurer of the APS Topical Group on the Physics of Climate, said her CVD experience was a positive one that she plans to use to benefit the physics community.

"A glimpse at science from the policymaker's perspective has motivated me to stay engaged with the public and become a more effective communicator of climate science. I look forward to working with APS in the future to elevate the profile of physicists in policymaking," she said.

Jim Adams, APS Councilor and Chief of Radiation Physics at the National Institute of Standards and Technology, echoed Spencer's sentiments about the Maryland team.

"Kandice and Sally were simply delightful to work with. They are first-rate professionals who possess a clear understanding of the issues that we presented," said Adams. "Kandice and Sally each brought relevant and compelling backstories, making that all-important human connection that truly lands the point and makes it memorable. It is a wonderful, if simple, example of how diversity of experience can lead to better outcomes."

Beverly K. Hartline, retired professor emerita from Montana Technological University, and Serenity Engel, a junior majoring in physics at South Dakota School of Mines & Technology, also spoke glowingly about their CVD experience.

"Serenity is amazing. She brilliantly sold the APS priorities for Fiscal Year 2022 R&D funding appropriations and qualified K-12 teachers by sharing her personal experiences doing federally funded undergraduate research and growing up in a small rural community in South Dakota, where the high school did not even offer physics," said Hartline. "This really resonated with the congressional staff of our predominantly rural states."

Added Engel, "Bev brought in great examples for the visa [issue] from her extensive career as a graduate dean and in research administration, seeing talented students forced to leave [the US] after completing their degrees, taking with them the state-of-the-art intellectual property developed during their master's or doctoral projects, and depriving the US and local communities of the economic development benefits. She was also able to explain the significance of the methane emissions and missile defense studies, so most of the staffers requested more information."

Mark Elsesser, Director of APS Government Affairs, said he was thrilled to hear the stories of how well APS members worked together.

"It's great to hear that the CVD teams drew on the strength of each other's experiences and backgrounds to advocate for crucial science policies that will benefit the entire physics community," he said. "Bringing diverse voices and perspectives to our advocacy efforts is a priority for APS Government Affairs because we know the positive impact that doing so has on reaching our members' policy goals."

The author is APS Senior Public Relations Manager.

APRIL CONTINUED FROM PAGE 1

All in-person attendees will be required to follow strict public health protocols to protect themselves and each other from COVID-19. Developed in consultation with public health experts, these requirements include an up to date vaccination status (including a booster shot, if eligible), a negative test result, and wearing a high-quality face mask at all times except when actively presenting, eating, or drinking.

APS and its partners are committed to reducing the environmental impact of its activities. For more information, please visit https://april.aps.org/sustainability.

Registration for the 2022 April Meeting is open through the meeting. Prospective attendees can secure the regular registration rate through March 22.

The author is APS Head of Public Relations.

APS Honors

These society-wide APS prizes and awards recognize achievements across all fields of physics. Please consider nominating deserving colleagues for the following:

APS Medal for Exceptional Achievement in Research
Deadline: May 2, 2022

Dannie Heineman Prize for Mathematical Physics
Deadline: June 1, 2022

Edward A. Bouchet Award
Deadline: June 1, 2022

George E. Valley, Jr. Prize
Deadline: May 2, 2022

Julius Edgar Lilienfeld Prize
Deadline: May 2, 2022

Maria Goeppert Mayer Award
Deadline: June 1, 2022

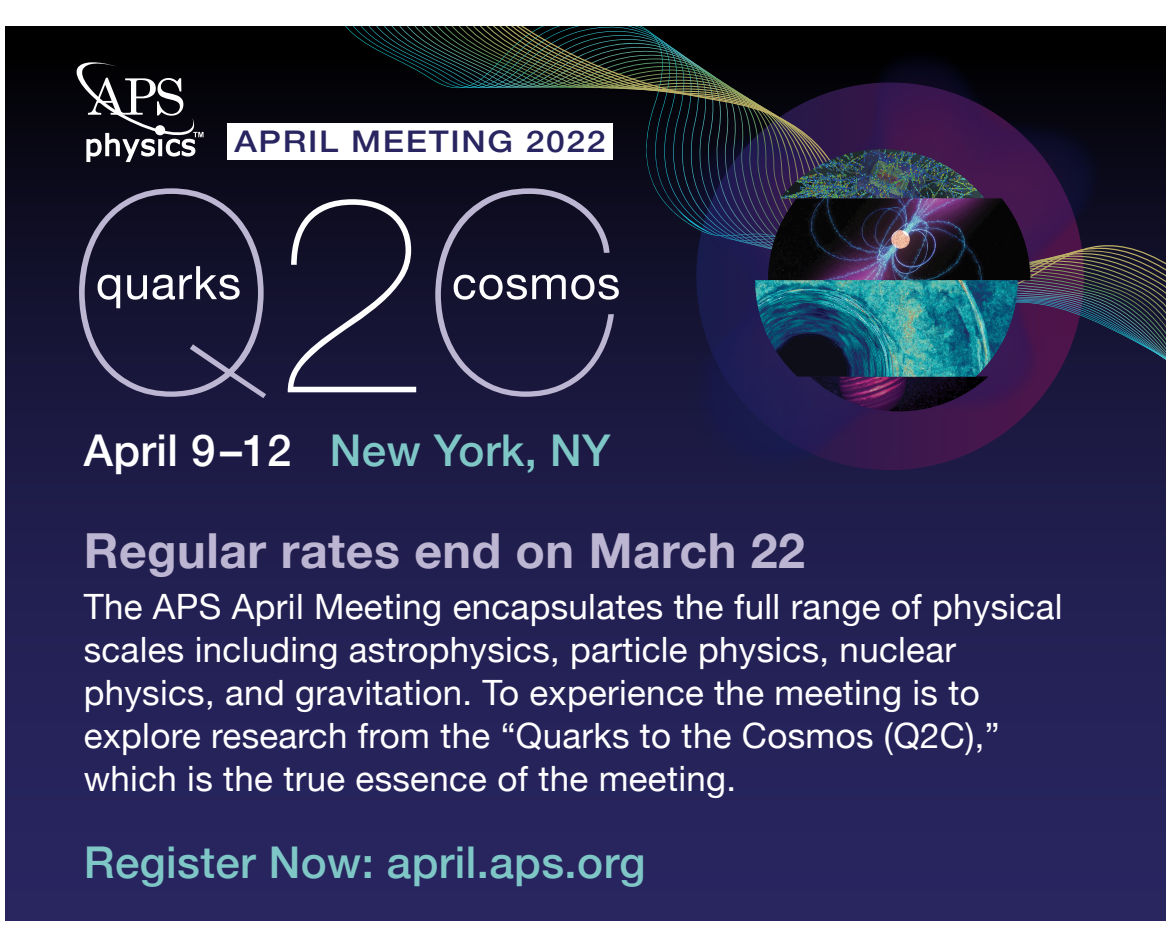
Prize for a Faculty Member for Research at an Undergraduate Institution
Deadline: June 1, 2022

LeRoy Apker Award for Undergraduate Achievement
Deadline: June 1, 2022

Serving a diverse and inclusive community of physicists worldwide is a primary goal for APS. Nominations of women and members of underrepresented minority groups are especially encouraged.

APS physics

LEARN MORE: aps.org/programs/honors



HISTORY CONTINUED FROM PAGE 2

They considered simulating the motion of each disk individually, but it was too computationally expensive. Edward Teller recommended they instead use statistical mechanics to calculate the disks' average values. To do this, Arianna and Marshall would generate random configurations of disks allowed for a given energy and temperature. (The element of randomness reminded Los Alamos physicists of a game of chance—hence "Monte Carlo," after the casino.) With enough configurations, they could estimate an average for the thermodynamic properties.

But some molecular arrangements are more probable than others. Their key innovation: Instead of generating completely random configurations, their algorithm forced the computer to sample configurations weighted by their probability.

The two ran the MANIAC during the midnight shift. They had the rare authority to call engineers in the middle of night to reboot the computer if it crashed, Arianna told Gubernatis in 2003. Arianna did all the programming, as she and Marshall both recounted later. She had learned to program the MANIAC when she verified calculations for the first full-scale test of a hydrogen bomb in 1952.

Interacting with the computer required detailed understanding of both the machine and the physics. Arianna meticulously coded in assembly language, just one level of abstraction above machine language. She would have, for example, needed to track the physical location of numbers stored in memory to use in calculations.

The Metropolis algorithm was one of the first examples of a "numerical experiment," said Adam Iaizzi, a physicist who dedicated his PhD dissertation to Arianna Rosenbluth. They had devised a new way to use computers beyond simply performing accelerated calculations that humans could already do.

The paper also furthered the understanding of solid-liquid phase transitions, says Gubernatis, a physicist now retired from Los Alamos. The simulation provided early evidence that molecules in a liquid exhibit some structure rather than being entirely disordered, as previously thought.

Arianna published a few more papers about the Metropolis algorithm, but she left physics to raise her four children in support of Marshall's career. Los Alamos was her last professional experience. Their marriage ended in divorce in 1978.

Over the subsequent decades, Arianna lost touch with her former collaborators. "She was simply surprised when I told her how famous this particular paper became," recalled Gubernatis of a 2003 phone call.

Arianna never expressed regret about leaving her career, her daughter Jean said. But "she was not the happiest person while we were growing up," said Jean. "I think part of it was that she missed her work, because it meant a lot to her."

Alan once asked her if she had ever experienced any gender discrimination in physics. "She said that she didn't always feel comfortable being the recipient of so much attention from all the men," he said. Felix Bloch also declined to take her as a graduate student at Harvard because he categorically didn't accept female students. "She shrugged it off matter-of-factly, although I think it annoyed her," he said.

An apocryphal tale about the algorithm's origins may illustrate the era's sexism best. The rumor, passed down among physicists over the years, said that Metropolis, Marshall Rosenbluth, and Edward Teller had devised the algorithm at a cocktail party and that they added their wives' names to the publication as a thank-you for enduring the technical conversation. There is no evidence this is the case.

Jean and Alan described their mother as a woman of many interests. She was an avid reader and a fan of L. Frank Baum's Oz series. She conducted personal mathematics research into knot theory. In the late 1970's, she built hobbyist computers out of kits.

For all her silence, the Metropolis algorithm still occupied Rosenbluth's thoughts years after she left physics. After Arianna died, Jean found an old issue of *Physics Today* that her mother had kept, from the 1970's. She had annotated the cover to single out a particular page. Flipping to it, Jean saw that Arianna had underlined a reference to the Metropolis algorithm.

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

Further reading:

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aps.org/apsnews

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build tools that aggregate data about misinformation into a "map" that tracks its evolution in public discourse. "And once you've got that, then you know where to go and intervene effectively," he said, adding later, "I think it's a unique opportunity for the physics community. … We should be the ones to map it out. And once you've [done] that, you're then the basis for every discussion about policy, regulation, et cetera."

Wilson pointed to social media as presenting a new and particular challenge in misinformation because it separates content from its producers. "I think that what's really changed is the emergence of mega-platforms, which both enables things to spread, but also sort of obfuscates the origins and intentions of different actors," he remarked.

That concern was echoed by David Helfand, an astronomer at Columbia University. He cited surveys showing increasing public reliance on social media for news, which he said reflected a demand for the kind of information presented on those platforms that would be difficult to counter by trying to stem the supply of misinformation. "It's not a supply problem, it's a demand problem," he asserted.

Helfand also observed that many surveys report there is a high trust in scientists in the U.S. relative to groups such as politicians and journalists. However, he pointed out there are divergences within different segments of the population on more particular issues, such as whether scientists working in different sectors provide advice that is disinterested or in the public interest. (Helfand chairs AIP's board of directors.)

This week, the Pew Research Center released a survey report showing that an increase in trust in scientists that occurred early in the pandemic has now been erased, tracking declines in trust in other professions. The same survey also showed that in the last two years confidence that scientists act in the public interest has dropped precipitously among Republicans, from 85% to 63%, while Democrats' confidence has remained steady at about 90%.

Efforts focusing on training and communication

In considering strategies for countering misinformation and disinformation, the panelists focused on science education and public communication. For instance, Helfand, who specializes in teaching science to non-science majors, discussed efforts to convey attitudes of curiosity and skepticism, as well as an appreciation for uncertainty in college-level courses. He also suggested such efforts should begin much earlier in the educational process.

Sara Gorman, a founder of the nonprofit organization Critica, which promotes the use of science in decision-making for health and safety, said scientific communities should train scientists in evidence-based methods of countering misinformation, drawing from behavioral science and centering concepts such as empathy and identity.

Before launching the Science Trust Project, last summer APS convened workshops in partnership with Critica to train members to have empathetic conversations around the topic of vaccine hesitancy. Callie Pruett told FYI that more than 80 people attended one or more of the workshops and that attendees reported it increased confidence in their ability to engage on the topic. Following up on that effort, APS is developing a four-week workshop around the topic of climate change, which it aims to launch in April with around 30 participants.

The workshops teach participants ways to identify different forms of misinformation and to broach difficult misinformation subjects with friends, neighbors, family, and acquaintances. Although a specific misinformation topic is chosen to provide concrete examples for the workshops, the techniques can generally be applied to different types of misinformation, the organizers say.

"By pairing these two methods, identification and action, together, our members can begin to make a meaningful difference in their communities," Pruett remarked.

Pruett said Science Trust Project leaders are currently focused on developing training sessions and fostering a community within APS around the issue of misinformation. If the next set of workshops is deemed successful, APS may expand its efforts and potentially partner with other scientific societies on them.

If you would like to help cover the costs of the Science Trust Project, please consider making a donation here: https://my.aps.org/multipledonations.

The author is a writer for FYI, an editorially independent science policy news service from the American Institute of Physics.

FYI: SCIENCE POLICY NEWS FROM AIP

National Science Board Weighs In on State of US Science

BY ANDREA PETERSON

A new report from the National Science Board finds that the US has continued to lose its clear leadership position in global science and engineering (S&E) as other countries—particularly China—have built up their research enterprises. Accordingly, the Board recommends in an accompanying policy brief that the nation position itself as an international hub for scientific collaboration and take urgent action to strengthen the domestic STEM workforce. The report draws on the Board's S&E Indicators, a collection of statistics and analyses Congress requires NSB to update every two years.

The report finds that the US continues to lead the world in annual R&D spending, with combined expenditures from public and private sources increasing to $656 billion in 2019. However, because global R&D spending has tripled over the past two decades, the US share of the total has fallen from 37% in 2000 to 29% in 2010 to 27% in 2019, while China's share increased from 5% to 15% to 22%.

The US remains the leader by far in spending on basic research, with annual expenditures of about $100 billion, roughly quadruple the amount spent by China.

Changes in other measures of scientific activity, such as publication output and patents, largely correlate with the trends in spending, the report shows. Given these shifts, the Board concludes that the US "no longer leads by default" and advocates that the country instead position itself as a "keystone" in the global R&D ecosystem.

It elaborates, "What does it mean to be a keystone of global S&E? It means strengthening international collaborations and engagements, not withdrawing from them. It means being a dependable partner and responsibly fostering open exchanges of ideas and people across fields, public and private sectors, and borders. It means being a hub of the worldwide S&E talent flow."

The report observes that the share of US publications with international coauthors increased from 19% in 2000 to 40% in 2020, and that US scientists contributed to 35% of global publications with authors from multiple countries in 2020.

In addition, it states that foreign-born workers accounted for 19% of the US STEM workforce in 2019, including 45% of workers in doctorate-level occupations, and that 37% of US-trained S&E doctoral recipients in 2019 held temporary visas.

While the report notes the fraction of such graduates who intend to remain in the US after graduation has remained higher than 75% over the past decade, the policy brief asserts that the country's ability to attract and retain scientific talent should not be taken for granted. It urges the US government to maintain a "clear, consistent, and predictable visa system, and ensure that those who come here feel welcome and secure."

FYI CONTINUED ON PAGE 6

LEADERSHIP

Frances Hellman's Presidential Address

As we enter the third year of this pandemic, I am sure you are as exhausted, frustrated, and yearning to reconnect with colleagues and friends as I am. My lab, like most others, got shut down when COVID came along. We're grateful to be back now—vaccinated, boosted, and masked—but it's been challenging for students who missed out on the crucial interactions that just can't be recreated online, and consequently hard to get our research, and our teaching, done. We had every intention of holding this meeting in-person in Washington, DC with a virtual component. Unfortunately, the rapid spread of the Omicron variant required us to make the difficult decision to pivot to a completely virtual event.

In the past two years, we have learned a lot about virtual meetings—what works, and what doesn't. And while they will never fully replace in-person gatherings, with their unique ability to spark new ideas and collaborations, we are working towards a hybrid approach that hopefully combines the best of both worlds. There's no doubt that virtual meetings are more accessible to our colleagues around the world in a wide range of circumstances, from parents of small children to attendees with disabilities or those whose jobs or other responsibilities preclude traveling to a conference.

While COVID has affected nearly everything we do—and how we do it—what hasn't changed is the vision and strategic priorities we at APS developed long before the pandemic, which are outlined in the 2019 Strategic Plan. It's a powerful and inspiring document that underlies everything we do. It's remarkable how much progress we have made in just the last year, thanks in no small part to your unwavering service and dedication to the Society as well as that of our hardworking APS staff, my predecessor Jim Gates and our CEO Jon Bagger who will be my much needed and much valued partner in moving APS forward in 2022. The last few years have shown us the importance of "increasing organizational excellence" so we are better prepared for the next storm and in a strong place to support the evolving needs of the physics community.

The very first specific action in the 2019 Strategic Plan calls for us to embrace "diversity, inclusion, and equity." This is a problem that has plagued our field from the very beginning, and still does, 60 years past the peak of the civil rights and women's rights movements. The murder of George Floyd shook us to the core and sparked an overdue global reckoning with systemic racism. It implored us to translate our words into action, to dismantle the barriers that have led to a gross underrepresentation of minorities, particularly Black Americans, in physics. The advancement of science depends on a diversity of ideas and approaches to difficult problems, and demands that we try harder to address this pernicious problem.

It is in this spirit that my predecessor, Jim Gates, launched the DELTA-PHY initiative as a forum to "change the culture of physics." Thank you, Jim, for your dedication to this cause and your gracious offer to help me continue this important work. The DELTA-PHY webinar series has brought our community together to discuss pressing issues at the intersection of physics and society. In the past two years, these focused on issues surrounding the indispensable contributions of immigrants to the US scientific enterprise; the negative impact of the US government's current approach to research security; and several specific ideas of how to remove barriers to the success of underrepresented sectors of our physics community.

Bringing people together to focus attention on CHANGE dovetailed with efforts led by our Government Affairs office and led to some real wins this past year. APS members in partnership with our Government Affairs office have worked tirelessly to push for reform of the US Department of Justice's egregious China Initiative, which has had a chilling effect on researchers from both countries. We are encouraged by the government's recent actions in this area that align with APS's recommendations. Furthermore, the National Science and Technology Council recently issued a memorandum regarding guidance on presidential memorandum NSPM-33 which deals with potential transgressions of conflict of interest or conflict of commitment. We are optimistic that this memo points the way to a more appropriate use of the judicial system to address criminal matters but leaves the scientific community and the federal science funding agencies to address non-criminal scientific transgressions.

And, this all points to the broader issue of ethical conduct in physics. While physics has for a long time had ethical standards around publishing and credit, it only relatively recently became clear that a more comprehensive standard of ethical conduct was needed. In the early 2000's, and again in 2020, APS surveyed its members and it came to light just how rampant harassment is in physics—particularly disturbing are recent surveys in which the incidents reported by young women physicists have affected their lives and careers. Responding to issues raised by our community, and our desire to be a more inclusive, ethical, and effective organization that supports our physics community, the APS Ethics committee established working groups focused on research integrity and ethics education, which led to revisions to our Guidelines on Ethics to address enablers of misconduct, the code of conduct for meetings, and conflicts of interest and commitment. Since then the Ethics Committee has introduced a revocation policy for APS prizes, awards and leadership positions and is working hard to educate the community on ethical practices. We anticipate further actions in the upcoming year as these policies and practices are implemented.

Another important priority for 2022 is centered on Global Science, a priority outlined in the 2019 strategic plan, but more relevant now than ever. We're called the *American* Physical Society, but we're in fact an international organization. Approximately 25% of our members live and work outside of the United States. 70% of APS journal articles with a US lead author have an international co-author. Global science challenges are all around us, from gravitational wave science to climate change. Equity and inclusion is an internationally relevant subject that limits all of us. Science thrives when people and ideas are free to flow across borders. International collaborations — both small and large — are essential to the advancement of physics and are our best chance to address the grand challenges before us. But recent survey data of APS members working in academia and the national labs show that they are withdrawing from collaborations with their colleagues abroad at an alarming rate. 1 in 4 report that they have either chosen to withdraw or been directed to withdraw from professional activities with colleagues outside the United States due to current research security policies. The best and brightest minds in the world no longer see the United States as a welcoming environment in which to build their careers, and many are taking their talents to other countries. This threatens our ability to do great science and APS is committed to addressing this threat.

In addition to the work previously described to reduce the US government overreach in the area of research security, in 2022, APS will be working with its sibling physics societies around the world to establish a set of agreed-to "rules of the road" for research and collaboration and, to quote a very recent (1/28/22) National Science Board report, to find ways to "[strengthen] international collaborations and engagements" and "responsibly foster open exchanges of ideas and people across fields, public and private sectors, and borders", thereby becoming "a hub of the worldwide science and engineering talent flow". Notably, we received a key endorsement from the IUPAP General Assembly to seek the recognition of 2025 as the International Year of Quantum by the United Nations, an effort to make the importance of both the science and technology represented by APS be visible to and valued by the public. Last year APS convened its inaugural International Young Leaders Forum, which brought together early career physicists from 22 countries and six continents. We've also continued to engage with physicists in China, Africa, and India to identify and address challenges and opportunities facing our colleagues in these countries.

I want now to say a few words about our outstanding portfolio of scientific publications. The Physical Review journals are our jewels, among the best in the world. But their prominence and sustainability is threatened by external forces, including fierce competition, open access mandates, and disruptive technologies. Our current operating structure is a hindrance to their continued growth and success. The changes to the governance of APS publishing under consideration by the APS Board and Council—which preserves scientific oversight but creates a more robust operational structure — are our best shot at ensuring that our journals will be able to continue to serve the scientific community for many years to come.

Frances Hellman

Returning to the 2019 Strategic Plan, I note the pillar of "Serving Members, the Physics Community, and Society," which calls on APS to better support what you might call the "whole physicist." In addition to the inclusion and ethics issues previously touched on, we are re-committing to being the professional home for anyone engaged in physics or who considers themselves a physicist, regardless of whether they're working in industry, academia, a national laboratory, or a science museum, whether teaching or research or science outreach to the public is their primary mission, and whether they conduct fundamental or applied research.

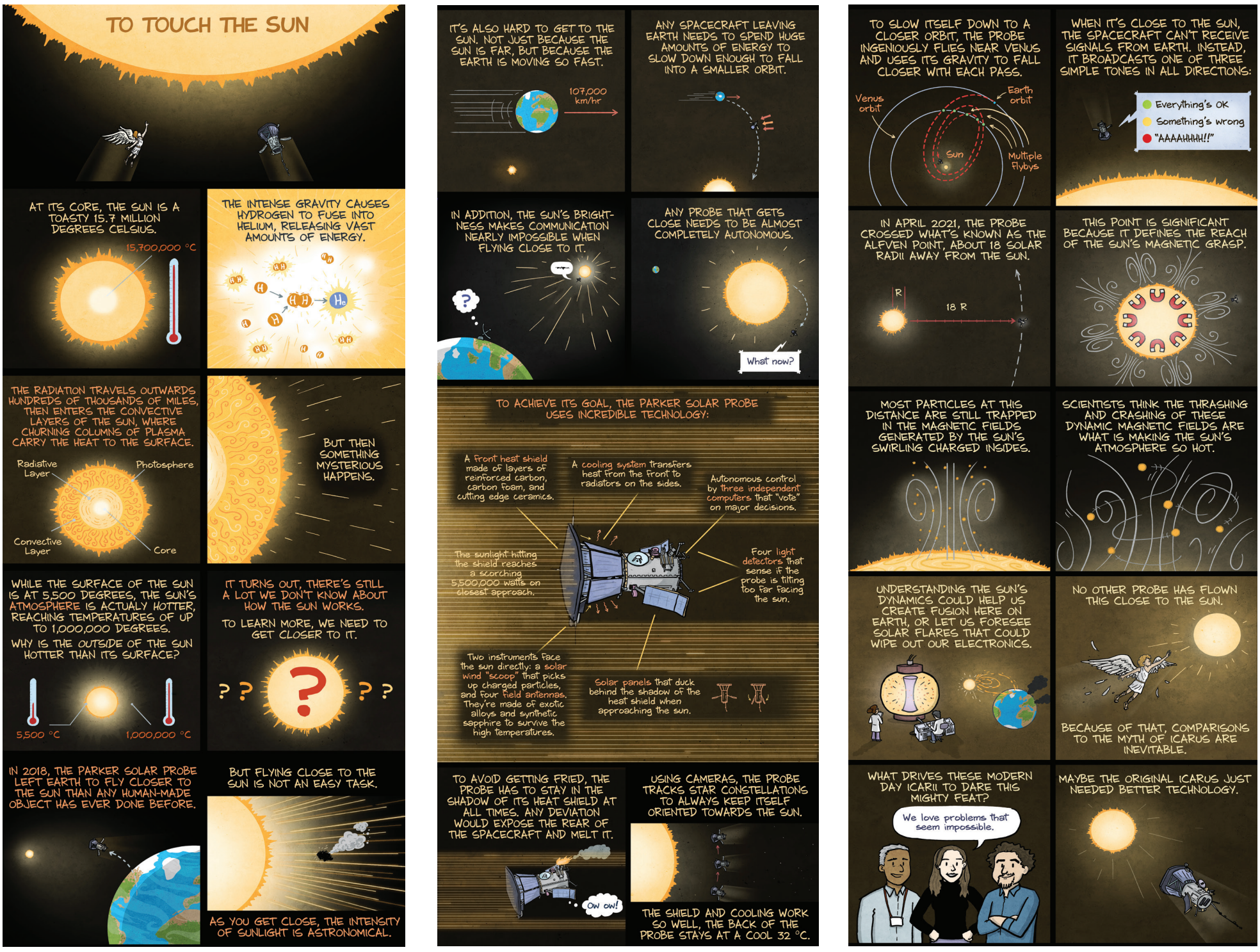
Our commitment to the next generation of physicists is vital to our mission and vision. Through its various education and outreach programs, as well as through several of its units, APS works to ensure that up-and-coming scientists are supported at every stage of their careers, starting as early as grade school. The only reason I started down the path of physics is that I had an amazing high school physics teacher. We spent our time learning about general relativity, how the universe began, and black holes, and even more importantly, we were encouraged to be creative and experimental in our thinking about these topics. Of course, that meant when I got to college I struggled in my introductory physics courses because I had not learned the basics, like springs. I found freshman physics both hard and boring, a bad combination, but my undergrad advisor helped me get caught up, so I eventually was able to get back to studying what to me was the exciting stuff: black holes, galaxies, quantum mechanics, superconductors. He told me years later that he recognized that I had a knack for physics, just needed some help getting started, a message I try to act on both with my own students and as APS president in support of our education and outreach programs.

That is just one example of how an exceptional high school teacher can set the course for one student's life's work. The Physics Teacher Education Coalition (PhysTEC), a joint project of APS and the American Association of Physics Teachers, has been addressing the nation's teacher shortage for more than 20 years. PhysTEC has helped over 60 US colleges and universities prepare new, qualified physics teachers to educate the next generation of STEM professionals and informed citizens. This past year, APS introduced middle and high school students to quantum science and technology by partnering to distribute PhysicsQuest kits and hosting a Quantum Crossing career event. These are just examples of the portfolio of education and outreach programs led by APS, and an important priority for the upcoming year is to develop a strategic plan for these, including their financial support. I've made developing a culture of philanthropy a priority for my presidential year, another specific action noted in the 2019 Strategic Plan. APS is in a strong financial position but we need to make sure that we diversify our sources of revenue.

Finally, I want to end by noting the continuing importance of ensuring that the public and our government appreciate the importance of the work we do and continue to support this work. This is an exciting time to be part of APS. There are challenges ahead, but we are well-positioned to tackle them. I strongly encourage you to review the Strategic Plan, to consider a financial contribution to support our mission, and to contribute your talents to helping us achieve our ambitious vision for the future of physics: A physics that is welcoming, diverse, and supportive. A physics that is ready, willing, and able to meet the needs of our Society, the scientific community, and the world, and to inspire us with its insights into how the universe works.

To Touch the Sun

WRITTEN AND DRAWN BY JORGE CHAM FOR PHYSICS MAGAZINE, **physics.aps.org**



FYI CONTINUED FROM PAGE 4

The vitality of the domestic STEM workforce is also a major concern for the Board, which has focused attention on what it calls the "missing millions" of workers stemming from the underrepresentation of women and Black, Hispanic, and Indigenous people across STEM fields. The Board connects these disparities to longstanding inequities in STEM education at the K–12 level as well as to socioeconomic barriers in higher education, such as the high cost of four-year colleges.

"To ensure that all Americans can participate in and benefit from the S&E economic engine, the US must invest in public K–12 and post-secondary STEM education in every state and strategically develop capacity by establishing innovation hubs across the country," the Board concludes.

The author is Science Policy Reporter for FYI.

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APS physics

MEMBERSHIP UNITS

APS Membership Unit Profile: The Forum on Diversity and Inclusion

BY ABIGAIL DOVE

For most of physics' long history, the field has been largely male and largely white. The APS Forum on Diversity and Inclusion (FDI) is dedicated to making physics more inclusive, diverse, and equitable by identifying and advocating for the needs of women, underrepresented minorities, the LGBT community, people with disabilities, and other groups who have been historically marginalized from the field.

While the physics community has become somewhat more diverse in recent years, it is still significantly less diverse than the country at large. Statistics from APS and the American Institute of Physics (AIP) Statistical Research Center indicate that only 11% of bachelor's degrees and 7% of PhDs in physics in the United States are awarded to people who are Black, Hispanic, or Native American, though these groups make up about 1/3 of citizens of college age. Likewise, women hold only about 20% of all physics degrees. These inequities become even sharper when it comes to the proportion of women and underrepresented minorities working as physics faculty at universities or recognized with high-profile scientific awards.

Feeling unwelcome or underrepresented in a field can take a significant toll. "There is an adage in the Black community that you have to be twice as good to get the same recognition," explained FDI chair Carol Scarlett (Florida A&M University). Likewise, women, LGBT people, and individuals with disabilities may also experience additional barriers that make the already-difficult work of physics research more challenging. "When entering a career, you want to feel like you're going to be as successful as you can be. It can feel deleterious when your path to the same goal is more complicated," said Scarlett.

Though a lack of diversity in physics is an issue as old as the field itself, FDI is one of the newest membership units at APS. The idea for a membership forum focused on diversity and inclusion was first raised in the 2016 APS LGBT Climate in Physics report, commissioned to investigate the educational and professional environment for LGBT people in physics. With strong support from existing APS committees including the Committee on Minorities in Physics (COM) and

FDI CONTINUES ON PAGE 7

FDI CONTINUED FROM PAGE 6

Committee on the Status of Women in Physics (CSWP), an organizing group was convened in 2017 to develop the forum's official mission and objectives. By 2019, a formal petition to establish FDI received over 1,600 signatures—well over the necessary 200—and was unanimously approved by the APS Council (see *APS News* January 2020).

While COM and CSWP have long been working for greater inclusion of underrepresented minorities and women in physics, APS committees of this kind comprise only nine appointed members and therefore have a limited capacity to tackle large issues. In contrast, forums like FDI are large membership units that any APS member can join. Forums also have more opportunity to garner visibility for issues of diversity and inclusion by organizing talks at major meetings and promoting the accomplishments of diverse members of the physics community by nominating APS Fellows and sponsoring prizes and awards. Additionally, as a unit focused on diversity and inclusion broadly, FDI creates a space for addressing issues of intersectionality, that is, the overlapping of multiple marginalized identities.

After only a few years, FDI has grown to include over 2,700 members—a remarkable feat given that the forum's founding coincided with the beginning of the COVID-19 pandemic, severely limiting in-person networking.

A major focus of FDI's activities is drawing attention to diversity and inclusion issues through talks at APS March and April Meetings. At this year's March Meeting, slated for March 14-18 in Chicago, FDI will host a panel discussion titled "Surviving Graduate Studies," featuring scientists from diverse backgrounds discussing the difficulties and challenges they faced while pursuing their physics PhDs. Notably, part of the agenda will include a listening session where APS members of all backgrounds can share their experiences. "We don't want to just disseminate information; we want to make sure that we're also listening," explained Scarlett. "The ground beneath us is shifting and changing, and we want to know what people's issues are and hear what people in the community are going through. Even if it isn't something APS can solve, it can be meaningful for people to know that someone is there."

Looking forward, the FDI executive committee's main goal for the forum is to put measures in place at the systemic level to support diversity within APS. As Scarlett put it, "We want to promote processes that make diversity common—something that everyone does because it's the best way to build a more sound scientific community."

So far, much of this effort focuses on enabling broader participation at conferences for APS members of diverse backgrounds. Some physicists from communities traditionally not represented in the field may have given up on attending conferences after having negative experiences, and Scarlett emphasized that FDI seeks to ensure that all scientists feel welcome at APS meetings. One such measure to this end could be promoting further improvements to conference infrastructure that enable people with disabilities—for example, hearing impairment or reduced mobility—to more fully participate in conferences.

APS members have much to gain by joining FDI. As Scarlett explained, "If you're a scientist and you recognize that there is a lack of diversity in physics—or if you're wondering why this community is more homogenous than the general population—then FDI is a place to learn what people are going through and what barriers exist to having the US population reflected in our scientific population."

Scarlett also pointed out that fostering diversity and inclusion can be viewed as an opportunity to maintain American competitiveness. "Globally, the United States wants to stay competitive and build scientific infrastructure. Other countries are doing the same. To be at the forefront, we have to be 'firing on all cylinders' and have all people represented. We can't do that if we restrict the science community to a homogeneous population, purely out of age-old dysfunctional views. We have to make sure we're utilizing our whole population, and not selectively cutting people out for no good reason."

Overall, FDI stands out as an important addition to APS, challenging physics as a discipline to be open to more people in order to achieve its full potential. More information can be found online at https://engage.aps.org/fdi/home .

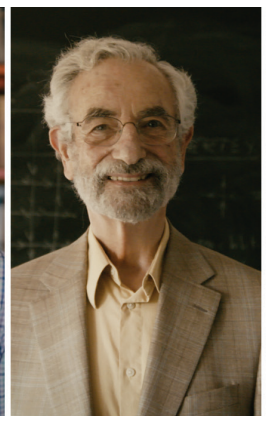
The author is a freelance writer in Stockholm, Sweden.

HONORS

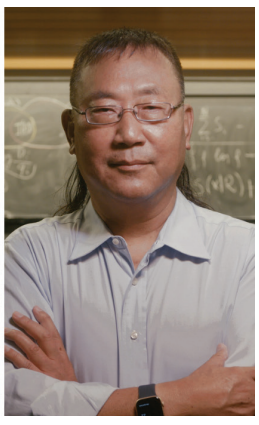
The 2022 APS Medal and Society Prize Ceremony

BY DAVID BARNSTONE

Andrew Lucas



Elliott H. Lieb



Chang Kee Jung

APS formally recognized the recipients of the Society's top honors during an online event as part of the 2022 Annual Leadership Meeting. Hosted by APS President Frances Hellman and APS CEO Jonathan Bagger, a documentary film featured three distinguished scientists honored for their major research accomplishments; impactful lecturing, mentorship, and communication of physics; and cutting-edge research.

Andrew Lucas of the University of Colorado Boulder received the 2022 George E. Valley, Jr. Prize for "pioneering contributions to developing the theory of hydrodynamic transport in interacting electron fluids." The Valley Prize recognizes an early-career individual for an outstanding scientific contribution to physics that is deemed to have significant potential for a dramatic impact on the field. The prize consists of $10,000, a certificate citing the contribution made by the recipient, and an invited talk at an APS March or April Meeting.

Chang Kee Jung of Stony Brook University received the 2022 Julius Edgar Lilienfeld Prize for "outstanding contributions and leadership in experimental neutrino physics, and for outstanding teaching and outreach, especially on the physics of sports." The Lilienfeld Prize recognizes outstanding contributions to physics and exceptional skills in lecturing to diverse audiences. The prize consists of $10,000, a certificate citing the contributions made by the recipient given at an APS meeting, a research university, and a predominantly undergraduate institution.

Elliott H. Lieb of Princeton University was awarded the 2022 APS Medal for Exceptional Achievement in Research for "major contributions to theoretical physics through obtaining exact solutions to important physical problems, which have impacted condensed matter physics, quantum information, statistical mechanics, and atomic physics." The Medal was established to recognize contributions of the highest level that advance our knowledge and understanding of the physical universe in all its facets. It is intended to celebrate scientific inquiry and the pursuit of knowledge. The Medal carries with it a prize of $50,000, a certificate citing the contributions made by the recipient, and an invited talk at an APS March or April Meeting. The APS Medal for Exceptional Achievement in Research is funded by a generous donation from entrepreneur Jay Jones.

In addition to the documentary film, the entire ceremony can be viewed on the Annual Leadership Meeting website and more information about the awardees is available at the APS Honors website.

The author is APS Head of Public Relations.

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THE BACK PAGE

Misinformation, Equity, and Science

CHARLES H. BENNETT

Around 120 centuries ago a technological innovation, agriculture, triggered the emergence of civilization, which led to science, and thence to such progress in understanding and controlling nature that by the 20th century our species attained the technical ability to sustain a world population of billions. The Enlightenment-inspired Universal Declaration of Human Rights (UHDR), promulgated in 1948 after a decade of technical sophistication accompanied by inequity and cruelty on an unprecedented scale, exemplifies the seemingly still attainable goal of an equitable, peaceful civilization that manages its environment and itself well enough to last millions of centuries.

Unfortunately, due largely to the increased range and speed of communication, misinformation has emerged as a grave meta-threat to both equity and civilization. By luring people into self-isolating bubbles, to be soothed, entertained, and incited by incompatible versions of reality, it empowers autocrats and demagogues, hobbles democracies, and makes cooperation on globally urgent problems like climate change almost impossible.

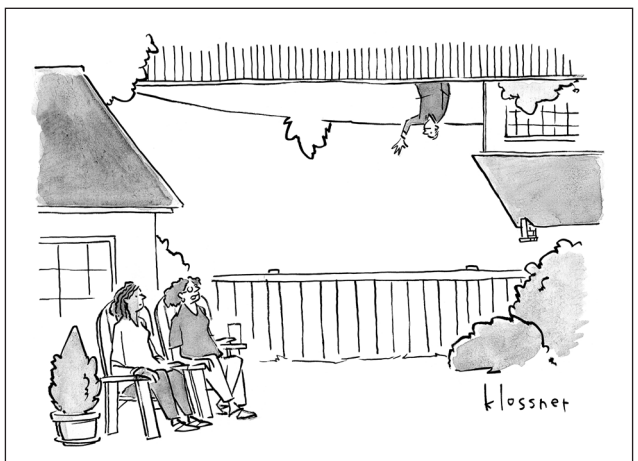
What can scientists, whose epistemic commitment to a single incompletely known but progressively knowable reality mirrors the UDHR's claim of ethical universality, do to nudge society into the UDHR's benign basin of attraction? Fermi's paradox suggests that advanced civilizations are typically short-lived, but that is all the more reason to try to make ours long-lasting.

Practicing scientists know that to be a good scientist requires a kind of humility, a willingness—even a perverse enjoyment—of having one's favorite ideas proved wrong, if possible by one's own efforts, but if necessary by one's colleagues. Thinking scientifically prepares people to confront big, complex problems less judgmentally and more constructively, as natural phenomena to be understood and mitigated, rather than denied or ineffectually condemned. For example, blaming people in a particular social environment for developing racist or jingoistic attitudes or believing patently false conspiracy theories is neither good science nor effective mitigation if, empirically, many similarly situated people respond similarly.

Even without misinformation, the Enlightenment notion of an inalienable right to the pursuit of happiness is an engine of inequity. Most people's happiness depends considerably on the success of their children or proteges, so unless a society is already so equitable that children's success is determined mainly by their own natural endowment, their parents or mentors will strive to inequitably advantage them over other children, thereby amplifying existing inequalities at every generation. Like the prisoner's dilemma, this rational dynamic, unless restrained by laws and customs, leads to less-than-optimal outcomes. Therefore, successful societies as a rule have unconsciously evolved, or consciously adopted, customs and laws that temper inequality and instill community solidarity, so members treat each other's children nearly as well as their own. The idea of a natural selection favoring fit societies as opposed to fit individuals is finding biological parallels in recently discovered symbioses. Unfortunately, as Woodhouse points out, in human societies such institutions are more fragile and take longer to develop in today's global village than in local villages.

Misinformation thrives, and efforts to combat it founder, on less rational aspects of human nature. People suffer from confirmation bias, close their minds when threatened or disrespected, fear dramatic or malicious hazards (terrorism, shark attacks) more than mundane ones like overeating, and are uncritically dichotomous, tending to think of other people, institutions, and even substances (Tiger Woods, socialism, capitalism, fructose) as all good or all bad. When things go wrong they look for someone to blame, rather than blaming chance, geometry, or perverse incentives such as those that have driven Facebook to maximize engagement regardless of social harm. While Google and Wikipedia both began with the goal of making the world's knowledge accessible to everyone, the latter, by refusing ads and fostering editor solidarity, has come much closer.

Scientists need to become more humble about our own blind spots, and the difficulty of thinking scientifically about matters impacting our self-image, such as the role of innate vs. environmental factors in determining individuals' success. Every age's conventional wisdom believes and condones things that a few decades later will appear foolish or shameful. Scientists, rightly skeptical of ideas that seem so self-evident that no one has bothered to test them, need to guard against claiming the moral high ground so confidently, and with such little historical perspective, that we appear to others (often but not always less socioeconomically secure, well-traveled, and accustomed to various kinds of diversity than ourselves) as a hypocritical elite that purports to defend marginalized people while marginalizing anyone who dissents from the current version of its cosmopolitan secular worldview.



"I'm always afraid he will drop in unexpectedly."

Love your neighbor, who doesn't think like you.

For example, scientists are often resented for having a condescending attitude toward religion. But even anti-religious scientists have an awe of and submission to nature not unlike a religious person's submission to God. As Kinsey eloquently expressed in the 1950s, it is precisely this humility before nature that gives scientists the right and duty to question every taboo and investigate every natural phenomenon. Einstein involuntarily exemplified this need for humility by being so offended by quantum weirdness that he couldn't appreciate its power and beauty, leaving that important task to others. As Bohr is said to have told him, "Stop telling God what to do." Most scientists are skeptical of supernatural elements of religion such as miracles and divinely revealed scriptures, the very elements Spinoza discarded in his radical redefinition of God. This skepticism reflects the view that supernatural phenomena violate Aristotle's and Occam's commandment to prefer simple explanations. But 20th and 21st century science has shown, via algorithmic information theory and puzzles such as the Boltzmann brain problem in thermodynamics and the measure problem in cosmology, that the concept of simplicity is itself anything but simple.

Jargon and nit-picking precision abound in science as in other specialties, but scientific discourse differs in another way from ordinary talk—its attempt to be unemotional and descriptive, like what Wikipedia calls Neutral-Point-of-View. For example, in ordinary speech an invasive species is bad for the environment, but an ecologist would likely describe it as currently proliferating in an environment to which it has not yet equilibrated. For scientists, terminology that is euphemistic or dysphemistic is automatically suspect, suggesting an aspect of conventional wisdom unlikely to stand the test of time. Contrast the taboo- and hypocrisy-ridden criminal conviction of Alan Turing for "gross indecency" with Kinsey's contemporaneous research evidencing, among other things, a continuum of what we now call sexual orientation. Similarly, terms like "intellectual property" that obscure a subtle distinction are best avoided, or the distinction acknowledged, in careful discourse.

Unfortunately, fine distinctions are easily lost in the political arena. As seen most recently with #MeToo and Black Lives Matter movements, identity (or difference) politics is uniquely effective for initiating the remediation of long unacknowledged inequities, but it is a blunt instrument, oversimplifying the complex dynamics of power and status, the same complexity that demagogues exploit to sensitize people to their own real or imagined grievances while anesthetizing them to their privileges. Like other politics it tends to push people into ill-fitting categories, as when early gay rights activists bashed bisexuals for being cowardly or self-hating homosexuals, as if they were "passing" for straight, to borrow a pejorative from the similarly fraught history of racial identity.

Politicians and political activists, even when sincerely pursuing the greater good, appeal to their constituents' baser instincts, hoping to rein them in after the goal has been achieved. While they deserve our admiration for this delicate feat of moral navigation when it succeeds, we scientists should be no part of it. We should neither speak unscientifically about our own research, nor avoid research because it might be weaponized by our opponents, nor remain silent when it is weaponized, even by allies. Our expert advice should not bend under external political pressure or the subtler internal pressure of our own politics and unconscious biases.

Fortunately, the technology that spawned the misinformation crisis can also combat it. Authoritarian governments are busy using advances in data gathering, surveillance, and analysis to stabilize themselves against dissent and hide inconvenient truths. In contrast to such unethical social engineering, the instability of once-stable democracies against runaway polarization and misinformation shows that the time is ripe for natural and social scientists, along with ethicists, jurists, educators, and others, to participate in a public discussion (as is already going on for human genome editing and geo-engineering) of what would constitute *ethical, UDHR-friendly* social engineering, i.e. policies and laws sufficient to stabilize good governance and encourage behavior people won't later regret while otherwise maximizing their freedom, creativity, and privacy. Different policies are already being tried in different countries. One hopes our species will choose fact-friendly ones, voting with their feet if necessary.

For example, one of the more intractable kinds of prejudice- and misinformation-driven violence is the fear that a stranger, especially one visibly different from oneself, might be dangerous. Though often used as a fake excuse for hate crimes, this fear is not always irrational, and where sincere it could be allayed by a smartphone-mediated interaction between the two people while still a safe distance apart, to reassure each other of their non-dangerousness by a conversation and/or exchange of authenticated background information they had opted in to providing. Police traffic stops are common situations where fear is often mutual and rational and has led to deaths of drivers and officers that could probably have been prevented by a preliminary safe-distance interaction. Secure 2-party computation, unlike Tinder, allows such negotiations to be conducted without revealing private information to a third party.

On a grander scale, the moral philosopher John Rawls defined an equitable society as (roughly) one whose members would not mind being reborn as a random other member. My colleague John Smolin takes this Gedankenexperiment a step further by proposing that the quickest way to reduce inequity would be to randomly permute each year's crop of babies, thereby harnessing the full power of a natural phenomenon, spontaneous adoptive-parental love, to counteract one of civilization's most dangerous dysfunctions.

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1. Alfred Kinsey's eloquent 1953 plea (go.aps.org/3LUtCea) that no subject be considered taboo from scientific study inspired me as an adolescent would-be scientist.

2. My ex-wife's 2015 sermon (go.aps.org/36oomPY). Born to poor white parents, she was the first in her family to get an undergraduate degree, subsequently doing graduate work at Yale and Columbia School of Journalism before becoming an Episcopal deacon.

3. My African-American stepson's 2020 letter (go.aps.org/3By802H), in the wake of George Floyd's murder, to the orthopedic surgery residents he supervises, about what they as privileged people can do personally to combat racism and inequity.

4. My sister's 2020 book "The Ecology of Childhood" (go.aps.org/3JE8g2Q) on the loss of solidarity-reinforcing socialization mechanisms for children in a globalizing world. See also her lecture, beginning at 00:21:35 of go.aps.org/3LU6soy.

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