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APS NEWS

APS physics

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OBITUARY

Steven Weinberg 1933-2021

BY DANIEL GARISTO

Steven Weinberg, a theorist who unified two fundamental forces and shaped the way physicists and the public thought about the universe, died July 23 in Austin at 88.

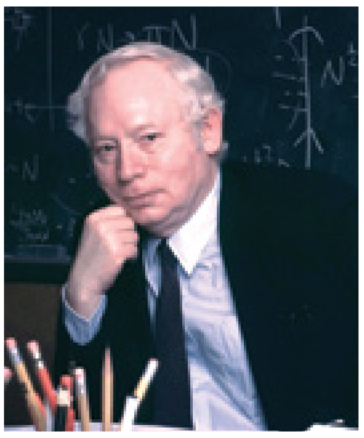
Weinberg shared the 1979 Nobel Prize in Physics with Abdus Salam and Sheldon Glashow for contributions to the theory that unified the weak and electromagnetic forces. He continued to win academic honors and awards for the next half century, including the 2020 Breakthrough Prize. In addition to his academic research, Weinberg wrote prolifically about science in popular books and publications such as the *New York Review of Books*. He was also a Fellow of APS.

"Steve was one of the last figures from this heroic era of particle physics that culminated in the development of the Standard Model," said Scott Aaronson, a theoretical computer scientist at the University of Texas at Austin, where Weinberg was a professor for forty years.

If he achieved mythic status through physics, it was from humble beginnings. Steven Weinberg was born in New York City to Frederick and Eva Weinberg, a court stenographer and homemaker respectively. Weinberg's interest in science was cultivated at the Bronx High School of Science, where he was—famously—classmates with Glashow, who would also go on to attend Cornell.

After Cornell, Weinberg married Louise Goldwasser, and the newlyweds spent a year in Copenhagen. He then went back to America and finished his PhD with Sam Treiman at Princeton on weak decays and renormalization, the mathematical technique for wrangling annoying infinities. Over the next decade, he bounced from Columbia to Berkeley before landing in Cambridge, MA, where he held appointments at MIT and Harvard.

In the early 1960s, Glashow and Salam attempted to unify electromagnetism and the weak force by proposing massive W and Z bosons



Steven Weinberg
CREDIT: LARRY MURPHY, UNIVERSITY OF TEXAS AT AUSTIN

as force carriers. But giving the W and Z mass made the theory nonrenormalizable. Weinberg took the idea of spontaneous symmetry breaking and in three brisk pages showed how the mechanism could lead the W and Z to appear massive at lower energies. One of the most

WEINBERG CONTINUED ON PAGE 5

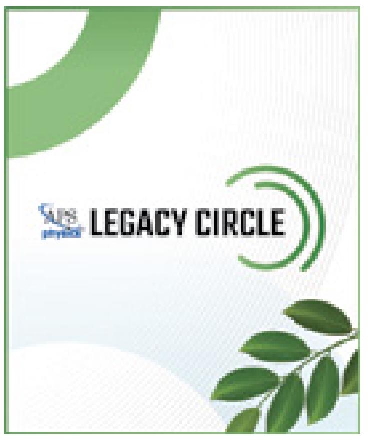
GIVING

APS Legacy Circle Profile: Robert Stanek

BY LEAH POFFENBERGER

As a high energy physicist, Robert Stanek has worked on some of the biggest experiments in physics, including HERA, Germany's largest research instrument, and as part of the ATLAS collaboration at CERN. To ensure students from low-income backgrounds or underrepresented groups have the opportunity to study physics, Stanek also joined the APS Legacy Circle, which recognizes donors who support APS initiatives through planned giving. APS members who join the Legacy Circle help to fund initiatives that will make a positive impact on the physics community.

"I've always been a proponent of helping students out.'" says Stanek. "I was going to leave all [of my money] to help scholarships for students [hoping to] go into physics. And then my wife convinced me to leave half to Lincoln Park Zoo [in Chicago] and half to APS. My motivation was to give



scholarships to students that could not afford [college] that wanted to go into physics."

Stanek received his PhD in 1980 from the University of Illinois at Chicago, completing his thesis work at Fermilab. After a brief stint working in nuclear medicine at the Edward Hines, Jr. VA Hospital,

STANEK CONTINUED ON PAGE 4

ETHICS

September Ethics Corner

BY FRANCES HOULE

Welcome to a new column on professional ethics, sponsored by the APS Ethics Committee. Comprised of appointees from several APS committees and the membership at large, the Committee's efforts include tracking emerging trends in ethical practices and concerns, recommending policies to APS leadership relevant to trends, and suggesting modifications to the APS Guidelines on Ethics when appropriate.

In 2021, subcommittees on Research Integrity and Ethics Education will serve to focus these efforts. We provide guidance as processes associated with new APS policies are established and implemented, most recently for the phased rollout of new professional conduct disclosure requirements for APS Honors and official leadership positions of the Society. We develop educational materials to examine specific ethics topics and presentation materials that can be used to lead ethics discussions. We invite you to visit our webpage to draw on these resources.

Frances Houle

Having conducted a survey of APS Early Career members in 2020, the Committee is now developing recommendations for new initiatives that respond to the community's needs, based on the survey results. Future columns will describe these activities and additional ethics resources for APS members and the physics community. We welcome your feedback!

The author is the chair of the APS Ethics Committee.

GOVERNANCE

Speaker of the APS Council Baha Balantekin

BY DAVID VOSS

The APS Council of Representatives currently consists of 35 members of the Society and is responsible for providing oversight of APS publications and conferences, approving policy statements, electing APS Fellows, distributing prizes and awards, ratifying amendments to the Constitution and Bylaws, and managing other matters relating to the scientific mission of APS.

The Council membership comprises four General Councilors, four International Councilors, the Treasurer, and Councilors representing the Divisions, Forums, and Sections. Activities of the Council are organized by the Council Steering Committee. The Council Steering Committee consists of four elected Councilors, the Speaker, the President-Elect, and the CEO and meets frequently between Council meetings.

The Speaker of the Council presides over the Council of Representatives and is elected from the Council. Baha Balantekin (University of Wisconsin) is the current Speaker, and *APS News* asked him to share his thoughts about his journey in physics and the role of the Council. The interview has been edited for length and clarity.

What was your path in research and with APS?

I went to graduate school at Yale University, where I worked on theoretical/mathematical nuclear/particle physics. After that, I went to MIT as a postdoc and a Wigner Fellow at Oak Ridge National Lab. Then I moved to the University of Wisconsin, where I've been for almost 35 years. I also have visiting adjunct appointments at the University of Washington in Seattle and the University of New South Wales in Sydney.

I've been involved with APS for some time. About a decade ago, I was the Councilor for the Division of Nuclear Physics and at that time I was elected to the APS Board and served just before APS reorganized its governance structures in 2014. Then a couple of years ago, the DNP Councilor left, so the division asked me to take over and run for the position again. So that's how I got to be on the Council a second time.

Baha Balantekin

What are some of your current research interests?

I am a theoretical physicist, even though I am a member of several experimental collaborations, but my role is primarily to provide theoretical feedback. And occasionally I take the night shift for fun. But my primary research area is theoretical physics at the interface of nuclear physics, particle physics, and astrophysics. And more recently, I'm getting involved in quantum information science applications in nuclear/particle astrophysics.

I'm collaborating with an experimentalist colleague, Mark Saffman, at the University of Wisconsin who's building a quantum computer

BALANTEKIN CONTINUED ON PAGE 6

OP-ED

The US Must Broaden On-ramps to the STEM Workforce

BY S. JAMES GATES, JR. AND GERALD C. BLAZEY

Editor's note: This op-ed was first published in The Hill on June 5, 2021. Since that time, the NSF for the Future Act, which is cited in the piece, passed out of the House of Representatives with strong bipartisan support. The next step is for the bill to go to conference with Senate-passed legislation concerning NSF. This process enables the reconciliation of differences between the pieces of legislation passed by each chamber of Congress.

Imagine an unfortunate world where Americans depend upon competitors for innovation, breakthroughs, and technological progress. In such a world, we won't create the first universal quantum computer or solve the mystery of dark matter. Nor will we create the next vaccine. Instead, we would have to forgo solving scientific mysteries, purchase breakthroughs from other countries, and get in line with everyone else.

Such scenarios once seemed far-fetched. But indicators show they are becoming increasingly more likely. Earlier this year, the United States fell out of the top 10 of the Bloomberg Innovation Index and also now ranks ninth globally in research and development spending as a percentage of the gross domestic product.

Maintaining our global competitiveness is an urgent problem, and creating a stronger, more diverse workforce in an environment of rapid cycles of innovation and STEM developments is key to com-

STEM CONTINUED ON PAGE 6

THIS MONTH IN

Physics History

September 19, 1926: Masatoshi Koshiba, Pioneer of Neutrino Astronomy, is Born

BY JULIA OSTMANN

Tiny and chargeless, neutrinos leave barely a trace on their journey around the cosmos—elusive players in the hunt for dark matter, the study of our Sun, and the evolution of the atom. Today, the vibrant field of neutrino research cuts across many areas of physics.

Yet we may never have confirmed that neutrinos burst from stars—or discovered why so many of them escape our detectors—had Masatoshi Koshiba listened to his high school physics teacher.

The future Nobel laureate was born September 19, 1926, in the seaside city of Toyohashi, Japan, the son of a military father. As a child, he liked mathematics, and as a teenager, he enjoyed reading *The Evolution of Physics*, a book on the history of physics by Albert Einstein and Leopold Infeld. Koshiba excelled at Japanese fencing, but after a bout of polio and diphtheria, took up building model airplanes from bamboo and rubber bands. He contemplated running a model airplane shop in the future.

After two attempts, the young Koshiba passed the entrance exam for a prestigious boarding school in Tokyo, arriving in the wrecked and burned hull of the city four months before the end of World War II. A classmate had found a usable transformer and jerry-rigged it to boil water, creating a hot outdoor bath on campus that would change Koshiba's life.

Koshiba was considering studying German literature at university. Then one night in the bathtub, he overheard a physics teacher—who had flunked him—gossiping to a star pupil about Koshiba's university plans. "Whatever he chooses to apply for, it cannot be in the physics department," the teacher said.

Koshiba was furious. He switched his focus, crammed for one month, and passed the requirements of the physics department. The star pupil failed, Koshiba later recalled.

At university, Koshiba struggled. His family fell on hard times, and to help, he tutored wealthy children and unloaded ships overnight at the docks, leaving little time for coursework. Then a connection through his boarding school convinced the University of Rochester to give Koshiba a graduate scholarship in 1953. There, he would earn his PhD in just two years—racing to get the guaranteed $400 per month salary for degree holders, which he needed to live.

For the next three decades, Koshiba worked on cosmic ray collaborations and particle accelerators all over the world. Then in the early 1980s, he turned his attention to the popular grand unified theory (GUT), imagining an underground detector that could capture its signature proton decay. In 1983, Koshiba had an enormous vat of water installed deep inside a tin and zinc mine in Kamioka, a mountainous town in central Japan, as the basis for his new detector.

MODEL OF THE KAMIOKANDE DETECTOR

CREDIT: WIKI COMMONS

The Kamiokande detector didn't detect proton decay as Koshiba intended. But after some reconfiguring he suggested, it made a major contribution to another mystery: the solar neutrino problem. In the late 1960s, Brookhaven National Laboratory scientist Raymond Davis Jr. captured the first presumed solar neutrinos with his detector, located in the Homestake Gold Mine in Lead, South Dakota. Only a third as many had turned up as the standard solar model predicted, suggesting a problem with our understanding of either neutrinos or the Sun.

Neutrinos passing through water produce a burst of light. In 1987, an exploding star spewed neutrinos across neighboring galaxies—and at least 11 of those neutrinos hit the Kamiokande detector. Graduate student Keiko Hirata had written criteria for detecting a neutrino signal, and she noticed the telltale peak in the data. The fiercely guarded first record of supernova neutrinos appeared in *Physical Review Letters* (Volume 58; Issue 14).

By 1990, Koshiba's detector had found solar neutrinos, supporting the Davis numbers and, crucially, confirming that the neutrinos originated from our sun.

HISTORY CONTINUED ON PAGE 3

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UNIT PROFILE

APS Membership Unit Profile: The New England Section

BY ABIGAIL DOVE

With over 2,500 members, the New England Section (NES) is a home for APS members based in Massachusetts, Connecticut, Rhode Island, Vermont, New Hampshire, and Maine. Consistent with the sheer multitude of academic and research centers in this part of the country, NES is one of the largest and most active geographical sections in APS's ranks.

Geographical sections are an important part of the APS ecosystem, strengthening the physics community in different parts of the country and helping APS diffuse the knowledge of physics at a regional level. In addition to acting as a networking platform for physicists in different fields and at different stages of their careers, geographical sections also provide a vehicle for interactions between neighboring academic institutions (from small liberal arts colleges to large research universities), government laboratories, and industry.

NES was established in 1932 as APS's first-ever geographical section. In an effort to build a bigger grassroots presence for APS across the country, geographical sections have expanded to encompass the entire US: in addition to New England, this includes the Eastern Great Lakes (EGLS), Far West (FWS; see *APS News* July 2019), Four Corners (4CS), Mid-Atlantic (MAS), New York State (NYSS), Northwest (NWS), Prairie Section (PSAPS), Southeastern (SESAPS), and Texas (TSAPS).

Richard Price

Involvement in a geographical section provides opportunities to learn about the research ongoing at other nearby institutions and—in contrast to more discipline-centered units at APS like divisions, topical groups, and forums—gives members unique exposure to other areas of physics outside of their particular field.

"Each geographical section has its own features. In the case of NES, the feature is a very high density of institutions of higher learning," explained NES chair Richard Price (MIT). This aspect of NES provides ample opportunities for networking: "Faculty at

NE SECTION CONTINUED ON PAGE 7

INDUSTRIAL

APS Works to Ensure US has Strong Semiconductor Manufacturing Industry

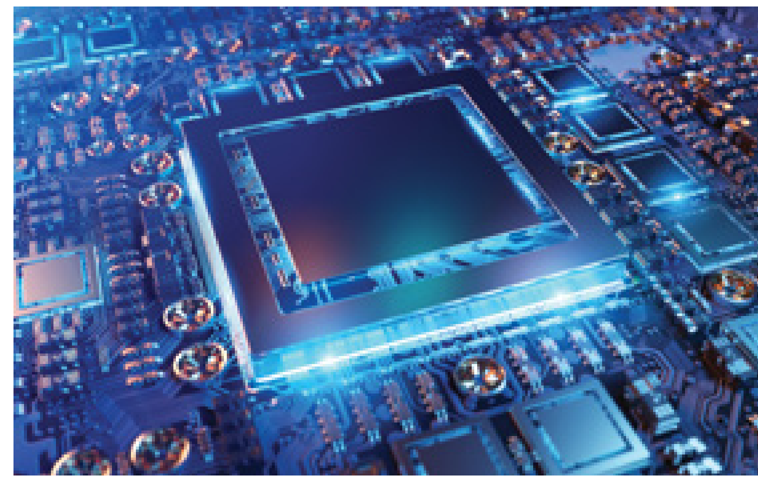
BY TAWANDA W. JOHNSON

Semiconductors are ubiquitous—the brains of modern electronics, from computers to smartphones to cars—and play a crucial role in keeping the US as a global technology leader, boosting the economy, and strengthening national security.

But America's leadership in the semiconductor field remains in a precarious position. According to the Semiconductor Industry Association (SIA), "federal investments in chip research have held flat as a share of gross domestic product (GDP), while other countries have significantly ramped up research investments."

There's good reason to boost investments in semiconductor research: according to "Sparking Innovation," a SIA report, "each additional dollar invested in federal semiconductor research increases US GDP by $16.50."

For its part, APS, through its participation on the Task Force on American Innovation, supported the inclusion of semiconductor R&D provisions in the Fiscal Year (FY) 2021 National Defense Authorization Act (NDAA). The Task Force is an alliance of the nation's leading companies, research universities, and scientific societies that advocates for robust federally funded research. Following the urging of the Task Force letter, Congress included the Creating Helpful Incentives



to Produce Semiconductors for America (CHIPS) Act in the NDAA authorization bill. The CHIPS Act authorizes the research and manufacturing provisions as well as tax incentives to strengthen the US semiconductor industry. Congress must now appropriate funding for those provisions in order for them to be implemented.

"We knew that many APS members, especially those who work in the semiconductor industry, would benefit from legislation that bolsters research and development in a field that's central to so many technologies. It was great to see members of Congress recognize this critical industry as part of last year's NDAA," said Mark Elsesser, Director of Government Affairs at APS.

APS Journal Key in Development of Semiconductors

APS's *Physical Review* journal played an important role in the publishing and dissemination of research regarding the invention of the semiconductor chip. In 1950, John Bardeen published his early work on the transistor in *Physical Review* (Volume 71; page 717). In his first article, he wrote that the transistor was the embodiment of a semiconductor chip. Bardeen followed that article with a second one, published in *Physical Review* (Volume 75; page 1208), where he explained the physical principles behind the transistor. In 1951, William Shockley, who also worked

INDUSTRY CONTINUED ON PAGE 4

HISTORY CONTINUED FROM PAGE 2

Still, the question remained: why is there a discrepancy between our mathematical model of the sun and actual observations of solar neutrinos? What's more, results from Kamiokande had revealed a new anomaly: an unexpected ratio of muon to electron neutrinos.

Fortunately, Koshiba was a better mentor than his high school physics teacher. Takaaki Kajita, one of Koshiba's graduate students, led a new Super-Kamiokande experiment that made the clinching observation in 1998: neutrinos oscillate between different forms, allowing them to dodge detectors—and proving they have mass. The finding required a rewrite of the Standard Model.

In 2002, Koshiba and Davis shared the Nobel Prize in Physics "for pioneering contributions to astrophysics, in particular for the detection of cosmic neutrinos." Kajita also shared a Nobel for his work 13 years later.

Fond of metaphor and pragmatic advice, Koshiba kick-started many research ideas that younger physicists pursued to great success. In the half century after World War II, he helped shape Japan into a high-energy-physics powerhouse and attract significant international attention. For example, Koshiba dreamed of bringing a next-generation linear collider to Japan. Before dying in 2020, he finally saw plans for one, the International Linear Collider (ILC), commence.

Koshiba faced major financial and societal setbacks that would have derailed most from a career in physics. But just like ghostly neutrinos—hiding in plain sight all around us, recognized only by a stroke of luck, perseverance, and the right conditions—Masatoshi Koshiba burst through. He could have ended up working odd jobs, teaching German literature, or selling model airplanes. Instead, he helped solve one of the leading scientific mysteries of the late 20th century.

Additional Reading:

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"The Nobel Prize in PHYSICS 2002 Masatoshi Koshiba Facts." NobelPrize.org.

INDUSTRY CONTINUED FROM PAGE 3

with Bardeen, published the physics behind a second semiconductor device called a junction transistor, which formed the basis of future semiconductors.

Several years later, Bell Laboratory scientists developed the processes necessary to manufacture the junction transistor. The key to that process: the ability to grow high purity, large single crystals of silicon and germanium. Gordon Teal and John Little reported this work in 1950 in *Physical Review* (Volume 78; page 647).

In 1951, Shockley, Morgan Sparks, and Teal published further work on the basics of the manufacturing processes in *Physical Review* (Volume 83; page 151). Similar articles were also published in the *Physical Review* journal from 1948-1952, covering the early work on the transistor.

"It is clear that APS was at the forefront in helping to disseminate such important science on the development of the semiconductor," said Dan Pisano, Director of Industrial Engagement at APS.

The Expansion of Semiconductor Manufacturing

Until 1952, Bell Telephone Labs was the only commercial manufacturer of the transistor. During that year, Bell Labs offered a license to 40 companies to the technology of the transistor. Later, companies such as General Electric, RCA, Fairchild Semiconductor, Texas Instruments, Mostek, Intel, and the Aerospace Corp. dominated the semiconductor industry. Sony was the only foreign licensee.

The shift to Asia-Pacific manufacturing began with designs in the US and fabrication in Asia. As demand and capability grew in Asia during the 1990s, it became the dominant source of semiconductor devices.

"The United States is now experiencing a shortage of semiconductor chips due to a high demand for the chips and relatively little supply available, especially in the car industry. It will take time and resources to restore manufacturing capacity in the US to get our nation back on track toward building the necessary facilities that will lead to a robust supply of semiconductors—the backbone of our modern society, national security, and economy," said Pisano.

The author is Senior Press Secretary in the APS Office of External Affairs.

STANEK CONTINUED FROM PAGE 1

Stanek returned to high energy physics as a post-doc at Argonne National Laboratory. Stanek would go on to work on polarized beams at Fermilab, Los Alamos National Laboratory, and HERA, before ending up at CERN, where he served as a project leader on ATLAS for four years.

Stanek is now connecting with the next generation of physicists through volunteer activities to help get kids interested in science. Before the coronavirus pandemic, Stanek spent his Saturdays volunteering at Chicago's Museum of Science and Industry performing physics demos. He also takes demos to local schools to "show kids that physics can actually be fun."

Inspired by his predominantly Hispanic community in the Southwest side of Chicago, Stanek became interested in helping students pursue college who may not otherwise be able to afford it. He has donated to the APS Bridge Program, which is working to increase the number of PhDs awarded to students from backgrounds that haven't been traditionally represented in physics.

Stanek encourages others to consider the impact of investing in physics on the future generation. "I would suggest thinking about supporting students to go into physics...these young kids that are coming up, are they going to have [to] make it on their own, or are you going to help them out if you can?" says Stanek. "It's my priority to get kids into high energy physics...but if somebody else wants to do solid-state physics, then that's fine with me, too."

For more information about joining the Legacy Circle, please visit the Legacy Circle page or contact Kevin Kase at 301-209-3224 or email kase@aps.org.

SCIENCE POLICY

APS Thrilled with DHS Withdrawal of Proposed Elimination of Duration of Status

BY TAWANDA W. JOHNSON

APS is delighted that the US Department of Homeland Security (DHS) has withdrawn a proposed rule that would have eliminated the duration of status guidelines that allow international students and researchers on certain visas—such as F and J—to remain in the country as long as they maintain compliance with their terms of admission.

The proposed rule change by the Trump Administration in fall 2020 called for replacing the duration of status with an arbitrary and restrictive two- or four-year term limit, depending on one's country of origin.

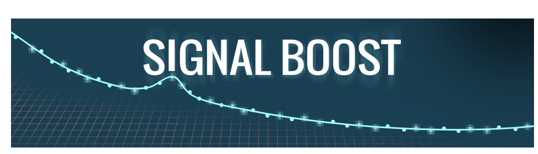
In response, the Society's leadership submitted a public comment in October 2020 in strong opposition, and APS Government Affairs mounted a grassroots campaign enabling APS members to submit unique, personalized messages to DHS. With the comment period only open for 30 days, there was a need to act quickly, and more than 1,600 APS members did so. Because the rulemaking process requires federal agencies to provide a distinctive reply to each unique comment, DHS had to respond to the various concerns of the scientific community before moving forward, thus pushing back the timeline of its implementation.

"This is fantastic news. The outstanding contributions of talented international students and scholars are essential to the success of both the physics community and US scientific enterprise, and ultimately, a firm foundation for the future of the economy," said APS President S. James Gates, Jr. "The outcome will help put our nation back on track to being the destination of choice for the best and brightest international students and scholars to come to study and work in our country."

Added Callie Pruett, Senior Strategist for Grassroots Advocacy, "Our team is thrilled that this draconian rule has been withdrawn and even more thrilled that we played a significant role in the push against it. Our members submitted more than 1,600 comments in opposition to the rule last year. What that translated to was nearly 1 in 20 comments originating from APS members, which is something that we are immensely proud of."

In the Society's response to the proposed rule signed by past APS President Phil Bucksbaum, he wrote, "History teaches that our economic competitiveness relies on top talent, much of which has come from overseas: more than one-third of all US Nobel Prize laureates were foreign-born; more than 44 percent of the Fortune 500 companies were founded by immigrant entrepreneurs or their children; and more than 30 percent

DHS WITHDRAWAL ON PAGE 7



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

FYI: SCIENCE POLICY NEWS FROM AIP

Secretary of State Tony Blinken Sets Out Vision for Global Technology Diplomacy

BY ANDREA PETERSON

Addressing an international conference convened by the National Security Commission on Artificial Intelligence in July, Secretary of State Tony Blinken and other US administration officials outlined a vision for building technology partnerships among democratic nations.

Much of the current wave of attention in Congress and the Biden administration surrounding R&D, technology, and supply chains is driven by concerns about the rising technological influence of rival nations, and especially China. However, Blinken argued it is not enough to "highlight the horrors of techno-authoritarianism." He said the US must instead establish an alternative model of governance for AI and other emerging technologies that embodies democratic nations' common values.

"Democracies have to pass the tech test together. And diplomacy, I believe, has a big role to play in that," he continued, arguing that technological cooperation among democracies will be accomplished through the accumulation of piecemeal agreements.

Blinken highlighted steps the administration has already taken toward this goal, including setting up the US–EU Trade and Technology Council, which was announced in June and will focus on topics such as technology standards cooperation, secure supply chains, data governance, technology and human rights, export controls, and investment screening. He also cited the US' recent bilateral agreements on scientific cooperation and emerging technologies with the UK, Japan, and South Korea, and pointed to the working group on "critical and emerging technologies" launched in March by the "Quad" countries: the U.S., Japan, India, and Australia.

Blinken reiterated the Biden administration's interest in building more resilient supply chains for critical technologies such as semiconductors, saying that it plans to work with partners to "friend-shore" and "near-shore" supplies in addition to expanding domestic production. He also reported the administration is working with international standards organizations to promote a "transparent, consensus-based, and private-sector-led approach to developing standards for emerging technologies."

More concretely, Blinken signaled that further specific policy actions are forthcoming. "We're taking a fresh look at tools like export controls, investment screening, and visa screening, to make sure our strategic competitors are not exploiting our own innovative ecosystems to gain military or national security advantage," Blinken said.

Outside of such technical matters, Blinken also stressed the importance of establishing inter-

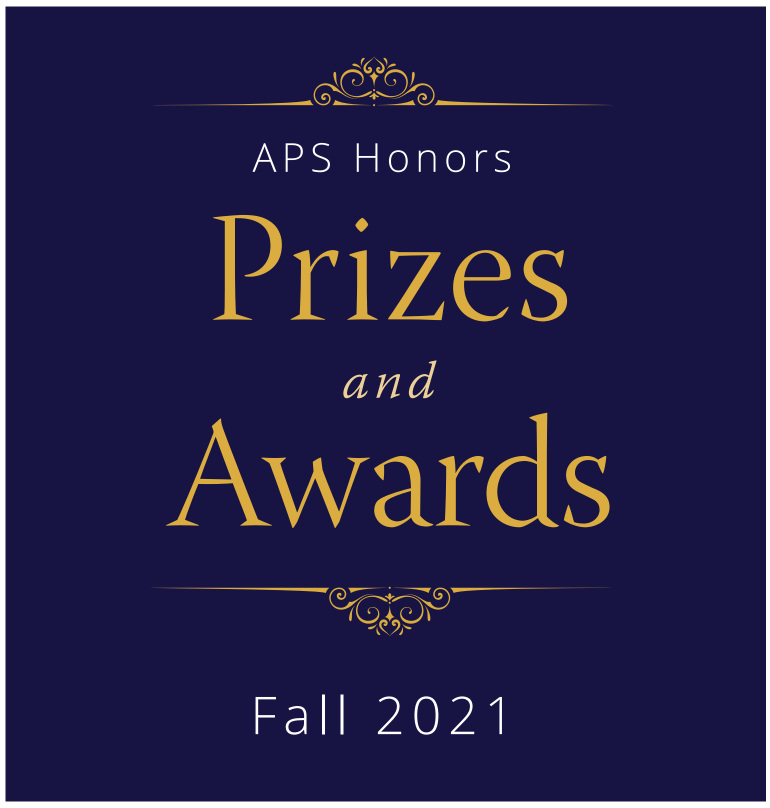
GLOBAL TECH ON PAGE 7

HONORS

2021 APS Fall Prize and Award Recipients

APS recognizes outstanding achievement in research, education, and public service with APS prizes and awards. With few exceptions, they are open to all members of the scientific community in the US and abroad. The nomination and selection procedure, which involves APS-appointed selection committees, guarantees high standards and prestige.

Prize and award recipients are nominated by their peers and colleagues and were selected from hundreds of nominees. Recipients of APS Prizes and Awards are announced in two groups, one in the Spring and one in the Fall. The list of Fall recipients appears below.



The **Andreas Acrivos Dissertation Award** in Fluid Dynamics recognizes exceptional young scientists who have performed original doctoral thesis work of outstanding scientific quality and achievement in the area of fluid dynamics.

"For developing a novel theoretical and computational framework which established fundamental insights into the turbulent bubble breakup cascade in oceanic breaking waves."

Wai Hong Ronald Chan, University of Colorado Boulder

The **Stanley Corrsin Award** recognizes a particularly influential contribution to fundamental fluid dynamics.

"For development, exposition, and combined application of computational and modal decomposition tools to understand coherent structures in turbulent flows and for continuing leadership in aeroacoustics and turbulence."

Tim Colonius, California Institute of Technology

The **Fluid Dynamics Prize** recognizes outstanding achievement in fluid dynamics research.

"For seminal contributions to wetting of surfaces and interfacial hydrodynamics by revealing the physics of the phenomena through reduction to their simple core."

David Quéré, ESPCI-Paris

The **Stuart Jay Freedman Award in Experimental Nuclear Physics** honors an outstanding early career experimentalist in nuclear physics.

"For excellence in experimental research into the fundamental nature of matter and mass based on low-energy cryogenic detection techniques, in particular neutrinoless double beta decay and dark matter searches."

Danielle H. Speller, Johns Hopkins University

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WEINBERG CONTINUED FROM PAGE 1

impactful papers in particle physics, "A Model of Leptons" went mostly unnoticed: for two years after it was published in *Physical Review Letters*, it garnered only two citations.

"Why doesn't anybody quote his paper between 1967 and 1970? The reason is nobody could do that calculation," said Helen Quinn, a professor emerita at SLAC. Weinberg knew that his model was "probably renormalizable," but it wasn't until a 1970 paper by Gerard t'Hooft that the dam burst and citations flooded in. When Quinn and her coauthors did the first one-loop calculation for Weinberg's theory, "he was so happy he invited us to sherry at his house," she said.

As a theorist, Weinberg was not particularly focused on model building. "It is ironic that his Nobel Prize was for a specific model, because he was really interested in the general picture and not in the specific models, no matter how beautiful," Howard Georgi, a Harvard physicist, wrote in an email to APS News.

"He told me why once: Models are almost always wrong. But if you have general arguments that follow from general principles, that has a chance of being correct in the long run," said John Preskill, a physicist at Caltech and one of Weinberg's students.

Quinn recalls an argument between Julian Schwinger and Weinberg during a student's thesis defense. "Julian's position was effectively that that theory is best which is flexible enough to accommodate all new data and be adapted to it," she said. "Steve's position was that that theory is best which is very well defined, and thus can be tested and ruled out."

Some of Weinberg's colleagues argue that his real seminal contribution to particle physics was not electroweak unification but articulating how to think about effective quantum field theories (EQFTs). Though EQFTs had been in use for decades, Weinberg's insight was that physics lurking at much higher energies would appear in terms suppressed by heavy masses. This perspective shaped the hunt for unknown particles and "underlies almost everything we do from LHC physics to string theory to dark matter," Georgi wrote.

Beyond particle physics, Weinberg also made contributions to astrophysics and cosmology, in particular by reintroducing the cosmological constant as a problem—prior to the discovery of dark energy—and working on matter-antimatter asymmetry in the early universe. He expounded on his view that the very small and very large were connected in *The First Three Minutes*, a popular science text, which both introduced the public to cosmic microwave background radiation for the first time and inspired a generation of practicing physicists to hone their cosmological queries.

In 1981, Weinberg followed his wife Louise to UT Austin, where she was already a professor at the law school. He established a theoretical physics department where his Tuesday pre-colloquium lunches became *de rigeur*. "The discussion was basically led by him," said Willy Fischler, a theorist at UT Austin. "Often, it was about history, poetry, and literature."

Despite his laurels and seniority, Weinberg continued teaching. This fall, he was set to teach a course on thermodynamics and statistical mechanics. "I was amazed. I mean Steve is 88, and he's going to teach a course that he has never taught," said Fischler.

Colleagues noted Weinberg's intensity and testified to his single-mindedness when attacking a physics problem. "He wasn't going to come to your office and say, 'How are you doing? How was your weekend?' He wasn't that kind of person," said Sonia Paban, a theoretical physicist at UT Austin.

Weinberg was known for his solitary style, and he was frequently a sole author. When working from home, Weinberg kept a TV on his desk and enjoyed listening to old movies in the background to feel less isolated. But earlier in his career, Weinberg frequently collaborated with physicists like Quinn, Glashow, and Benjamin Lee.

When Quinn and Roberto Peccei published their approach to the strong CP problem, they did not predict an axion. "Weinberg actually called me up and asked me, 'Did you notice that your theory has this property that there's a pseudo-Goldstone boson?' And I said, 'Well, no, I didn't. But you're absolutely right. Obviously, it does.' And he said, 'Well, in that case, I'll publish it myself.'" Quinn said. "So what he was doing was giving me the opportunity to be a co-author of the paper with the axion."

Others also spoke to Weinberg's sense of fairness. Paban recalls an incident when a visiting Nobel laureate dismissed a question by a student during a colloquium. "The speaker looked at [the student] and said, 'I see you don't understand' and he proceeded," she said. "Steve raised his hand and said, 'I don't understand that—and don't give me that answer.'"

For Weinberg, the pursuit of understanding was not an idle matter. "Our mistake is not that we take our theories too seriously, but that we do not take them seriously enough," he wrote in *The First Three Minutes*.

"Steve said, 'I think we don't take our theories seriously enough, because it's so hard to believe that the squiggles that you make on a piece of paper are actually the way nature works.'" Preskill said. "In his case, and in a few spectacular examples, they were indeed."

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BALANTEKIN CONTINUED FROM PAGE 1

based on neutral Rydberg atoms. We are hoping that he will be able to have a functioning quantum computer with 121 qubits. With that we want to be able to simulate the behavior of the nuclei in target materials for dark matter detection. We also want to explore collective neutrino oscillations in supernova and neutron star mergers.

What do you see as the role of the Speaker?

The role of the Speaker is to set the agenda, chair the Council meetings, and sort of gently nudge the discussion, encouraging people to participate. In the present structure, the Council has a more active role. In the past, there were a lot of routine activities the Council had to do, and while it was good for the membership to have input, there wasn't as much active discussion in the Council meetings. The role of the Council and the role of the APS Board are very carefully defined now. For example, budgetary matters are the responsibility of the Board.

What are some of the challenges facing APS and the Council?

Of course, the biggest questions for APS in general and Council in particular involve the pandemic. This has been unprecedented—I don't remember any other time in APS history when activities were curtailed to this extent. Undergraduate and graduate teaching went online, which was a completely new paradigm for most of us. Research activities went online, and we couldn't travel. When you are together with your collaborators in front of a blackboard things go much faster.

My experimental colleagues couldn't go to their labs for a long time. So, this affected the physics community in so many ways, and this is obviously one of the greatest challenges we face as a community. We must get back to our routine and basically build it better than it was.

We learned valuable lessons from this. For example, we put all the meetings online and everything became virtual. There are some very positive aspects of online meetings. People who have childcare responsibilities or care for their older family members didn't have to travel. But there were some negative aspects, such as the question-and-answer periods not being as active as before. And of course, a meeting doesn't end when the talk is over. It goes on in corridors and during the lunches and dinners. We missed all that, and we're now trying to decide what future APS meetings should look like. That's a place where the Council can play a role.

I'm aware of the publication issues as well. There are completely different questions coming into play, like what happens to the *Physical Review* journals as open access becomes more widespread? What's the future of the journals? So those are questions, I think, more likely to be discussed in the APS Board because most of them directly relate to budgetary issues—the journals bring in a lot of revenue to APS. But of course, one would like to get input from the Council and the membership as well.

During the pandemic, a lot of graduate students couldn't finish their experiments, so they couldn't graduate. Many universities basically stopped faculty hiring for some time. These things very negatively affected the younger people in the field. That's something that we must address and see how we can resolve some of those problems now.

There are two other areas the Council can play a role. One is that APS has recently revamped its ethics guidelines. The other is diversity, equity, and inclusion. This is something that APS is trying to bring to the forefront. For example, we would like to be more inclusive in the council meetings. That means we are bringing in representatives from national Black and Hispanic organizations, as well as the recently established APS Forum on Diversity and Inclusion.

How does the Council represent the membership?

The Council is the bridge between the APS members and the APS leadership, so it is a very valuable avenue to provide input into APS. The Councilors come from all the membership units, so the Council is attached to the membership directly. But the goal is for the membership to own these priorities as opposed to us telling them what they're going to do. And something like that, I think, can only be achieved in a group like the Council.

I would like to see APS members to be more active in the Society's affairs in any way they can. People are busy, but I want them to increase their involvement in APS and make sure that they understand what APS is trying to do. I want them to speak up and provide input to the Council and to the Board. I think that's very important because that's the only way the Council will be a true representation of the membership.

Members can join APS Divisions and other membership units and directly talk to their unit counselors and ask them to bring up something at the Council meetings. This can be a valuable conversation in both directions. There are so many good things that APS does over a wide range of activities. But not everyone in the membership is aware of these activities. Sometimes they say, "why doesn't APS do X," and it turns out APS is already doing that.

For more information about the APS Council, visit aps.org/about/governance/leadership/council/.

STEM CONTINUED FROM PAGE 2

petition. A recent report by APS titled, "Building America's STEM Workforce: Eliminating Barriers and Unlocking Advantages," points out that the country must do a better job of attracting women, racial and ethnic minorities, and rural Americans to the US scientific and technical workforce. Dr. Sethuraman Panchanathan, Director of the National Science Foundation (NSF), refers to the "missing millions" as people who are capable of succeeding in science, technology, engineering, and math fields but have no access to pathways to get them there.

Enabling the "missing millions" to participate in US STEM isn't just a path to establishing equity; it is the path to restoring US competitiveness in science and technology. According to the 2020 NSF Science & Engineering Indicators, for example, members of underrepresented minorities represented approximately 15 percent of the US science and engineering workforce and more than 28 percent of the US population (ages 21 and up). These percentages point to a clear opportunity for building the STEM workforce with talented and capable US citizens who just need an on-ramp.

Noting the importance of diversity in boosting innovation and productivity, the APS report states that one way to achieve that goal is by expanding opportunities for students from underrepresented groups or underserved areas to participate in research, a high-impact practice for student retention and workforce strengthening and diversification.

Fortunately, leaders of the House Committee on Science, Space, and Technology have a perspective similar to the report's recommendation, and they included an important provision in the bipartisan NSF for the Future Act. That provision would establish a pilot program to create meaningful, lasting partnerships between major research institutions and emerging research institutions—colleges and universities that have smaller research footprints and capacity, due, in part, to monetary and equipment constraints.

If enacted into law, the legislation would require NSF to direct at least 25 percent of any multi-institutional award exceeding $1 million to emerging research institutions to build research capacity, which could include purchasing new equipment or providing paid research experiences for undergraduate students.

The legislation also includes an important review and assessment of the program. The full House Committee on Science, Space and Technology is slated to mark up the bill in the coming weeks.

The benefits of creating this partnership pilot-program would be substantial, both for students and faculty members. For example, students with little formal research training could gain meaningful experience in a laboratory setting, using cutting-edge equipment that otherwise would not have been available. Meanwhile, lead investigators could develop powerful insights into the lived experiences of non-traditional and under-represented students, as well as strengthen their scientific knowledge through partnerships with major universities.

By strengthening partnerships between research-intensive universities and emerging research institutions, the NSF for the Future Act would help address funding inequities. According to the APS report, of the 637 universities that received federal R&D funding in 2018 for science and engineering, 78 percent—of which the vast majority are emerging research institutions—received only 10 percent of the funding, despite serving 57 percent of all students attending those types of institutions. Further, these institutions served 68 percent of Pell Grant recipients and 66 percent of under-represented minority students. Said another way: Two-thirds of our nation's students of color at research institutions see only about 10 percent of the federal R&D dollars.

The NSF for the Future Act addresses this funding disparity not by cutting research to research-intensive universities, but by growing the resources so emerging research institutions can be meaningfully supported. This proposed partnership with emerging research institutions addresses two imperatives: excellence in research and diversifying opportunities in science. Faculty and students at emerging research institutions are fully capable of performing world-class research; all they need is the opportunity to do so.

S. James Gates Jr., PhD, is the APS President and director of the Brown Center for Theoretical Physics. Gerald C. Blazey, PhD, is vice president for Research and Innovation Partnerships at Northern Illinois University.

HONORS CONTINUED FROM PAGE 5

The **John Dawson Award for Excellence in Plasma Physics Research** focuses specifically on achievements in plasma physics research.

"For developing Monte Carlo methods that overcome the fermion sign problem, leading to the first ab initio data for an electron gas under warm dense matter conditions."

Travis Sjostrom, Los Alamos National Laboratory

Fionn D. Malone, QC Ware

Tim Schoof, DESY

Simon Groth, Christian-Albrechts University in Kiel

Tobias Dornheim, Center for Advanced Systems Understanding (CASUS)

Michael Bonitz, Institute for Theoretical Physics and Astrophysics, Kiel University

William Matthew Colwyn Foulkes, Imperial College London

The **James Clerk Maxwell Prize for Plasma Physics** recognizes outstanding contributions to plasma physics broadly.

"For ground-breaking discoveries in space plasma physics and for seminal theoretical contributions to understanding space plasma processes and magnetohydrodynamics."

Margaret Galland Kivelson, UCLA: Earth, Planetary, and Space Sciences

The **Marshall N. Rosenbluth Outstanding Doctoral Thesis Award** goes to a young plasma physicist who has performed original thesis work of outstanding scientific quality and achievement.

"For pioneering the development of adjoint methods and application of shape calculus for fusion plasmas, enabling a new derivative-based method of stellarator design."

Elizabeth Paul, Princeton University

The **Thomas H. Stix Award for Outstanding Early Career Contributions to Plasma Physics Research** recognizes contributions to plasma physics research by early career physicists.

"For groundbreaking contributions and scientific leadership in the understanding of non-axisymmetric magnetic fields and relativistic electrons in tokamak plasmas."

Carlos Paz-Soldan, Columbia University

For more information on the recipients, please visit the APS Honors webpage at aps.org/programs/honors/.

DHS WITHDRAWAL CONTINUED FROM PAGE 4

of the US science and engineering workforce is foreign-born. The long-term consequences of losing out on top international talent will be severe."

The DHS withdrawal of the proposed rule is a huge win for not only APS but for many other organizations that sought to stop the measure from being implemented.

According to the Federal Register, DHS received more than 32,000 comments during the 30-day comment period, and more than 99 percent of commenters requested that DHS withdraw the rule. Those who opposed the rule argued that it "discriminates against certain groups of people based on their nationality."

Francis Slakey, Chief External Affairs Officer, said he is proud of how APS members rallied to make their voices heard on such an important issue.

"Our members are always ready to fight for a stronger and just scientific enterprise. When we informed them about this issue, they rose to the challenge and made an impact that resulted in a positive outcome that was crucial to the sustainability of graduate research programs and a key part of our STEM talent pipeline," he said.

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GLOBAL TECH CONTINUED FROM PAGE 4

national norms for the ethical use of emerging technologies, arguing, "If they're going to be used as part of our national defense, we want the world to have a shared understanding of how to do that responsibly, in the same way that we've hammered out rules for how to use conventional and nuclear weapons."

For the US to meet its diplomatic goals, Blinken said the State Department will have to significantly expand its technological capacity. "Virtually everything on our agenda has some tech or science or innovative component to the solution. We need to do a better job bringing that knowledge, that expertise, that focus into the department and to everything we do," he remarked.

Accordingly, Blinken said he has asked deputy secretaries of state Wendy Sherman and Brian McKeon to provide recommendations on how to "elevate and institutionalize" cyber and technology capabilities across the department.

Looking forward, Blinken said, "I intend to leave my successor at the State Department with strong capabilities in cyber and tech diplomacy, with clear leadership, lines of authority, organizational homes, and talent at every level. We need to become much better at anticipating the foreign policy implications of the next wave of innovation, and the wave after that. I want to shape the strategic tech landscape, not just react to it."

The author is Science Policy Reporter for FYI.

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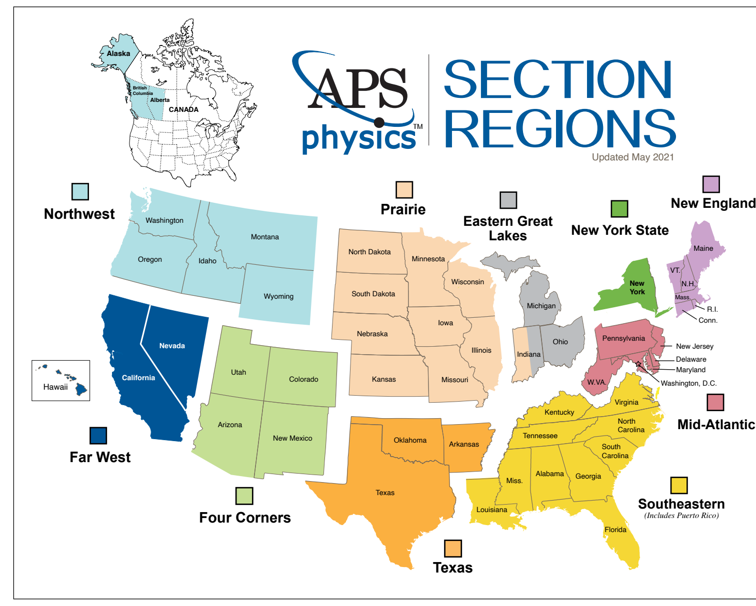
NE SECTION CONTINUED FROM PAGE 3

research-intensive institutions can find that there is overlap with work going on at small schools. The faculty at these research institutions can also use their involvement in NES as a way to make connections with and attract potential graduate students. Conversely, potential graduate students get an opportunity to introduce themselves to researchers they might want to work with."

A particular point of pride for NES is its semi-annual meeting, held every year in the spring and fall. Typically, NES meetings feature invited sessions featuring leaders in their respective fields paralleled by contributed talks and a poster session. Many of these presenters are undergraduates and graduate students having their first experience of discussing their work at a professional meeting. Past plenary sessions spanned such diverse topics as astrophysics and atmospheric physics, gravitational wave detectors and quantum sensing, geological characteristics of spacetime, medical physics, and applications of artificial intelligence.

The NES Fall 2021 Meeting is slated for October 22-23. Though academic life is edging closer to normal, out of an abundance of caution the meeting will take a virtual format. Price framed the virtual format as an opportunity to involve more remote institutions in New England that have not been the site of an NES meeting for many years, if at all. "For us in New England, 'remote' means Maine, so we will have a 'Maine Event' featuring the University of Maine, Bowdoin, and Bates," he explained. In lieu of physically hosting the meeting, these three institutions will present an invited talk on their physics departments and encourage their students to present talks or posters—thereby reaping many of the institutional benefits of hosting a meeting in-person without the demands of physically doing so.

More information about NES's Fall Meeting can be found on the meeting website. Abstracts are due on October 14, and registration closes on October 21.



NES strongly encourages the active participation of undergraduate and graduate students—who make up 40 percent of the section's ranks—in its semi-annual meetings. Price pointed out that attendance at a NES meeting can be a "distinct opportunity" for students, allowing them the chance to present posters or deliver a talk to a friendly audience outside their own institution "without the intimidation of a research-dominated environment." As an added incentive, students who submit first-author abstracts to NES meetings can be reimbursed up to $300 for travel-related expenses. The NES Fall Meeting will additionally include cash prizes for student talks and student posters.

Another perk for students who attend NES meetings is the opportunity for career development, including a career paths outside of academia—an area that is often unfamiliar to young scientists. "Like APS itself, NES is increasing its connection to industry careers. We have been featuring speakers from industry and non-academic careers as well as trying to have meetings in non-academic settings," explained Price.

Looking to the future, the NES executive committee's goals for the section center around boosting participation at NES meetings to pre-pandemic levels. This is a worthwhile mission: these semi-annual meetings provide an important vehicle for APS to hear from people who might not otherwise attend the larger March Meeting or April Meeting—for instance, students, industrial physicists, and the faculty at smaller institutions—and can in turn help make APS more important in the professional lives of these people on the outskirts of the traditional APS demographic. "The executive committee is addressing this with more timely and frequent messages about meetings and opportunities (nagging), with innovations (student cash awards), and with our fingers crossed (hope)," noted Price.

Overall, NES stands out as a lively and inclusive geographical section, with plenty to offer members in terms of professional development and valuable learning opportunities. More information on this unit can be found at the NES website: engage.aps.org/nes/home.

The author is a freelance writer in Stockholm, Sweden

THE BACK PAGE

APS-IDEA: Transforming the Culture of Physics

BY THE APS-IDEA STEERING COMMITTEE [1]

APS physics IDEA

Inclusion, Diversity, and Equity Alliance

The APS Inclusion, Diversity, and Equity Alliance (APS-IDEA) is a new, community-wide effort of physics organizations (including physics departments, national labs, and research collaborations) to shift the culture of physics to be more equitable and inclusive. APS-IDEA's guiding principles are based on current research on how to create effective change and the network is being driven by overwhelming interest from the community. APS President S. James Gates, Jr. recently commented that, "On diversity, equity, and inclusion, I want our Society to be an example to all STEM societies" [2].

Numerous recent reports have identified how the culture of physics contributes to a persistent lack of diversity and a problematic lack of equity in physics, including: Task Force to Elevate African American Representation in Undergraduate Physics and Astronomy (TEAM-UP) report (2020) [3], Women in Physics and Astronomy report (2019) [4], LGBT Climate in Physics report (2016) [5], Access for All: A Guide to Disability Good Practice for University Physics Departments report (2008) [6], among several others.

Underrepresented group members are too often targeted because of their identities; they are told they don't belong in subtle and overt ways, they face sexual and/or other identity-based harassment, and their presence is not planned for in our community. These negative experiences lead people from traditionally underrepresented groups to leave physics resulting in a homogenous community.

As a response to these concerns, in 2019 APS-IDEA was formed through support from the APS Innovation Fund (and, recently, through an Alfred P. Sloan Foundation grant) and, in summer 2020, APS-IDEA established a network of nearly 100 physics organizations [7] (vastly exceeding our original target of 25 organizations!) who are interested in changing the cultures of physics through strategic, evidence-based change efforts. Participating teams represent nearly 1,500 individuals at organizations from North and South America, Europe, Africa, and Australia, including universities that are public and private, large and small, predominantly undergraduate and research-intensive PhD-granting, as well as multi-institution research collaborations and national labs.

Kick-off workshops in summer 2020 (focused on shared leadership, defined below) were followed by a two-day workshop in September 2020 (focused on theories of change) and another full day workshop in February 2021 (focused on providing resources that teams themselves identified a need for). Further, since October 2020, teams have been organized into 21 different "Online Learning Communities" (OLCs) who meet in smaller groups to support one another and report on their progress towards their goals, with help from a team of external facilitators.

APS-IDEA's four guiding principles are to: **center people whose identities are marginalized, utilize sensemaking, start with research-based change-management methods, and use shared leadership**. It is common for the physics community to center (i.e., expect, consider the needs of, plan for, and presume normal) white, cisgender, heterosexual, able-bodied men. In APS-IDEA, we intentionally plan for, expect, and **include people whose identities have typically not been planned for**. One way we enact this principle is by ensuring our steering committee and advisory board include people with different identities and from varied backgrounds to share in the decision-making process. We also plan for and expect people from different social identities, backgrounds, and positions to participate in the network.

Sensemaking refers to the stories we tell ourselves and each other to make sense of and interpret our experiences. In APS-IDEA, sensemaking means that we work to understand the current culture of physics, ways in which it is problematic, and each of our roles in reinforcing or changing this culture. For example, within the steering committee, we intentionally make space and time for members to critically reflect on these questions in order to foster a shared vision by which we take steps to move toward being more inclusive, equitable, and diverse.

APS-IDEA starts with the recognition that individuals, organizations, the physics profession, and society at large all influence a department's culture and diversity. And, in order to make substantial and sustainable change, we must draw upon **research-based theories** to guide our thinking and areas of emphasis. The aim of the network is to change the culture of physics to be more inclusive by creating a community of transformation [8,9].

Shared leadership is the sharing of power and decision-making among people from different social identities (e.g., race/ethnicity, gender, ability status) and positions within the community (e.g., students, faculty, postdocs) [10]. We encourage teams to enact shared leadership by ensuring each team includes stakeholders from all groups in their organizations. For example, we asked teams from research-intensive, PhD-granting institutions to include undergraduate and graduate students, postdoctoral scholars, early career faculty, senior faculty, staff, etc. But shared leadership goes beyond merely who is in the room where decisions are made and also includes paying attention to who feels empowered to voice their opinions and who is part of the decision-making process.

APS-IDEA is one of many initiatives aimed at addressing the lack of diversity in physics and its problematic culture. We seek to support the success of these efforts by connecting them with APS-IDEA teams. Several notably important efforts include:

- AIP National Task Force to Elevate African American Representation in Undergraduate Physics & Astronomy (TEAM-UP)
- AAAS SEA Change Project
- APS Site Visit Program and AAS Site Visit Program
- APS Effective Practices for Physics Programs
- APS National Mentoring Community and Bridge Program
- APS Forum on Diversity and Inclusion
- Accelerating System Change Network
- The Departmental Action Team Project
- The Inclusive Graduate Education Network
- The STEP UP Program
- The Underrepresentation Curriculum Project
- The Access Network
- Towards a More Inclusive Astronomy
- DELTA-PHY

We strongly encourage every member of the physics community to become involved in efforts to change physics culture, through the APS-IDEA and other initiatives. Change efforts will be different across organizations because effective change needs to be reflective of local organizational cultures, norms, and practices. For example, if we compare a primarily undergraduate institution with a national research laboratory, the stakeholders, organizational priorities, and power structures would be different; effective change efforts need to be reflective of these differences. One size does not fit all when it comes to making sustained cultural change. To get started, here are steps an individual can take:

- Determine if your organization is a member of APS-IDEA [7] and, if so, get involved in your team's activities.
- Join the APS-IDEA mailing list.
- Read the reports listed above and implement their suggestions.
- Learn about and implement shared leadership in your organization.
- Establish equitable institutional cultures, norms, and practices that ensure the success of colleagues from marginalized groups.

The APS-IDEA Steering Committee has received interest and commitment from the community that far exceeded our initial hopes, and the project was recently awarded an Alfred P. Sloan Foundation Grant to support the network's activities in the coming year. We believe this presents a significant opportunity to meaningfully change the culture of physics if we, as a community, persist in our efforts to challenge established norms that marginalize individuals and prevent more equitable cultures from flourishing.

This project is funded (in part) by the American Physical Society (APS) Innovation Fund through Award IF-3. The American Physical Society (APS) Innovation Fund provides funding to advance collaborative projects that support the APS mission "to advance and diffuse the knowledge of physics for the benefit of humanity, promote physics, and service the broader physics community." Visit APS.org and follow @APSphysics.

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