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APS NEWS

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GOVERNANCE

Jonathan Bagger Selected as Next APS CEO

BY DAVID VOSS

Theoretical physicist Jonathan Bagger, Director of the TRIUMF laboratory in Vancouver, British Columbia, has been selected to succeed Kate Kirby as APS CEO in 2021. His appointment was unanimously approved by the APS Board of Directors in June, following a recommendation from the CEO Search Committee. Kirby will retire from the top staff position at the end of this year.

"I am deeply honored to have been selected as the next CEO of APS," said Bagger. "This is a critical moment for physics. I look forward to working with the Board and Council to ensure that APS faithfully represents the interests of its members while continuing to build a broad and inclusive community to address the world's most pressing challenges."

APS President Philip Bucksbaum highlighted Bagger's stewardship of TRIUMF over the past six years. "Jon Bagger is a distinguished physicist and an exceptional leader," said Bucksbaum. "He has managed TRIUMF through years of transition and growth, and has had great success in positioning the laboratory for a bright and vibrant future."

"I am delighted and excited that Jonathan Bagger has accepted our invitation to be the next CEO of the APS," added APS Past President David Gross, who chaired the CEO Search Committee. "Jon's extensive experience in scientific management and his deep commitment to the APS and to its mission will serve the society well in these tumultuous times."

The members of the CEO Search Committee were: 2019 APS President David Gross (chair), 2020 Speaker of the Council Andrea Liu, 2011 APS President Barry Barish, 2015–2016 APS Committee on Minorities Chair Nadya Mason, 2016–2018 APS Board Member Nick Bigelow, 2020 APS President Phil Bucksbaum, and 2018 Speaker of the Council Tim Gay.

Bagger has been Director of TRIUMF since 2014. The Canadian particle accelerator lab has a staff of more than 500 and, before the pandemic, served 1,200 users from over 40 countries each year. In addition to being an APS Fellow, Bagger has had a long relationship with the Society, serving on the editorial board of *Physical Review Letters* and as an Associate Editor for *Physical Review D*, on the APS

Jonathan Bagger

NEW APS CEO CONTINUED ON PAGE 6

DIVERSITY

The APS-IDEA Network Gathers Nearly 100 Inaugural Members

BY LEAH POFFENBERGER

Members of the physics community have been mobilizing to promote equity, diversity, and inclusion within their individual institutions. Bringing these groups into a larger network to share their experiences and expertise can expedite systemic change for the physics community at large. The APS Inclusion, Diversity, and Equity Alliance (APS-IDEA) is creating such a network made up of teams from a wide variety of institutions, all committed to creating a social movement to transform the culture of physics.

APS-IDEA is a new initiative, supported by the APS Innovation Fund (IF), with a mission of empowering physics departments, laboratories, and other organizations to achieve cultural change. Two online workshops on June 12 and July 30 brought the newly formed network together to begin a collaborative effort to make the physics community welcoming to all.

"The ultimate vision for APS-IDEA that we're heading for in say, 10 or 20 years, is to transform the culture of physics to be more equitable and inclusive, and with a diversity that better reflects the nation," says Monica Plisch, Director of Programs at APS and a member of the APS-IDEA Steering Committee. "Essentially we're seeking to establish a community of transformation."

APS-IDEA was launched in

APS-IDEA CONTINUED ON PAGE 6

BOARD STATEMENTS

APS Board Approves New Statements on Racism, New START Treaty, and Nuclear Testing

BY DAVID VOSS

At its virtual meeting near the end of July, the APS Board of Directors approved three new Board Statements. The statements call for an end to systemic racism in physics, support extension of the New Strategic Arms Reduction Treaty (New START), and reaffirm a 2018 APS statement that nuclear testing is not required to ensure reliability of the US nuclear weapons stockpile.All APS Board Statements can be viewed at aps.org/policy/statements/executive.cfm.

The APS Board Statement on Racism begins: "The current outrage over the killing of George Floyd, Breonna Taylor and others has awakened the conviction that without sustained effective action, systemic racism in America will continue to impede full Black participation in many walks of American life, including the field of physics."

The text notes the decades-long decrease in the percentage of physics bachelor degrees awarded to Black students and refers to the recent TEAM-UP report from the American Institute of Physics on steps needed to reverse the trend.

The Board Statement on New START calls on the United States and the Russian Federation to sign a five-year extension, explaining that "Without this extension, the treaty will expire on February 5, 2021, leaving the United States and Russia without any nuclear arms limitations treaty or agreement in place for the first time in nearly fifty years."

According to the Statement, "The US military and intelligence communities have publicly stated these weapons limits and verification provisions are of great value because they provide predictability and transparency with regard to

STATEMENTS CONTINUED ON PAGE 4

DIVERSITY

Physics Departments Ditch the GRE in Bid for Equity

BY DANIEL GARISTO

Physics and astronomy departments at US and Canadian universities are dropping the general Graduate Record Examination (GRE) and physics GRE (PGRE) requirement in droves. Since March, over two dozen departments have abandoned the tests, according to James Guillochon, an astrophysicist formerly at the Harvard-Smithsonian Center for Astrophysics (CfA) who maintains a public list of GRE requirements.

A 2019 survey by *Science Magazine* found that physics programs were among the slowest to drop the GRE. Now, more than half of the programs on Guillochon's list have permanently done away with the GRE requirement, and a full two-thirds no longer require it for the 2020–2021 admissions cycle. Physics departments have issued statements that "acknowledge the significant disruption" from the COVID-19 pandemic and the difficulties associated with taking the GRE at this time.

"I think that this pandemic has exposed for people in a new way the levels of inequity throughout our society," says Alexander Rudolph, an astronomer at California State Polytechnic University who directs the Cal-Bridge program. "It seems to have incited a real examination of the way culture and systems and societal inequities play themselves out … in particular in graduate admissions."

Although the recent move away from the GREs is primarily driven by the COVID-19 pandemic, it coincides with Black Lives Matter protests and threats to legal immigration from the Trump administration. Physics remains one of the least diverse STEM fields—with only 20 percent of PhDs awarded to women and 5 percent awarded to underrepresented minorities in 2019—and there has been growing pushback against the GREs for years.

"We'll see what happens once COVID is over, whether or not [departments] decide to continue to do admissions more inclusively," says LaNell Williams, a PhD candidate at Harvard.

Advocates for dropping these tests claim that the GRE has no bearing on graduate school success and when universities require it, they end up with a less diverse applicant pool. Evidence for both claims has been bolstered by studies in recent years.

"One of the most commonly reported things is, 'Hey, I took the GRE and I bombed it'," says Ted Hodapp, APS Director of Project Development and a former director of the APS Bridge program, which aims to increase the number of PhDs awarded to underrepresented minorities in physics. In 2019, Hodapp was coauthor on a study which found the physics GRE did not predict PhD completion.

"[We found] that the PGRE tends

GRE CONTINUED ON PAGE 7

Revised 08/31/2020

Education and Diversity News

2020-2021 STEP UP Ambassadors

The STEP UP project, which mobilizes teachers to inspire young women to pursue physics in college, held its 2020 Summit—virtually! And now our 80 STEP UP Ambassadors are trained and ready to run workshops on the STEP UP Lessons for teachers in your area—check out the map on the homepage (stepupphysics.org) and get in touch with us at STEPUPphysics@aps.org to learn more about working with one of these amazing educators.

Physics and Astronomy "New" Faculty Workshop, Oct. 15–17, 2020

Register now for the virtual 2020 Physics and Astronomy "New" Faculty Workshop, October 15-17 from 11am-5:30pm ET each day. All faculty and soon-to-be faculty members are invited to attend (no matter how "new" you are!). Space is limited so that participants may engage in creative online interactions with their peers and with experts in teaching physics. Registration is $45. Details will be available at aapt.org/Conferences/newfaculty/nfw.cfm.

Innovation Fund

Earlier this year, in response to new and evolving personal and professional challenges imposed on the physics community by the COVID-19 pandemic, we announced the re-launch of the 2020 Innovation Fund for a condensed cycle to fund projects that address critical needs of the global physics community. We are pleased to announce the two projects receiving Innovation Fund grants, which both have an education and diversity focus, are:

Modern Physics in the Latin-American Classroom

Project Lead: Nathan Berkovits

During the pandemic, high school physics students and teachers in Latin America are lacking interesting classroom material that can be taught online. The Perimeter Institute (Waterloo, Canada) has developed 15 volumes of material on modern physics for high-school students, which is available online in English, French, and Portuguese. This project will translate the material into Spanish so that it can be used throughout Latin America.

Departmental Admissions Practices that Maintain Excellence and Diversity in the Face of COVID-19

Project Leads: Geoff Potvin, Christopher Porter, Galen Pickett

This project will generate critical knowledge to support physics departments to effectively adapt their graduate admissions in 2021 and beyond to the emerging constraints imposed by COVID-19 and associated uncertainty (travel restrictions, safety/health concerns, disrupted instructional modalities, etc). It will particularly focus on practices in graduate admissions and student on-boarding that support continuing efforts to promote diversity, cohort size, and student success through these challenges.

For more information on the Innovation Fund, please visit aps.org/programs/innovation/fund/.

THIS MONTH IN

Physics History

September 23, 1846: Neptune's Existence Observationally Confirmed

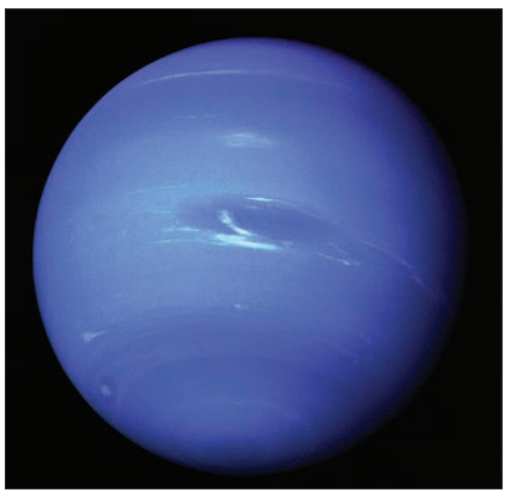
When Isaac Newton formulated his laws of motion and universal law of gravitation in the 17th century, he could not have foreseen that his work would one day lead to the discovery of a new planet in the solar system: Neptune. Credit for predicting its position in the night sky is historically given to the French astronomer and mathematician Urbain Le Verrier, but Le Verrier had a British rival, John Couch Adams, who independently arrived at the same conclusion.

There is evidence of prior sightings of Neptune after the invention of the telescope: Galileo Galilei in 1612/1613, Jerome Lalande in 1795, and John Herschel in 1830, most notably, although none realized the object they had observed was a planet. Galileo thought it was fixed star, probably because Neptune was going into retrograde (apparently moving in a direction opposite to that of other planets) when he observed it and thus appeared to be stationary. Herschel also mistook Neptune for a star.

However, in 2009, physicist David Jamieson, argued that Galileo may have suspected it was a planet. Jamieson found a note in one of the astronomer's notebooks noting the movement of a "background star" on January 28, 1613, also marking a dot with a different ink, which Jamieson interpreted as having been from an earlier sketch on January 6—evidence that Galileo was tracking its possible movement. But there is no record of Galileo ever following up on this.

The hunt for a possible new planet was triggered in 1821, when Alexis Bouvard published astronomical tables for the orbit of Uranus. The tables predicted the planet's position based on Newton's laws of motion of gravitation, and astronomers began comparing their observations to those tables. That's how they discovered some significant discrepancies between the predictions and their observations, especially once Uranus had completed one full orbit (in 1847) following its 1781 discovery by William Herschel. These discrepancies could have been due to the influence of the Sun's gravity, or the result of observational error. Or they could have been evidence that the orbit of Uranus was being perturbed by another, as-yet-undiscovered planet.

Le Verrier was among those who favored the new-planet option. Born in 1811, Le Verrier attended the École Polytechnique, initially studying chemistry before switching to astronomy, with a particular interest in celestial mechanics. He took a job with the Paris Observatory, where he would spend much of his career, serving as director from 1854–1870, and from 1873 until his death in 1877. Following early work on the stability of the solar system and on periodic comets, he turned his attention to the irregularities in Uranus's orbit, at the urging of the physicist Arago.



The existence of Neptune was independently predicted by Urbain Le Verrier and John Crouch Adams. This picture of Neptune was produced from the last whole planet images taken by the Voyager 2 spacecraft. IMAGE: NASA/JPL

On August 31, 1846, Le Verrier presented his predicted position for a new planet to the French Academy, and also sent a letter to Johann Galle at the Berlin Observatory containing his conclusion. Galle wasted no time turning his telescope to the predicted position. The very first night, on September 23, 1846, Galle and his colleague, Heinrich d'Arrest, found Neptune within 1 degree of Le Verrier's predicted location. It took them less than an hour to do so. Just 17 days later, William Lassell discovered Neptune's moon, Triton.

But controversy broke out soon after. While Le Verrier was making his calculations, a young British mathematician and astronomer named John Couch Adams was doing the same in England. Born in 1819 to a poor tenant farmer in Cornwall, Adams was privately educated, until a chance inheritance made it possible for him to attend the University of Cambridge to study astronomy. While still an undergraduate, he learned of the discrepancies in Uranus's orbit, and the possibility of a new planet. Adams thought he should be able to use observational data on Uranus to determine the mass, position, and orbit of that suspected planet using Newtonian physics.

He continued this work after completing his

NEPTUNE CONTINUED ON PAGE 3

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MEMBERSHIP UNITS

The APS Forum on Physics and Society

BY ABIGAIL DOVE

From climate change to the proliferation of nuclear weapons, physics principles are deeply tied to many of society's most pressing issues. The Forum on Physics and Society (FPS) serves as a home for physicists who are passionate about better understanding, analyzing, and debating such issues, as well as those actively engaged in efforts to inform the public and advise policymakers on these subjects.

Many physicists affiliated with FPS have gone on to hold influential roles at the highest levels of government. Three FPS members have served as members of the US Congress—Vern Ehlers (R-MI, 1993-2011), Rush Holt (D-NJ, 1999-2015), and Bill Foster (D-IL, 2008-2011 and 2013-present)—and several have worked as science advisors at the State Department, Department of Energy, and even the White House.

FPS was founded in the late 1960s and was formally incorporated as APS' very first forum in 1972. Amid the political tumult of the 1960s and 70s—characterized by the energy crisis, the rise of nuclear weapons, the Vietnam War, a burgeoning environmental movement, and a national reckoning over civil rights—many physicists felt a professional responsibility to engage with these societal issues and lend their scientific expertise to the discussion. Today, with over five thousand members, FPS remains highly engaged with these original

Bill Colglazier

interests in energy, climate, nuclear, and national security-related issues, and has also expanded its scope to include newer issues such as artificial intelligence, autonomous weapons, sustainable development, and cybersecurity.

"Scientists and physicists now recognize how important science is not only to their field, but to humanity, the world, and the future. Likewise, policy makers and diplomats have recognized that having stronger connections to science matters for them too," explained FPS chair Bill Colglazier (American Association for the Advancement of Science, AAAS), former Science and Technology Advisor to the Secretary of State and co-chair of the UN's Ten-Member Group on science, technology, and innovation.

FPS CONTINUED ON PAGE 7

DIVERSITY

The Conferences for Undergraduate Women in Physics Will Welcome Students Online in 2021

BY LEAH POFFENBERGER

Each January, the Conferences for Undergraduate Women in Physics (CUWiP) bring students together at sites all over the country for an exciting weekend of physics and networking. The goal of CUWiP is to help undergraduate women continue in physics by providing them with the opportunity to experience a professional conference, obtain information about graduate school and professions in physics, and network with other women in physics of all ages. The 2021 CUWiP organizers hope to meet the same goal while looking a little different than usual: CUWiP will be held virtually, as a result of the coronavirus pandemic.

On January 22 through 24, CUWiP attendees will be able to hear from dynamic speakers, attend enriching workshops, and network with peers, all from the comfort of home. Typically, more than 2,000 undergraduate women in physics attend CUWiP at 10 different locations, and the virtual conference is aiming to serve a similar number of students.

"We're hoping to have the same size conference as we usually do to make sure we're still able to offer high-quality networking, which is a big part of these conferences" says Renee Michelle Goertzen, Assistant Director of Programs at APS. "With networking platforms, we hope to give attendees chances to make connections."

In addition to ample networking opportunities, the virtual CUWiP will offer a slate of workshops on navigating different aspects of physics, from graduate school to alternative careers in physics and much more. CUWiP will also feature talks from inspiring women in physics, with a keynote presentation by Mary James, Professor of Physics at Reed College and the Dean for Institutional Diversity.

CUWiP is normally spread over 10 physical locations, but in 2021 it will be a virtual meeting. TAKEN AT CUWIP 2020

While most years the specific workshops and speakers are selected by each site, the 2021 CUWiP will serve as a pilot program for a newly formed student advisory council to help guide what content is included in the conference.

"Usually each site has input from students as they plan, but for the virtual CUWiP, we came up with a student advisory council to help plan the conference," says Kai Wright, Senior Coordinator at APS. "This is something we want to continue moving forward with CUWiP, to have student voices in the national organizing committee."

The formation of a student advisory council will help ensure CUWiP's activities are useful for student attendees and will add additional perspectives to the planning process.

"The student advisory council was selected in part based on groups we are looking to reach with the CUWiP conference," says Goertzen. "We also want this council to amplify diverse voices—we want everyone to feel welcome coming to a CUWiP conference."

Another change to CUWiP being piloted by the 2021 conference is a new date: Usually CUWiP has been held over Martin Luther King Jr. weekend, but organizers are experimenting with shifting the conference date to see if it better accommodates students.

"We're experimenting with this change to make CUWiP more accessible," says Goertzen. "We want students to be able to attend CUWiP but also be able to take part in MLK weekend and Day of Service activities."

Since its inception in 2006 at the University of Southern California, CUWiP has become a hallmark event for undergraduate women in physics, reaching almost every woman in the US who is pursuing a physics degree, according to a recent CUWiP impact report. Funding to support CUWiP and provide an important experience for women seeking physics degrees comes from the National Science Foundation, the Department of Energy, the Heising-Simons foundation, and the Alfred P. Sloan Foundation.

Applications for the 2021 CUWiP conference open September 8 and will close on October 30. The application is available on the CUWiP website.

NEPTUNE CONTINUED FROM PAGE 2

studies and becoming a fellow of his college, tutoring undergraduates. It seems that Adams told James Challis, director of the Cambridge Observatory, about his completed calculations in mid-September 1845, but this claim has not been definitively confirmed. Furthermore, Adams did not provide detailed calculations, merely the method by which he arrived at his predictions. Challis did not, at the time, deem this sufficient to start looking for the hypothesized planet.

In October 1845, Adams called on the Astronomer Royal, George Biddell Airy, but he was away. Adams purportedly left a manuscript for Airy containing detailed calculations of his own solution to the conundrum. Airy responded with a letter requesting some technical clarifications, to which Adams never responded. (This may have been due to the young man's tendency toward procrastination and disorganization.)

When Airy heard about Le Verrier's prediction, he instructed Challis to look for the presumed planet, hoping to beat France to the discovery. Adams provided six different solutions in 1845 and 1846, some of which led Challis to search the wrong part of the sky. But after Neptune was officially discovered, Challis realized that he had observed the planet on August 8th and 12th, a month or so before Galle and d'Arrest. He just didn't recognize it as such because his star map was out of date.

While others might have bitterly debated who most deserved priority in predicting the position of Neptune, Adams himself took pains to acknowledge the prior claims of Le Verrier in a paper presented to the Royal Astronomical Society in November 1846 on his own work.

"There is no doubt that his researches were first published to the world, and led to the actual discovery of the planet," he wrote, lamenting his own failure to convince his colleagues of the veracity of his own calculations. "I would not expect however that practical astronomers... would feel as much confidence in the results of my investigations, as I myself did." He would go on to succeed Challis as director of the Cambridge Observatory, a position he held until his death in 1892.

Further Reading:

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CAREERS

A Successful Summer Webinar Series

BY LEAH POFFENBERGER

As part of the APS response to COVID-19, the APS Careers team, together with Farah Dawood, APS Chapters Program Manager, has been hard at work all summer, hosting webinars and online workshops aimed at early career physicists. The Summer Webinar Series, which ran from May to August, included more than 20 online sessions covering topics from career development to mental health and self-care.

While APS has been offering free webinars for a number of years, the Summer Webinar Series ramps up the content available online to support APS members, especially those who are students and early career physicists.

"Before COVID and the Summer Webinars, we had been getting fifty to sixty people registering for webinars, but the first Summer Webinar—Building Your Professional Path During COVID—had 400 registrants," says Crystal Bailey, Head of Career Programs at APS. "People are much more willing to attend webinars now that they're stuck at home."

The Summer Webinar Series began as a way to offer online resources, specifically in response to anxiety about job opportunities drying up during COVID, and a recognition of the number of early career APS members who are likely facing increased stress.

"Farah Dawood wanted to put together a series of webinars in response to COVID, and we know a significant portion of our membership community is undergraduates, graduates, early career physicists, basically early career folks who are probably at home worried about all kinds of things," says Bailey. "We realized that we had an opportunity to provide information that would be useful to them, so Careers teamed up with Dawood to create the Summer Webinar Series."

To build the series, Dawood started off by sending a survey to early career members of APS to find out what kinds of webinars and workshops would be most useful. As a result, the Summer Webinar Series offered more than 20 different sessions, including both webinars and virtual workshops, on topics from managing workflow and stress to exploring "off the beaten path" physics careers. The virtual workshops provided a complementary component to the large webinars by giving attendees a space to interact with each other and facilitators.

After each webinar session, attendees were able to share feedback, ensuring the series continued to provide relevant and useful information. According to Bailey, most of this feedback has been positive. "Since I am a graduate student close to finishing [my] PhD program, I learned a lot of things from this webinar. It really helps to prepare [me] further," said one participant in the Building Your Professional Path During COVID Webinar.

In addition to the Summer Webinar Series, APS Careers has put together several workshops and webinars for use by Research Experiences for Undergraduates (REU) sites that have had to operate

WEBINAR CONTINUED ON PAGE 5

STATEMENTS CONTINUED FROM PAGE 1

Russia's nuclear weapons arsenal. The US State Department's April 2020 report on arms control compliance concludes that Russia remains in compliance with this Treaty."

The third Board Statement concerns recent reports that some in Congress and the Trump Administration have expressed interest in resuming nuclear testing. In response, the Board Statement reaffirms the 2018 APS statement that "fully informed technical studies have concluded continued testing is not required to retain confidence in the safety and reliability of the remaining nuclear weapons in the United States' stockpile. Resumption of nuclear testing may have serious negative international consequences, particularly on the nonproliferation regime."

APS Board Statements are one of the three ways that APS officially comments on public policy matters (in addition to APS Public Policy Statements and Unit Statements). In general, any APS member, group of members, or APS Membership Unit may submit a proposal for a statement to the APS Panel on Public Affairs (POPA).

The APS Board of Directors or its Executive Committee (BEC) may decide that an especially timely issue requires an expedited statement, in which case they will draft a Board Statement, assisted by the POPA Steering Committee. As part of the review process, POPA obtains comments from the APS Public Policy Committee, the APS Council Steering Committee, and the APS Office of Government Affairs.

Following any revisions, the Board approves the statement and it is distributed to the membership. A Board Statement is archived after one year, but may become an APS Public Policy Statement if it goes through a more extensive review. (For details on procedures for APS Statements see aps.org/about/governance/documents/joint.cfm.)

GOVERNMENT AFFAIRS

APS Pushes Back on White House Executive Actions that Threaten International Students

BY TAWANDA W. JOHNSON

During the past several months, APS leaders, staff, and members have diligently worked to push back against White House executive actions that harm international students who are essential to the physics community and vital to the US scientific enterprise.

US Immigration and Customs Enforcement (ICE) announced the most recent rule change on July 6, which would have forced international students currently in the US to return to their home countries or switch to an institution offering in-person instruction if their current institution was offering only online courses this fall. In response, on July 8, APS leadership sent a letter to members, alerting them to steps the organization was taking to fight the ICE directive, including a phone-in campaign organized by the APS Office of Government Affairs (APS OGA).

After Harvard and MIT filed suit against the rule, APS wrote an amicus brief to support their case. Sixteen scientific organizations, including the American Association for the Advancement of Science and the Optical Society, joined the APS brief in support. Apparently caving to this widespread opposition, ICE rescinded the directive, reverting to its March 9 guidance. That guidance enables current international students to take a course load that includes online classes due to the pandemic, but prevents new students from entering the US for online-only classes.

"The government capitulated entirely," said APS President Phil Bucksbaum. "These actions show the importance of an organization reacting quickly, and they also show that the science community can truly make a difference."

Said Callie Pruett, Senior Strategist for Grassroots Advocacy about the outcome, "More than 260 legislators were contacted by APS members who spent a total of almost seven hours on the phone stating that the directive would do irreparable harm to the science community."

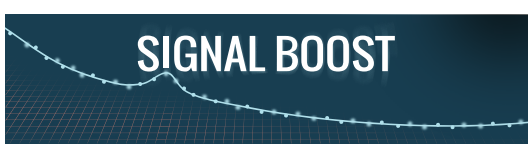
Added Francis Slakey, APS Chief External Affairs Officer, "This was a terrific outcome. I want to thank all of the APS members who made those seven hours of phone calls to Congress. Overall, it took a sizable amount of pressure from hundreds of universities, dozens of advocacy organizations and many other societies, including APS, to get a win on this issue."

Prior to the ICE directive being released, the White House issued a proclamation on June 22, impacting the H-1B visa program and some categories for J-1 visas. According to the American Immigration Council, "the H-1B is a temporary (nonimmigrant) visa category that allows employers to petition for highly educated foreign professionals to

work in specialty occupations that require at least a bachelor's degree or the equivalent." Also according to the Council, "J-1 visa holders enter the United States on a work-based program, including as a researcher."

Because APS had heard reports weeks earlier of a possible threat to the Optional Practical Training (OPT) program from the proclamation, APS OGA, with support from the Society's Office of International Affairs and Office of Industrial Engagement, developed a plan to get the word out to House Republicans about the importance of OPT. The OPT program enables highly skilled international students who completed their studies in the US to gain work experience for a period of time and is used as a recruiting tool by

ACTION CONTINUED ON PAGE 6



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

Pandemic Taking Heavy Toll on Scientific Workforce

BY MITCH AMBROSE

A grim picture is emerging of the pandemic's disruptions to the US scientific enterprise, with the costs of lost research, project delays, and other expenses already running into the tens of billions of dollars.

The Association of American Universities, which represents 63 leading US research institutions, has estimated the combined costs of the pandemic to its members for the year will range between $20 billion and $32 billion. The Association of Public and Land-grant Universities has projected its 246 members will face around $45 billion in total costs. Together with other research groups, they have proposed (go.aps.org/3g0SH65) that Congress distribute at least $26 billion across science agencies to support research recovery activities and provide an additional $47 billion for broader financial relief.

Recent surveys have also shed light on how the pandemic has upended the lives of individual researchers, especially those with young children.

A survey (go.aps.org/3g77UTp) of 329 members of the US high energy physics community found widespread work slowdowns, anxieties about potential layoffs and diminished career prospects, and mental health concerns. While a handful of people reported being more productive, the average estimated efficiency of work-from-home arrangements was 72%, and some respondents with childcare responsibilities reported efficiencies as low as about 5%.

One wrote, "Every scientist I know with small children is facing a complete breakdown of their ability to accomplish anything, all of our work is low-quality, and despite being exhausted beyond anything I have ever experienced in my life, I am slipping ever-further behind my peers."

Respondents also raised concerns about how new visa restrictions could impair recruitment and how continuing travel restrictions could prevent US researchers from flying to Europe to visit CERN, which hosts the Large Hadron Collider.

Disruptions to work at the LHC itself are also coming into focus. The Department of Energy reports (go.aps.org/3axPXfk) it will have to reset its baseline cost and schedule commitments to

an ongoing accelerator upgrade due to pandemic-related delays. In a high-impact scenario, the department estimates the project will require an additional $30 million and 15 months to complete. A number of other construction projects underway across science agencies face similar challenges.

To scope out the broader consequences of the pandemic, the American Institute of Physics convened a nine-member task force this spring. Its report (go.aps.org/3aFgqrG) stresses that curtailed international exchange, reduced job opportunities for early career researchers, and knock-on effects of university budget contractions could severely diminish the physical sciences workforce.

The task force anticipates that

PANDEMIC CONTINUED ON PAGE 6

OBITUARY

Joan Feynman 1927–2020

BY LEAH POFFENBERGER

Joan Feynman, an astrophysicist known for her discovery of the origin of auroras, died on July 21. She was 93.

Over the course of her career, Feynman made many breakthroughs in furthering the understanding of the solar wind and its interaction with the Earth's magnetosphere, a region in space where the planetary magnetic field deflects charged particles from the sun. As author or co-author of more than 185 papers, Feynman's research accomplishments range from discovering the shape of the Earth's magnetosphere and identifying the origin of auroras to creating statistical models to predict the number of high-energy particles that would collide with spacecraft over time. In 1974, she would become the first woman ever elected as an officer of the American Geophysical Union, and in 2000 she was awarded NASA's Exceptional Scientific Achievement Medal.

Feynman's choice in pursuing a career as a scientist was often at odds with the expectations for women, especially the expectations for a wife and mother, but she persisted to become an accomplished astrophysicist. During the 2018 APS April Meeting, where Feynman spoke at the Kavli Foundation Plenary Session, she recalled her mother discouraging her childhood interest in science, calling "women's brains too feeble," likely a common belief at the time.

"Joan Feynman made important contributions to physics," said APS President Philip Bucksbaum. "Her work on solar wind and the earth's magnetosphere led to the discovery of the cause of auroras. She also developed a method to predict sunspot cycles. Her efforts in the geophysics community for fair treatment of women, together with her own example as a leader in solar physics, helped to change society's attitudes in the mid-20th century about the contributions that women can make in physics."

Born in 1927, Feynman grew up in Queens, New York, alongside her older brother Richard, nine years her senior, who would eventually become one of the world's most well-known physicists. He would become Joan's first teacher and someone who fostered her inquisitive nature, believing her capable of learning all the math and science he could teach her. In her 2018 talk, Feynman recounted early memories of solving math problems for the unique reward of getting to pull her brother's hair and serving as his "lab assistant" at the age of five. A late-night trip to the golf course near the Feynman family home to see an aurora inspired Feynman's curiosity and would eventually guide her research.

For her fourteenth birthday, Richard gave Feynman a copy of *Astronomy* by Robert Horace Baker. Feynman credited a figure attributed to Cecilia Payne-Gaposchkin for proving to her that women could indeed have a career doing science.

Feynman would go on to receive a bachelor's degree from Oberlin

Joan Feynman

College, and she attended Syracuse University, studying condensed matter theory and earning a PhD in 1958. By 1960, Feynman was married with two children and, having not secured the kind of research position she was looking for, she decided to take a break from physics to take on the role of homemaker.

The break was short-lived, as Feynman grew depressed from the drudgery of keeping a home and caring for two small children: In 1962, at the advice of a therapist, she went in search of employment, securing three job offers at Columbia University's Lamont-Doherty Earth Observatory. At Lamont, where she worked part-time, Feynman began her research into Earth's magnetosphere, identifying its shape.

In 1971, Feynman accepted a job at the NASA Ames Research Center, where she developed a way to detect solar coronal mass ejections from the sun by searching for the presence of helium in solar wind. She would go on to hold positions at the High Altitude Observatory at the National Center for Atmospheric Research in Boulder, Colorado; the National Science Foundation; and Boston College. In 1985, Feynman accepted a position at the Jet Propulsion Laboratory (JPL) in Pasadena, California, where she would conduct research until her retirement.

As part of her research at JPL, Feynman identified the mechanism that leads to the formation of auroras and developed a statistical model to determine the number of high-energy particles expelled from coronal mass injections that would hit a spacecraft during its lifetime. After her retirement from a senior scientist position in 2003, Feynman continued to conduct research on the impact of solar activity on the early climate of the Earth and the role of climate stabilization in the development of agriculture.

"Joan Feynman leaves a legacy of exemplary scientific research, having made important contributions to our understanding of the solar wind, the earth's magnetosphere, and the origin of auroras," said APS CEO Kate Kirby. "Despite being discouraged to pursue science by women in her family, she persevered, and her accomplishments serve as an inspiration to women who wish to pursue a career in science."

INTERNATIONAL AFFAIRS

APS Engagement Around the World

APS serves a global physics community. Roughly 23% of APS members live outside of the United States in over 100 countries. Thousands of physicists from abroad attend and present at APS meetings every year, with 30% of March Meeting attendees coming from outside of the United States. The 2020 APS Virtual April Meeting attracted over 1800 international physicists, accounting for over 25% of attendees compared to an average of 6% international participation at previous APS April Meetings. Approximately 70% of articles published in APS journals are authored by scientists outside of the United States.

APS members, regardless of their nationality, have stated they value being a part of a larger physics community as the primary reason for joining APS; they view APS as a "hub" where the international physics community connects. Nonetheless, many members outside of the US have expressed their desire to be more proactively included in all APS activities—not only participation in meetings and publications in journals, but also inclusion in programs, in membership unit activities, advisory committees, and other aspects of the Society's leadership. Some physicists have even asked "Why *should* I belong to the *American* Physical Society? What does APS do for physicists in my country?"

To address this concern, APS launched the Task Force on Expanding International Engagement in March 2017. The Task Force was charged with assessing APS stakeholder interests and identifying goals and recommendations for increasing the scope of engagement with APS members and international physicists. This effort resulted in a report, recommendations, and implementation plan to guide the Society as it aims to better serve these communities (go.aps.org/2E4q0IH). The report recognizes that while APS has been building new programs for physicists worldwide, the Task Force recommended adding or expanding international elements of existing APS programs.

But to better serve international physicists, APS also must communicate the breadth of opportunities and services for all physicists outside of the United States. Toward this end, the Society created a tool, APS International Engagement Around the World (IEAW). This resource (go.aps.org/3g6bih2) highlights, by country or region, the ways APS supports physicists worldwide. In doing so, the tool offers various programs, opportunities, grant applications, and other resources, tailored to individual regions or even specific countries.

The APS International Engagement Around the World (IEAW) tool displays information about the ways APS engages with international physicists with regionally specific information.

Through the IEAW tool, any physicist in *any* country can see how they can participate in APS and how the Society engages with their community. The opportunities and information highlighted on each page of this web tool will continue to grow and evolve across all areas of APS—from membership to programs to publications and advocacy on behalf of international physicists.

The heart of the IEAW web tool is the way it provides a chance for all physicists to participate in APS activities, connect to international offerings, and tap into the conversations and publications related to their local community. The IEAW tool highlights relevant *APS News* articles, stories from the APS Forum on International Physics (FIP) Newsletter, and publishing statistics from the *Physical Review* Journals for every country or region. Likewise, physicists can view APS membership statistics or the winners of APS Prizes and Awards in their region.

To highlight the inclusion of international voices in APS Leadership, the site displays the current International Councilors who advise the APS Council of Representatives from the perspective of members outside the United States. In short, each page is specifically tailored to highlight APS content that is of greatest interest to physicists working in that region or country.

As a few examples, African physicists can learn more about the Society's efforts to enable connectivity and information sharing across the continent through the *African Physics Newsletter.* Physicists in China, looking for tips on writing articles and publishing in APS journals, can view an instructional webinar organized by APS Editorial staff and the Chinese Physical Society in both English and Mandarin. Physicists across the Middle East can access valuable training at the SESAME Light Source in Amman, Jordan through the SESAME Travel Award Program, which is supported by a partnership of 12 scientific societies in the US and Europe led by APS. Displaying programs in a space designed for a specific regional audience amplifies their visibility to the scientists that stand to benefit the most.

As APS expands its offerings and creates new opportunities, the Society hopes to grow this web tool as a valuable way to connect with and serve physicists living outside of the US. With that goal in mind, APS welcomes feedback from you regarding what programs, resources, and activities would be most useful to physicists in your region. Please contact the APS Office of International Affairs at international@aps.org to give your input on how APS can better serve your region and what you would like to see from our new tool, APS International Engagement Around the World.

WEBINAR CONTINUED FROM PAGE 3

virtually due to COVID-19. The APS Editorial Office has also been offering webinars on topics like writing a great scientific paper, further increasing the kinds of information APS members can access from the safety of home.

As the summer comes to a close, the Summer Webinar Series will end with a special two-part event on science policy, in partnership with the American Association for the Advancement of Science.

"Given that Science policy continues to be an active career option for physicists, we partnered with AAAS to provide an overview of the available opportunities in this field, as well as to give our audiences a chance to directly interact with science policy professionals through a virtual panel and networking event," says Midhat Farooq, Careers Program Manager.

APS Webinars will continue in the fall, with new content covering a variety of careers topics.

"People have been really happy with what we're doing, and we need to build on that momentum—this is obviously something that we're offering that is valuable to the community," says Bailey. "The plan moving into the fall is to continue offering regular webinar presentations on specific professional development themes, for example careers in industry."

APS Careers is also working to launch a professional development e-mail series called "Shape-Up" to help participants keep track of their professional development goals through small, actionable tasks.

"We'd like to take an audience-based approach to everything we do in Careers...we'd like to understand people's goals and tailor what we offer accordingly," says Bailey.

All webinar sessions from the Summer Webinar Series can be accessed online at aps.org/careers/guidance/webinars/summer-webinars.cfm. Other past webinars can be found at aps.org/careers/guidance/webinars/archive.cfm.

APS-IDEA CONTINUED FROM PAGE 1

October 2019, and the program is already exceeding expectations: The first call for applicants to join the APS-IDEA network took place earlier this year and garnered 109 applications in just over a month, outstripping the original goal of 25 to 30 teams.

"A short-term goal of APS-IDEA is to build up our network, and we're off to a very good start in terms of engaging the community," says Plisch. "Applications were mostly from US physics departments, but also included 14 international teams, 13 laboratories and four large collaborations. There were a wide variety of colleges and universities, including some Hispanic Serving Institutions and Historically Black Colleges and Universities. We've had very broad interest."

A total of 97 teams—collectively including about 1200 individuals—were selected as inaugural members of the APS-IDEA Network. Each team is made up of members who represent a range of stakeholders, making sure to include both high-level members of physics departments and students.

"We encouraged the teams to have not just the senior people but also folks who are more junior or in positions of relatively low social power, because to make change you need that," says Plisch. "The people at the top have the power to make change. The people at the bottom are the ones who have the clearest perspective on what needs to change. This is an example of what is called 'shared leadership.'"

The two online workshops—both of which had identical content but were held on different days to maximize team involvement—gave APS-IDEA Network members their first chance to begin getting to know one another and learning about concepts for improving equity, diversity, and inclusion, such as shared leadership.

"Physicists are typically not aware of the social science literature, including some of the strategies from the business literature, the higher education literature, and others on how to change culture," says Plisch. "At the first kickoff meeting, it was widely acknowledged that culture change is what we need to do."

An impetus for creating APS-IDEA came as Plisch began to notice an uptick in physicists working to advance EDI within their physics departments, labs, and collaborations, but many groups were essentially working in isolation.

"It became clear to me that a lot of these folks were doing the work without the benefit of being connected to a larger community, and there was a need for connection to expertise, to the relevant literature, and to other folks who had done things successfully," says Plisch. "I connected with Ed Bertschinger at MIT, who had a similar vision, as well as Jason Gardner who was chair of the Forum on Early Career Physicists, and we joined forces to submit a pre-proposal to the APS Innovation Fund."

Through the IF review process, a couple of groups with a similar vision merged to develop a network of connected EDI efforts. The current APS-IDEA steering committee includes: Ed Bertschinger, Professor of Physics at Massachusetts Institute of Technology; Erika Brown, Education and Diversity Programs Manager at APS; Michelle Lollie, a physics graduate student at Louisiana State University; Jesús Pando, chair of the Department of Physics and Astrophysics at DePaul University; Monica Plisch, APS Director of Programs; Geoff Potvin, Associate Professor in the Department of Physics and the STEM Transformation Institute at Florida International University; Edward Price, Director of the Center for Research and Engagement in STEM education at California State University San Marcos; and Erin Scanlon, a postdoctoral scholar in the physics department at the University of Central Florida.

With the huge initial success of APS-IDEA, the Steering Committee is actively working to build up the infrastructure needed to advance the mission of promoting EDI in physics.

"When we got such a large number of teams applying, we realized pretty quickly we had to scale up our operation," says Plisch. "We're actively seeking facilitators for online learning communities and recruiting more steering committee members so that we can fully support all of the teams that have joined the APS-IDEA Network."

For more on APS-IDEA, visit aps.org/programs/innovation/fund/idea.cfm.

ACTION CONTINUED FROM PAGE 4

high-tech companies. Businesses such as Amazon, Microsoft, and Intel are among numerous tech firms that annually employ thousands of scientists under the OPT program.

Slakey worked with the office of US Rep. Steve Stivers (R-15th-OH) on a letter defending OPT, which could then be signed by additional Republicans and sent to the Trump Administration

Slakey recalled a couple of challenges going into the campaign: asking APS members to participate in advocacy during a weekend and requesting Republicans to go against the Trump Administration on a signature issue.

"I'm delighted that more than 500 APS members took action that weekend, making phone calls and sending personal emails. And, as a result, 12 Republicans contacted by APS members agreed to sign the letter from Stivers, tilting the issue in our favor," said Slakey.

Mike Mayo, an APS member and tech firm owner in Austin, also played a role in the OPT campaign by writing an op-ed that appeared in the *Austin Business Journal* (go.aps.org/3g7BxE1).

In his piece, Mayo wrote, "It's clear that OPT remains an essential tool to fill high-skilled jobs in science and technology areas. Therefore, I urge the Texas delegation to support OPT, including US Sen. John Cornyn (R-TX), who as a member of the Senate Judiciary Committee, can clarify the importance of OPT to the Texas economy in his communications to the White House. And I hope the delegation moves quickly because a decision by the Trump Administration is likely imminent based on reports circulating on Capitol Hill."

Although APS was pleased that OPT and STEM categories for the J-1 visa program were spared in the June 22 proclamation, the Society was dismayed that the H-1B visa was included.

"The Trump Administration has suspended entry into the US of anyone trying to get into the country on an H-1B visa, but who does not currently have an H-1B visa," explained Slakey.

He added that a colleague who represents a coalition of industries is leading a court case against the H-1B provision.

"He estimates that they have a better than 50-50 chance of stalling the implementation of the proclamation," explained Slakey.

Meanwhile, OPT and the J-1 visa may not be out of the woods.

"Some White House staff were furious that OPT wasn't included in the proclamation," said Slakey, adding that those staff are now pushing for executive action exclusively on OPT.

In an effort to ensure OPT and the J-1 visa remain available for talented international students and scientists, APS OGA is conducting an advocacy campaign in which APS members share their positive experiences and outcomes, such as papers published, made possible by OPT and the J-1 visa program. Those stories will be shared with an APS contact at the State Department who is working to preserve both OPT and the J-1 visa. The stories will be accompanied by results of APS OGA surveys of graduate students and early career scientists, which will provide data on the value of OPT and J-1.

"So far, we have received more than 120 heartfelt, impactful stories from all over the country. From early-career physicists to a Nobel Prize winner. We are thrilled at the response from the APS membership. These stories are sure to make an impact," said Pruett.

The Trump Administration issued its first in a series of proclamations on May 29, blocking Chinese graduate students, postdocs, and visiting researchers affiliated with China's military-fusion strategy from entering the United States on an F or J visa. The premise of that proclamation: China is engaged in acquiring intellectual property from the US to strengthen its military capability.

APS does not have legal standing to challenge the proclamation, but the Society is examining a strategy that involves sending Freedom of Information Act requests to the White House to seek legal documents that helped develop the proclamation.

"APS will continue to push back on these executive actions that send the wrong message that the United States can only be secure if it is isolated from the rest of the world. Science thrives when diverse perspectives and openness are the foundation of our research," said Bucksbaum.

PANDEMIC CONTINUED FROM PAGE 4

the financial toll will be "particularly disastrous" for Historically Black Colleges and Universities (HBCUs), anticipating the pandemic will "slow the outsized contributions that HBCUs have made toward creating a more diverse physical sciences community."

The task force nevertheless does identify some opportunities arising from the pandemic, observing that the expanded use of virtual teaching and conference tools could help engage previously unreached audiences. It also identifies an opportunity to draw more people into the physical sciences by demonstrating their relevance to crisis response.

"Just as the launch of Sputnik and the resulting large investment in K–12 science education it engendered led to an explosion in the number of students studying the physical sciences, the pandemic may cause a significant jump in students interested in studying biology and medicine," the task force states. "A parallel increase in the number interested in the physical sciences could occur if there is high-quality instruction and if the case is made strongly that physical sciences advances are critical to addressing crises of all kinds, including those of a medical nature."

The author is Acting Director of FYI.

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NEW APS CEO CONTINUED FROM PAGE 1

Council and Executive Board, as a member of numerous APS committees, and most recently as chair of the APS Task Force on Expanding International Engagement.

As part of his deep commitment to building a diverse and inclusive workforce, he reshaped TRIUMF's hiring practices and established the laboratory's Committee on Equity, Diversity, and Inclusion. He stated that "an inclusive workforce is essential to the future of physics – it enriches our science and engages the broader community, to the benefit of all." Bagger also believes that APS and its members must continue to speak out in support of the US scientific enterprise. He said he is "proud to join an organization that stands up for science and the values we hold dear."

Following receipt of his undergraduate degree from Dartmouth College, Bagger was awarded master's degrees from Cambridge University and Princeton University. He completed his PhD thesis under the supervision of Edward Witten at Princeton.

Prior to taking the directorship at TRIUMF, Bagger was Krieger-Eisenhower Professor of Physics and Astronomy at Johns Hopkins University in Baltimore, Maryland, serving as chair of the department, vice-provost, and interim senior vice president for academic affairs. He is currently Professor of Physics and Astronomy at the University of British Columbia and Research Professor at Johns Hopkins.

"I am absolutely delighted with the appointment of Jonathan as the next APS CEO," said Kate Kirby. "Jon and I have already had some good conversations and together we are planning for a very smooth and seamless transition."

For more on APS Governance, visit aps.org/about/governance/.

FPS CONTINUED FROM PAGE 3

In the age of the novel coronavirus, a newfound focus within FPS is how physicists can contribute to the pandemic response. APS members have been involved in the development of low-cost, rapidly-built mechanical ventilators to meet the current ventilator shortage, elucidating the fluid dynamics of respiratory droplet transmission, and an international effort to repurpose physics infrastructure such as x-ray facilities, cryo-electron-microscopy, lasers, and NMR for urgently-needed research related to COVID-19.

More broadly, FPS members have been involved in dissecting how the United States, despite having one of the most sophisticated scientific advisory ecosystems in the world, has underperformed so dramatically relative to other industrialized nations in containing the spread of COVID-19, and how scientists can make better connections with policy makers and society at large to prevent similar missteps in the future.

Colglazier discussed this in a recent editorial in *Science & Diplomacy* (go.aps.org/346Zwke). He argued that while the global scientific community responded well to the pandemic with "unprecedented scientific collaboration and sharing of information," this was hindered by a broken interface between science, policy, and society in the US. He outlined four elements that must be in place to foster wiser, more science-based decision-making in future times of crisis: (1) A culture of trust between scientists, politicians, and the public; (2) A duty for scientists to tell the truth to the public, even in the face of contradictory information from the government; (3) A duty for scientists to inform politicians and the public about threats as well as opportunities that emerge from rapidly-advancing science and technology; and (4) A duty for scientists to marshal their technical knowledge to help achieve our nation's goals and to redress its failings. The editorial is a compelling read, illustrating the importance of scientists in public policymaking and how much is missing when they are not empowered.

FPS offers its members several opportunities to engage more deeply with issues of science and society. Since 1982, FPS has organized several two- to three-day short courses on timely issues at the intersection of physics and society—in particular, nuclear arms, energy, and climate change. FPS is also very involved with the AAAS-partnered APS Congressional Science Fellows program, which gives physicists with an interest in science and technology policy the opportunity to work in government for one year in a congressional office. Through this program, Fellows can offer their scientific expertise to Members of Congress (few of whom have a technical background) and in turn broaden their own understanding of legislative and political processes and enhance the physics community's influence on science-related policy.

At a broader level, FPS sponsors seven to eight sessions each year at APS March and April Meetings, bringing awareness to the wider APS community of the essential role of scientists in addressing societal issues. Several FPS-sponsored sessions from last year's social-distancing-friendly APS April Virtual Meeting are still available to registered attendees to watch at the meeting website, featuring topics such as science and national security, science and international relations, physics and the pandemic, and science and politics. The 2020 sessions on artificial intelligence and the future of humanity, science and ethics, and communicating science to the public that could not be held due to the pandemic will be among those scheduled for future APS meetings.

Additionally, all APS members can access FPS' highly-regarded quarterly newsletter, *Physics & Society* – launched over 40 years ago by FPS co-founder Martin Perl, who won the 1995 Nobel Prize for his discovery of the tau lepton. The newsletter overviews current events at the intersection of physics and policy and provides a platform for physicists who wish to share data or perspectives on such topics.

Going forward, a major priority for FPS is inspiring the next generation of physicists to continue the conversation between scientists, policymakers, and the public. "My aspiration for the forum is to reach out to young members of APS and give them the opportunity to understand the complexities of interaction between public policy, diplomacy, and their own disciplines," explained Colglazier. "FPS has certainly affected people of my generation, and I want to make sure there is a new upcoming generation to continue the work. This is so important for the future of a peaceful and prosperous world."

Overall, FPS stands out as one of APS' most important and influential units, at a time when science-informed policy, science-based diplomacy, and credibility of scientists are more crucial than ever. More information can be found at the FPS website at aps.org/units/fps/.

The author is a freelance writer based in Stockholm, Sweden.

GRE CONTINUED FROM PAGE 1

to be correlated with the grades in the first year of grad classes," Hodapp says. "But it's not a measure of your potential for success."

Part of this may have to do with the format of the exam, a closed-book test that consists of 90-second multiple choice questions across a broad range of subject areas.

"It's very clear to me as someone who's gone through grad school, that I never did any problem that even remotely resembles what a physics GRE problem looks like," says Guillochon.

Educational Testing Services, which owns, designs, and implements the GRE, notes in its guidance for graduate admissions, that "using a minimum GRE score as the only criterion for denial … is not good practice." However, many programs don't follow this guidance, and use it as a cutoff, according to Hodapp.

In a statement, David Payne, a Vice President at ETS, defended the continued use of the test. "Using GRE scores as part of a holistic admissions process is especially vital in the wake of a global pandemic to ensure programs can continue to admit a diverse and academically prepared class with as much information as possible about each applicant," he says.

Current graduate students pointed to other issues with the test. While the GRE is offered three times a year in the US, in many places, international students have fewer chances. Sanjana Sekhar, a PhD candidate at Johns Hopkins University, had to delay her application an extra year to retake the test, which is offered once a year in India.

"The first thing to know about these two exams is just that they're really expensive," Sekhar says. The cost to take both the GRE and PGRE can total 75 percent of the monthly stipend for a PhD student in India, according to Sekhar, which she says actively deters students there from applying to US universities.

The testing cost comes on top of three-figure application fees for international students. Just applying to a dozen schools can easily cost $1,500. Even with fee waivers, taking and sending the test scores costs hundreds of dollars, according to George Iskander, a graduate student at the University of Chicago.

In 2015, the American Astronomical Society issued a recommendation that graduate astronomy programs stop requiring the GRE because of these concerns. The APS Panel on Public Affairs is developing a statement about the entire graduate admissions process, with the PGRE as a component, which will be put to the membership for comment, likely this Fall.

Preliminary results of eliminating the GRE as a requirement within astronomy programs show a dramatic impact. David Charbonneau, an astronomer at CfA, says that when the program eliminated the GRE requirement in 2016, applications rose from 184 to 324, with the largest increases coming from US citizens who are underrepresented minorities and women who are non-US citizens. Laura Lopez, an astronomer at the Ohio State University, found a similar pattern of diversified applicant pools across 27 astronomy programs. What this means for actual admissions, however, has not been well studied.

Other admissions criteria are also being reexamined. The research Hodapp was involved in found that GPA is not a good predictor for success in graduate school and concerns swirl around letters of recommendation, which may create a bias against applicants from institutions such as Historically Black Colleges and Universities.

Yoni Kahn, a theoretical physicist at the University of Illinois who co-wrote the popular book "Conquering the Physics GRE," says that although the test format has "very little relationship to grad school work," some strategies to solve problems—such as dimensional analysis, limiting cases, and order-of-magnitude estimates—are valuable.

"It would be worth having a community-wide discussion on the intended purpose of the GRE in admissions decisions, and how the exam and the admissions process more generally could be restructured to emphasize these useful elements while minimizing the standardized-test baggage," Kahn says.

APS News also asked graduate students about their thoughts on fair ways to diversify admissions. Sekhar suggested that for PhD-only applicants, the statement of purpose, which highlights research, might be a better metric. Iskander, who is a first-generation student, emphasized the importance of peer mentorship to his success. Williams, who is Black, says the onus of admitting and retaining a diverse group of grad students should not be on underrepresented minorities, but the responsibility of predominantly white institutions.

"I would challenge universities to think about what these things are actually measuring," she says. "Take this moment to do the right thing."

The author is a science writer based in Bellport, New York.

THE BACK PAGE

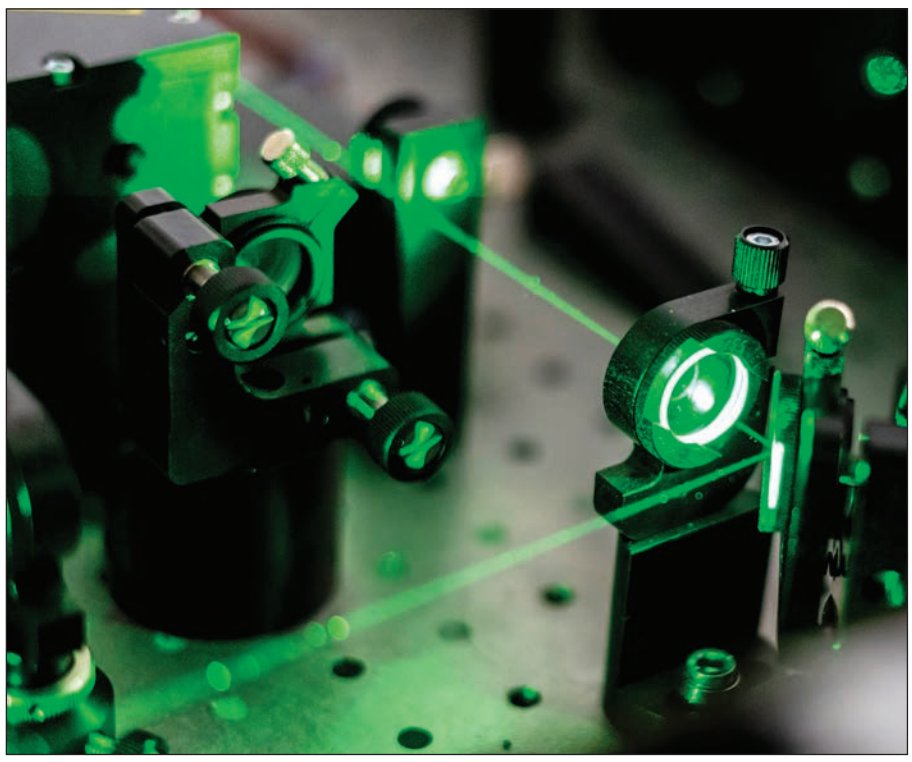
The Quantum Internet Will Require Bigger Quantum Science

BY CHRISTOPH SIMON AND MARIA SPIROPULU

A functional quantum internet, a network in which information stored in qubits is shared over long distances through entanglement, would change the fields of secure communication, data storage, precision sensing, and computing [1,2]. Innovations in these fields would alter society—for example, we trust that enhanced privacy would strengthen democratic institutions—but building such a network will be a complex task.

A whole zoo of components will need to be developed and integrated, from quantum transducers and quantum memories to classical light sources and classical communication channels [3]. And because of the scale of the potential impact, including challenges and consequences not quite yet thought through [4], the scientific community will need to consult social scientists, legal experts, and historians to ensure that the benefits of this new technology are widely and equitably shared across society.

To achieve these ambitious ends, we believe the quantum science community may have to structure itself differently—to embrace a larger-scale venture with expertise spanning classical and quantum, public and private, hardware and software, science and society.



Although the individual components of a quantum internet can be developed on a laboratory bench, assembling a working global network will require international collaboration and a "big science" approach.

A new model for quantum collaboration is needed

We believe it will be a challenge to achieve the necessary level of collaboration and integration within the current organizational model for quantum science and technology, which is focused on individual research groups and relatively small-scale collaborations between such groups. The incentive for individual groups is often to push for improvements or pivot in directions that directly pay off in high-impact publications and further funding. However, the incentives to produce components that are useful for integration into a larger system, which requires central organization and long-term planning, are comparatively paltry.

To give an example from the field of quantum memories, individual groups have often focused on maximizing one specific metric, such as memory efficiency, storage time, or bandwidth without regard to systems-level demands. To build a trans- or intercontinental quantum network—or any large-scale demonstration—will require hundreds of researchers from many groups to coordinate their efforts. This collaborative depth is unlikely even in the large, multi-institution quantum projects such as those in Europe. Joint funding, even on a large scale, is not the same as real collaboration.

In light of these deficiencies in the current funding models, we think that it is time for serious reflection and discussion about how to organize large-scale efforts in quantum networks. While one size is unlikely to fit all, the experience of other research communities, such as high energy physics and astronomy, who went through this type of organizational change decades ago, can provide useful examples and guidance for this process.

What can we learn from Big Science?

"Big Science," a term popularized by Oak Ridge National Laboratory's then-Director Alvin M. Weinberg, has been used to describe the 20th century's large-scale and large-scope scientific enterprise. It conjures up the seemingly unending supply of instruments and budgets within large collaborations—collaborations aimed at fundamental science goals that would otherwise be unreachable. The history of nuclear and high energy physics is filled with postwar efforts that required extraordinary financial resources and large, multidisciplinary teams. Today, such projects are also commonplace in astrophysics and cosmology, and modern successes for this model include LIGO's observation of gravitational waves and the LHC's discovery of the Higgs boson.

Several fields, including materials science and condensed matter physics, have embraced large facilities (e.g. photon sources such as the Linear Coherent Light Source at SLAC and the Advanced Photon Source at ANL) while maintaining a diverse collection of small experiments. In this model, one big facility generates and provides beams to several projects. Indeed, these big facilities have become critical resources in experimental efforts spanning biology, chemistry, and engineering, to name a few. Industrial researchers also use big facilities to characterize new and better materials, batteries, etc; in this way, the big science of the 20th century is becoming the big "networked science" of the 21st century, wherein small efforts and industry are integrated into a larger facility.

The quantum internet is not benchtop science

While not all problems in quantum science and technology require large collaborations at this stage, building a functional quantum internet is a different type of challenge compared to, for example, building quantum computers. Coordination between many actors is much more important for networks. The incentives are not the same. Quantum computing has clear industrial motivations. In contrast, many of the motivations for quantum networks are societal benefits that may be harder to monetize in the near term, such as enhanced privacy and security. A comparative study of the development of classical information technology strengthens this point. The internet and the World Wide Web originally grew out of public rather than commercial initiatives (ARPANET and CERN, respectively).

Historically, big science approaches have been adopted when exciting common goals are coupled to otherwise insurmountable technical challenges. Even under these conditions, transitions to big science—in high energy physics, astronomy, and elsewhere—have not been trivial. Robert Wilson, the founding director of Fermilab, strongly expressed his unhappiness about the level of bureaucracy that was involved in running big projects [5]. And, as Norm Augustine postulated, "If a sufficient number of management layers are superimposed on each other, it can be assured that disaster is not left to chance." Yet the high energy physics research community grew supportive (on the whole) of this direction because it recognized that there was simply no other way to achieve its scientific goals.

The quantum internet will be international

The quantum internet is by definition global, so different nations will have to agree on technologies and standards. The network will necessarily involve many different technologies and platforms, so the respective communities must work together starting from the definition of the scientific scope, the goals, the roadmap, the deliverables, the funding profile and all the feasibility demonstrations (such as for example in [6]) needed to address the challenges and build up a functional quantum internet.

In the United States, the NIST-spawned and industry-supported Quantum Economy Development Consortium (QED-C) is charged with enabling the development of a supply chain for quantum devices and systems. QED-C also works to ensure a well-matched boundary condition between industry, national labs, and academia. These functions will be crucial during the current research and development era—and also during the future quantum-tech era.

The degree of private-public partnership needs special attention, building of trust, and addressing issues of conflicts of interest and regulations. This rests on the recognition that science and technology is a driver of long-term economic growth that requires large-scale government investment supplemented by industry.

Making the quantum internet a success

We are convinced that the quantum internet is another example where a big science approach will be needed. The challenge for quantum science communities in different countries is to find ways of organization that are compatible with their systems. In the United States, national labs already have experience in coordinating big science projects involving many institutional partners. It may be possible to leverage this experience for quantum science and, in particular, for the quantum internet. We do note that in the United States, the National Quantum Initiative promotes national collaborations that can form a firm basis for international and global projects and a quantum internet blueprint has been recently published by the Department of Energy [7].

With quantum scientists finding effective ways to work together and integrate cross-disciplinary experts in their efforts, with a large-scale multi-organizational structure (including academia, industry, national labs, and federal agencies) to build a roadmap with a clear science and technology charge, with an entity of authority, responsibility and accountability, and with appropriate resources, the quantum internet can become a major success story in science, technology, and society.

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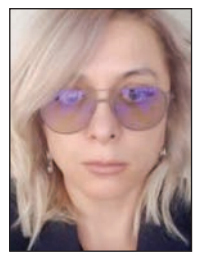

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