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APS NEWS

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INDUSTRY

APS is Committed to Helping Entrepreneurs Thrive in the Business World

BY TAWANDA W. JOHNSON

Many physicists do not follow an academic path after graduation, with a significant number instead choosing careers in industry, including starting their own businesses. APS remains committed to helping those entrepreneurs by providing access to technical findings in its scientific journals and reports; hosting conferences that encourage the sharing of ideas; providing guidance and support through its careers and professional development programs; and advocating for robust research budgets for key federal science agencies.

Adam Steele, owner of ZeroK NanoTech, a business based in Gaithersburg, Maryland, that develops and commercializes new technologies that utilize laser-cooled focused ion beams for nanomaching, said *Physical Review Letters* played an integral role in helping him start his business.

"It helped answer the question of how many atoms could we capture from a background vapor and extract into a slow beam," recalled Steele, who added that technical findings in *Physical Review Letters* and *Physical Review A* were instrumental in guiding him as he launched his business.

APS Publisher Matthew Salter said he was pleased that Steele found the Society's journals useful.

"The *Physical Review* journals publish some of the most impactful and important research in physics and physics-related research, serving a wide range of user communities ranging from theoretical and experimental physics through to topics of interest to applied physicists in academia and industry," explained Salter.

"We are proud of the role that the *Physical Review* journals play in supporting all researchers and entrepreneurs who are inspired to

BUSINESS CONTINUED ON PAGE 4

MEMBERSHIP UNITS

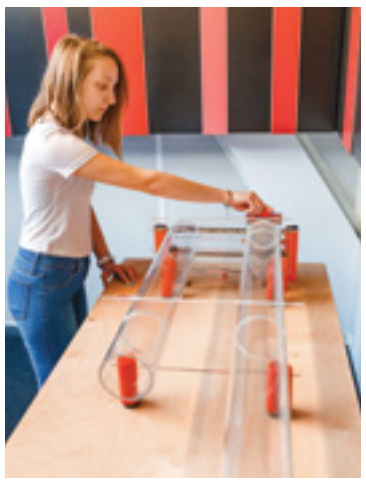
The APS Topical Group on Physics Education Research

BY ABIGAIL DOVE

The APS Topical Group on Physics Education Research (GPER) is a home for members interested in research on the learning and teaching of physics—a broad, multidisciplinary area encompassing everything from institutional practices to neural and cognitive processes to the social and contextual components of physics educational practices.

Physics education research (PER) falls within the purview of the emerging area of discipline-based education research, a field that focuses on the comprehensive study of learning and teaching in particular academic disciplines, most often (but not exclusively) at the university level.

Researchers in the GPER community are also focused on wider aspects of the teaching, learning, and practice of physics that extend beyond physics content itself. "For example, we need to ensure that students' attitudes and habits of mind in physics classes are



strengthened by our courses," explained GPER chair-elect Mila Kryjevskaia (North Dakota State University). "We also need to ensure that our instructional efforts support all students rather than a subpopulation of students. Do we provide adequate support for those students who need it most?

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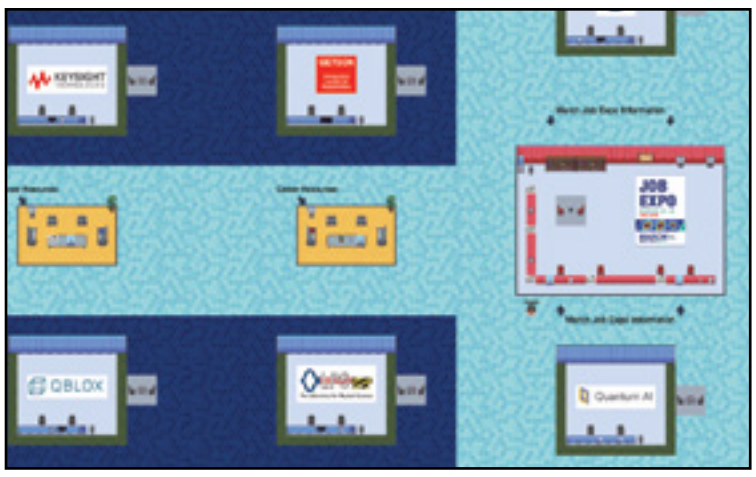
CAREERS

Giving Online Job Searching a Personal Touch

BY LEAH POFFENBERGER

For students or early career APS members, career fairs at APS Meetings have provided a crucial opportunity to build connections with potential employers. At the 2021 March Meeting, which took place entirely online, the APS Careers team rolled out a virtual career fair to reproduce a traditional job fair as closely as possible. Following the success of that event, another online job fair—the 2021 APS Virtual Career Fair—will be held for the first time from September 13 to 15.

The career fair at the March Meeting was held across three days, drawing around 300 attendees over the course of the event to a virtual space on Gather.Town, which was set up to mimic the usual conference environment with customized booths for each employer. For the first time, the March Career Fair was open to all early career, undergraduate, or graduate student members of APS,



Attendees of the March Career Fair were able to visit with potential employers in a virtual exhibit hall.

regardless of whether they were attending the rest of the meeting.

"Eighteen employers participated, and most of them said they'd participate in a similar event again," says Crystal Bailey, Head of Career Programs at APS. "The employers also said they were able to chat with potential candidates and get the word out about new programs...and the event attracted very good applicants."

Creating spaces for networking and building personal connections at virtual meetings has been challenging but employing a platform such as Gather.Town—where users have avatars they can use to walk around a space and initiate conversations—has its upsides.

"Gather is the best tool I've seen to partially recreate these environments. It's not perfect, but there are ways it's actually better, like finding people quickly or chatting across distances, which is not something you can do in an exhibit hall," says Bailey. "A lot of people are going to be drawn

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JOBS CONTINUED FROM PAGE 1

to go back to the old way of doing things, but the important thing that Gather has allowed is a lowered barrier to participation. You don't have to find money to come to an event or negotiate visas."

The 2021 APS Virtual Career Fair is looking to capitalize on the success of the March Meeting fair by launching a similar event, this time combined with a grad school fair. The three-day event will welcome students and early career scientists to network with employers in industry, national labs, and academia, as well as graduate programs.

"This event will be very similar to March, with tables, literature, promo videos, and private conversation spaces—we're also looking at best mechanisms for posting jobs or advertising specific jobs," says Bailey. "We're also combining the career fair with a grad school fair. A downside of grad fairs at March Meeting is that a lot of students have already decided where they're going, but September is an ideal time to recruit."

According to Bailey, following a slight dip in hiring last year due to the pandemic, hiring activity in physics-related jobs has bounced back. "Things are looking great," she says. Still, for job seekers worried about job hunting in a virtual scenario, Bailey suggests seeking guidance from APS Webinars for tips and tricks on navigating career exploration. For would-be attendees of the September virtual career fair, Bailey offered more advice.

"Have an agenda—do some research, look at who is there, understand what they're looking for," says Bailey. "Think of this as an opportunity where you have access to people. Plan out who to visit, and what questions you want to ask. Be intentional, and use the resources on the APS Careers website, which has a lot of great information to prepare job seekers."

To learn more about the Virtual Career Fair, or to register as a recruiter or attendee, visit go.aps.org/CareerFair.

THIS MONTH IN

Physics History

July 19, 1921: Birth of Rosalyn Sussman Yalow

BY LEAH POFFENBERGER

Medical physicist Rosalyn Sussman Yalow became the first American-born woman to receive the Nobel Prize in Physiology or Medicine in 1977. Yalow was one half of a 22-year scientific partnership with physician Solomon Berson that resulted in the development of the radioimmunoassay (RIA) technique. The creation of RIA, which allows for the detection of small quantities of substances such as insulin or enzymes in blood, was influential in opening doors for the field of endocrinology.

Rosalyn Sussman Yalow CREDIT: WIKI COMMONS

Yalow was born on July 19, 1921, in the Bronx, New York, to Clara (née Zipper) and Simon Sussman, and was the youngest of their two children. Neither Clara, who immigrated to New York at the age of four, or Simon, who was born on the Lower East Side, had high school educations, but they expected both of their children to attend college. Yalow, in her Nobel biography, described herself as a "stubborn, determined child," with a fondness for reading and a dedication to mathematics, which developed in seventh grade. By the age of eight, she had aspirations of being a scientist. She attended high school at Walton High School, at the time an all-girls institution, where she became interested in chemistry.

After high school, Yalow attended Hunter College, an all-female, tuition-free school, where her family hoped she would study to become a teacher. Instead, Yalow was drawn to physics, in part by the excitement surrounding the field of nuclear physics in the late 1930s. Eve Curie's biography of her mother, Marie Curie, was a source of inspiration for Yalow. Her professors at Hunter College encouraged her to pursue a career in physics, despite Yalow's worry that good graduate schools would not offer a woman in physics a position or financial support. In September 1940, during her senior year, one of her professors secured her role as a secretary for a leading biochemist at Columbia University, which was supposed to allow her the ability to take graduate courses. The only catch was that she had to commit to taking stenography. However, in February 1941, Yalow received an offer of a teaching assistantship in physics at the University of Illinois Urbana-Champaign, the most prestigious school she had applied to.

In September 1941, Yalow entered the University of Illinois, becoming the only woman among the 400-member faculty of the College of Engineering, and the first woman there since 1917, according to the Dean of Faculty at the time. In her Nobel biography, Yalow notes that the draft of college-aged men into the armed forces leading up to World War II likely opened up space for her to attend graduate school. Her first year was difficult: since Hunter College had not offered many physics courses, Yalow sat in on two undergraduate courses without credit in addition to taking three graduate courses and working as an assistant teaching freshman physics. Yalow would receive straight As in all of her courses, except in an optics laboratory course, where she received an A-, prompting the chair of the physics department to respond, "That A- confirms that women do not do well at laboratory work."

At the University of Illinois, Yalow would also meet her future husband, Aaron Yalow, who was also a graduate student in physics, the first day of school. They would marry in 1943, with some delay caused by anti-nepotism rules that prevented married couples from being employed by the same university. In January 1945, Yalow received her PhD in nuclear physics and moved back to New York City without her husband (he would join her later that year) to work as an engineer at the Federal Telecommunications Laboratory. In 1946, she returned to Hunter College to teach physics, whose student body now included returning veterans. While teaching at Hunter College, Yalow influenced a young Mildred Dresselhaus to pursue a career in physics instead of becoming a primary school teacher.

Although she would continue teaching at Hunter College until 1950, Yalow began consulting at the Bronx Veterans Association Hospital in 1947 as part of a research program to explore the medical uses of radioactive substances. It was there she would meet Solomon Berson who would become her chief collaborator for the

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MEETINGS

The First US-Bangladesh Physics Conference

BY SULTANA N. NAHAR

The Frontiers of Physics (FOP), a US-based collaborative program, held the first US-Bangladesh Conference on Physics in partnership with University of Dhaka and the Bangladesh Physical Society (BPS) in Dhaka, Bangladesh on February 5 and 6, 2021. FOP was founded in 2019 for the purpose of advancing science and education in Bangladesh by Charles Clark (National Institute Standards and Technology), and the author (The Ohio State University). Clark's interest in promoting science in Bangladesh was inspired by his collaborator, well-known Bangladeshi American neutron spectroscopist Mohammad Arif, who passed away recently. Clark provided the start-up funds for FOP and I am the FOP liaison to Bangladeshi institutions. BPS covered the expenses for the conference.

The inaugural conference year of 2021 was chosen to coincide with the centennial anniversary of the University of Dhaka and of Satyendra Nath Bose joining its Physics Department. It was there that Bose, while giving lectures on radiation, introduced a new concept of particles with integer spin, now called bosons. This concept led to the development of Bose-Einstein statistics and the prediction of Bose-Einstein condensates.

Satyendra Nath Bose
CREDIT: WIKI COMMINS

The US-Bangladesh Conference on Physics featured Nobel Laureate Eric Cornell as the public keynote lecturer. Cornell was awarded the 2001 Nobel Prize in Physics, along with Carl Wieman and Wolfgang Ketterle, for experimental verification of the existence of Bose-Einstein condensates. The conference also featured presentations by seven speakers from Princeton University, University of Florida, The Ohio State University (OSU), the Joint Institute for Laboratory Astrophysics (JILA), and NIST, and by seven of the

BANGLADESH CONTINUED ON PAGE 7

EDUCATION

2021 Chairs Conference Gathers Department Leadership to Share Solutions to Challenges

BY LEAH POFFENBERGER

The Physics Department Chairs Conference, organized by APS and the American Association of Physics Teachers (AAPT), brings chairs together from departments across the country. Connecting chairs from a variety of types of institutions provides an important opportunity for both new and existing chairs to discuss challenges, share solutions, and build a network of resources.

On June 3 and 4, around 150 chairs participated in the two-day event, which drew on feedback from the first virtual conference in 2020 to create a vibrant online experience. The 2021 Conference explored topics from improving departmental culture through diversity, equity, and inclusion to managing departmental threats in order to build a thriving department. Each session was highly interactive, generating lively discussion from attendees.

"Much of the feedback from last year's virtual event was around the need for networking and informal 'hallway' conversations," said Farah Dawood, a member of the conference organizing committee at APS. "This year we did not have any sessions that were fully presentation-style—every session had a short intro, and then we had participants go into breakouts to have small-group discussions."

Another change from last year was the return of Congressional Visit Day (CVD), which traditionally takes chairs to Capitol Hill for meetings with their congressional representatives This time chairs had the opportunity to meet with representatives or staffers online to discuss issues facing the physics community.

"As far as [CVD] being online, you don't have that experience of walking around in Washington and being in the room where it happens," said Monika Kress, a member of the steering committee and professor and chair at San Jose State University. "It was still a great experience to do it online… I felt like we made good impressions and got as much accomplished over zoom. Ultimately it is time with your elected representative or close staffers, which is really unique."

The main portion of the conference kicked off the morning of June 3 with a New Chairs Workshop, designed for newly appointed chairs interested in learning how to effectively lead a department. Attendees were able to learn about best practices gathered from previous Chairs Conferences.

Following the New Chairs Workshop, the theme of the first day of the conference was on thinking about equity, diversity,

Monika Kress

and inclusion (EDI) as a department chair. The opening plenary session on "How to be Intentional About Equity, Diversity and Inclusion as a Department Chair" was led by Martha-Elizabeth "Marty" Baylor, Carleton College; Taviare Hawkins, University of Wisconsin-La Crosse; and Jonathan Pelz, Ohio State University. They shared their personal experiences of promoting equity, diversity, and inclusion in their respective departments before asking attendees to break into groups and reflect on three different scenarios through an EDI lens.

CHAIRS CONTINUED ON PAGE 6

HONORS

Quantum Scientist Wins APS Prize

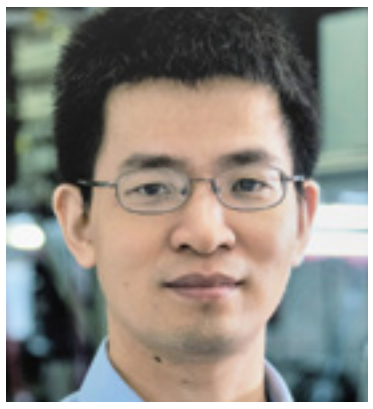
BY SOPHIA CHEN

Chao-Yang Lu received the 2021 APS Rolf Landauer and Charles H. Bennett Award in Quantum Computing, for"significant contributions to optical quantum information sciences, especially on solid-state quantum light sources, quantum teleportation, and optical quantum computing."

Lu has worked on some of the flashiest projects in the development of quantum technology.

A physicist at the University of Science and Technology of China (USTC) in Hefei, China, Lu is a member of the team that launched the world's first known quantum satellite, Micius, which delivers information encoded in single photons to the ground from low-Earth orbit. Using Micius in 2017, his team orchestrated the world's first intercontinental quantum-encrypted videocall—for 75 minutes, with colleagues in Vienna. In 2020, Lu's team published in *Science* that their quantum computer used 76 photons to execute an algorithm in 200 seconds that they estimated would take a conventional supercomputer 2.5 billion years: a demonstration of so-called quantum advantage. (Researchers predict that this algorithm, known as Gaussian boson sampling, could be useful for biology or business applications that involve graph theory, although they have not conclusively demonstrated any applications.)

Now 38, Lu began his career in 2003 as an undergraduate protégé of physicist Jian-Wei Pan, who has



Chao-Yang Lu

been dubbed China's "father of quantum" and is co-lead editor of the APS journal *Physical Review Research*. After meeting Pan at a dinner party as a third-year college student, Lu worked with Pan at USTC, where he earned a master's degree before moving to the University of Cambridge for his PhD. In 2011, he returned to his alma mater as a professor. In less than two decades, Lu has witnessed the field of quantum technology grow from a small academic community to an international arena involving billions of dollars in investment.

Still, experts anticipate that it will take decades of development before they build a fault-tolerant quantum computer—a device that can correct its own errors. Lu spoke to *APS News* about his career and his perspective on the race to build a useful quantum computer.

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next 22 years, until his death on April 11, 1972.

The first investigations Yalow and Berson undertook together were applying radioisotopes to blood volume determination, diagnosis of thyroid diseases, and the kinetics of iodine metabolism. As their work progressed, they found similar techniques could be employed to trace hormones, such as insulin. RIA was first used in 1959 to study insulin levels in people with diabetes but has been since applied to the detection of other hormones, vitamins, and enzymes to diagnose a number of endocrine-related diseases. Yalow and Berson would continue to collaborate until 1968, when Berson accepted the position of Chair of the Department of Medicine at the Mount Sinai School of Medicine.

During this time period, Yalow also balanced life as a wife and mother, raising two children and keeping a kosher home. Yalow held traditional views on her role in homemaking, telling *The New York Times* in 1978 that she believed it to be a wife's responsibility. She expressed a belief that the low number of women in science was due to a lack of interest rather than lack of opportunities. While such views caused her to eschew organizations specifically promoting women in science, Yalow had a strong belief in the capabilities of women to succeed in the field. Her Nobel lecture included a call to other women in science: "we must believe in ourselves or no one else will believe in us; we must match our aspirations with the competence, courage and determination to succeed, and we must feel a personal responsibility to ease the path for those who come afterward."

In 1972, Berson died of a heart attack while attending a medical meeting, leaving Yalow to continue their research alone. According to *The New York Times*, many people—including Yalow—began to doubt that she would ever receive a Nobel Prize for the pioneering work on RIA, especially after the loss of Berson, who some—erroneously—viewed as the leader of their collaboration. However, in 1977, Yalow received one half of the Nobel Prize, with the other half going to Roger Guillemin and Andrew Schally for work in other fields.

Yalow died May 30, 2011 in the Bronx, New York, and is survived by her two children and two grandchildren. Her scientific legacy also continues to live on through her contributions to medicine. In 2021, to commemorate 100 years since her birth, the University of Illinois honored Yalow as a pioneer for women in STEM by creating the Rosalyn S. Yalow Professorship.

Additional Reading:

Straus, Eugene (1999). Rosalyn Yalow, Nobel Laureate: Her Life and Work in Medicine

Yalow, Rosalyn (1977). "Autobiography." Nobelprize.org.

Stone, Elizabeth (1978), "A MME. Curie from the Bronx." Nytimes.com

BUSINESS CONTINUED FROM PAGE 1

use their scientific talent to address global challenges."

Salter continued, "Although all of the *Physical Review* journals are world-leading in their fields, our core focused journals, *Physical Review Applied*, launched in 2014, as well as *Physical Review Fluids* and *Physical Review Materials*, launched in 2016 and 2017, respectively, are likely to be of particular interest to industrial researchers and entrepreneurs."

APS meetings and conferences offer additional avenues for entrepreneurs to gain insight into launching new businesses, with the meetings representing opportunities to test new ideas as novel scientific results are shared and discussed among attendees.

Steele first presented his invention of a focused ion-beam system at the APS Division of Atomic, Molecular, and Optical Physics (DAMOP) meeting a few years ago.

"I found the DAMOP meeting useful in the same way that I found the journals; it was a chance to learn about the latest scientific results in laser cooling," he said, adding that he thinks the meeting is also a great way to recruit future employees.

Similarly, entrepreneur Gil Travish, who developed field enhanced emitters for X-ray sources, gleaned helpful information for his company Vibo Health while attending the APS March Meeting in 2018. Travish discussed his findings with colleagues and with vendors with experience on e-beam guns.

The Society has also utilized career and professional development programs to encourage and support entrepreneurship among its members. Launched in 2016, the purpose of the NSF-funded PIPELINE program is to develop and disseminate new curricular and co-curricular approaches to physics innovation and entrepreneurship (PIE) education. Examples include relating physics content to its real-world applications, building students' communication skills, and familiarizing students with basic business concepts.

"Motivation for this project stems from the fact that 90 percent of physics graduates, including half of all PhD recipients, find employment outside of traditional faculty positions—yet there are very few experiences incorporated into the standard undergraduate physics degree that explicitly help to prepare students for these career eventualities," said Crystal Bailey, Head of Career Programs at APS.

"There is also strong evidence that physics programs that provide engaged learning environments focused on future career development have higher retention rates and improved student experiences, and that future employability is an especially important factor for students from underrepresented groups when choosing a major."

A newly released report, *Educating Physicists for Impactful Careers*, provides an overview of the PIPELINE project, including curricular approaches that were designed and tested among the institutions participating in the three-year project.

"We hope that this report helps [faculty members] build the case for what they are trying to do. We also hope that we can seed a community of practice so that educators can share the approaches they are developing more broadly," added Bailey.

APS Government Affairs (GA) also does its part to support APS members on the entrepreneurial path by advocating for robust budgets for federal science agencies that support projects "across the R&D continuum, from foundational and use-inspired research to tech transfer and commercialization," said Mark Elsesser, GA Director.

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

GOVERNMENT AFFAIRS

APS Members Help Move Needle in Reversing Rollback of Methane Emissions Regulations

BY TAWANDA W. JOHNSON

The United States House of Representatives recently approved a reversal of the Trump Administration's rollback of methane emissions regulations, following robust engagement by APS members to support the change. The resolution, which was passed by the Senate in April, will now head to President Biden for his signature.

"We are extremely happy about this development, which will help reduce methane emissions from the oil and gas industry in a significant way. APS members have consistently ranked climate change as one of the issues most important to them, and they deserve credit for dedicating their time to reach out to their members of Congress to urge action on this matter," said Mark Elsesser, Director of APS Government Affairs.

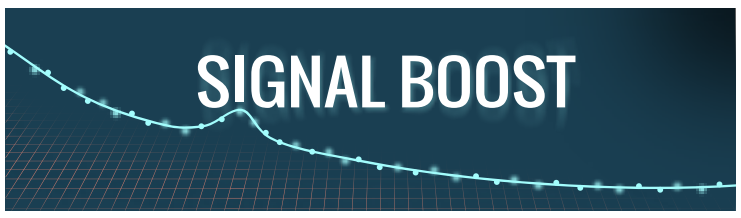
In response to recent scientific results indicating that the negative environmental impacts of methane are significantly higher than previously estimated, the Society submitted a public comment in fall 2019 to the US Environmental Protection Agency (EPA), opposing the agency's proposed policy amendments to curtail regulation of greenhouse gas emissions. The amendments would have eliminated requirements on oil and gas companies to install technologies to monitor methane leaks in pipelines, wells, and storage facilities. APS had urged the EPA to instead carry out a rigorous assessment of methane emissions—a major contributor to climate change.

"With the risks of methane emissions now determined to be higher than previously estimated, this is not the time to be relaxing regulations," APS stated in the comment.

Unfortunately, regulations concerning methane leaks were put in place when new EPA rules were finalized during the last few months of the previous administration. But with support from APS Government Affairs, Society members pushed back by asking their congressional members to support a reversal of the rollback.

Both the House and Senate had recently introduced a joint resolution of disapproval via the Congressional Review Act, which provides an opportunity to quickly address the issue rather than going through the lengthy rulemaking

METHANE CONTINUED 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

Congress Seeks Compromise on Landmark Competitiveness Legislation

BY MITCH AMBROSE

This century's biggest US science policy debate to date has reached a pivotal phase, with the House and Senate preparing to iron out differences between their distinct visions for expanding federal science agencies.

In June, the Senate passed the sprawling US Innovation and Competition Act (USICA), a 2,376-page legislative package that is primarily aimed at countering the Chinese government's growing technological and geopolitical clout. The package includes the Endless Frontier Act, which would add a directorate to the National Science Foundation dedicated to advancing a periodically refreshed set of 10 "key technology focus areas."

Through an at-times chaotic amendment process, the Senate assigned the Department of Energy and Defense Advanced Research Projects Agency a major role in supporting the same set of technology areas. It also added $52 billion for domestic semiconductor manufacturing incentives and R&D to implement the recently enacted CHIPS for America Act.

Rather than take up the USICA, the House passed the first pieces of its own legislative vision in June, starting with the NSF for the Future Act and the DOE Science for the Future Act. These and other bills will form the basis of negotiations with the Senate over a compromise package that will likely take months to complete.

The House Science Committee began developing the NSF bill soon after Senate Majority Leader Chuck Schumer (D-NY) first introduced the Endless Frontier Act last year with Sen. Todd Young (R-IN), unconvinced of the senators' technology-centric vision for expanding the agency. Work on the DOE bill predates the Endless Frontier Act and reflects the committee's longstanding interest in providing comprehensive policy direction to the DOE Office of Science.

The NSF for the Future Act would add a directorate to NSF focused on addressing a range of "societal challenges," including ones not amenable to technological solutions or motivated by geopolitics. The bill also proposes Congress increase the annual budget of the new directorate to $3.4 billion over five years, whereas the Senate bill sets a target of nearly $10 billion.

A Democratic staff member for the committee told FYI the gap between the bills reflects "key philosophical differences."

The staff member explained, "I still see the Senate approach as, 'We have this gap in technology development. We don't know how and where to fill it. We're just going

FYI CONTINUED ON PAGE 6

PROGRAMS

David Wirth Named 2021 PhysTEC Teacher of the Year

BY LEAH POFFENBERGER

Each year, the Physics Teacher Education Coalition (PhysTEC) recognizes outstanding physics educators with the PhysTEC Teacher of the Year award. The winner of the 2021 PhysTEC Teacher of the Year award is David Wirth, who teaches at Millennium High School in Goodyear, AZ.

PhysTEC is a joint initiative between APS and the American Association of Physics Teachers (AAPT) to address a critical shortage of qualified physics teachers in the United States through improved teacher education programs. Alumni of PhysTEC member institutions are selected for the Teacher of the Year award to highlight exemplary educators who demonstrate the value of teacher preparedness. Each year, PhysTEC names one national Teacher of the Tear as well as local Teachers of the Year—this year, ten local winners were selected.

Wirth, an alumnus of PhysTEC member institution Arizona State University, has spent a 29-year teaching career bringing students unique opportunities to take their enthusiasm for physics beyond the classroom. Through co-founding an annual math and science expo called STEMCon, which drew in nearly 1000 students in its 10th year, and participation in the "I am a Scientist" campaign, Wirth has inspired students to pursue careers in science.

In the classroom, Wirth uses the Modeling Instruction method, as well as the latest pedagogical best practices, to create an exceptional learning environment for his students. He has also raised over $50,000 in grants to purchase equipment to give students opportunities to explore physics in hands-on ways and build confidence in their physics skills. Wirth also

David Wirth

mentors fellow teachers, sharing techniques he has tested in his own classroom.

Beyond the classroom, Wirth continues to provide students with opportunities to learn and grow their enthusiasm for science.

PHYSTEC CONTINUED ON PAGE 6

JOURNALS

APS to Launch New Open-Access Energy Sciences Journal: *PRX Energy*

As part of its strategy to provide expanded open-access offerings in the *Physical Review* journal portfolio, APS is launching *PRX Energy*, a new selective journal featuring papers on energy sources, storage, and utilization research. Submissions will be accepted starting in late summer 2021 with the first papers published in the fall.

"The physics community has long been central to fundamental energy science and many resulting applications," said APS Editor in Chief Michael Thoennessen. "But communication and collaboration across traditional boundaries is now critical, as researchers and stakeholders from a diverse array of disciplines and regions focus their efforts on achieving a sustainable energy future."

PRX Energy will continue the path set by *Physical Review X* (PRX), the Society's selective multidisciplinary open-access journal, which celebrates its 10th anniversary this year, and *PRX Quantum*, which launched one year ago with a focus on quantum information science. Publication charges will be waived for submissions until 2023.

"*PRX Energy* is the latest in a series of selective topical journals that draw on the strength of the *Physical Review* brand," said APS Publisher Matthew Salter. "This new journal will enable APS to better serve scientists working at the interface of physics, engineering, and materials science."

In addition to broadening the open-access options for authors in energy science, the journal launch will enhance the ways that APS serves applied and industrial physicists.

"By seamlessly connecting the communities that conduct fundamental and applied research, such as physics, chemistry, materials, engineering, technology, biology, environmental studies, and policy, we can move more quickly toward discovering the sustainable energy solutions for the future, a primary motivator of the next generation of physicists and the catalyst for industry," said APS Chief External Affairs Officer Francis Slakey.

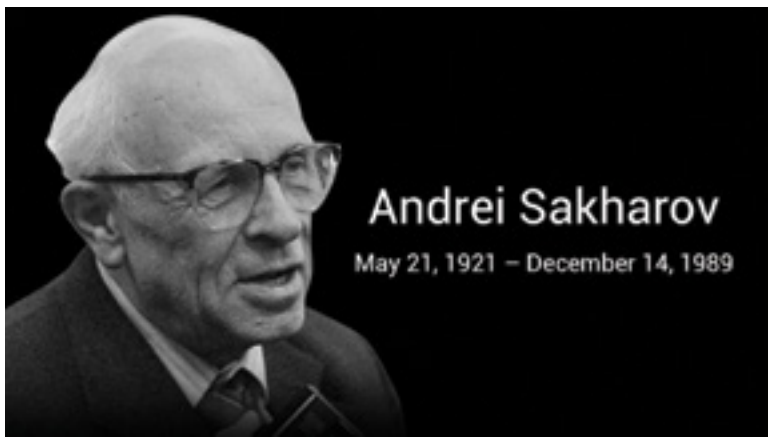
APS CEO Jonathan Bagger emphasized the breadth of the Society's commitment to all areas of physical science research, saying that "any physicist who is inspired to use their scientific talent to address global challenges should feel at home at APS."

For more information on the Physical Review journals published by APS, visit journals.aps.org.

MEETINGS

Celebrating Sakharov

BY DAVID VOSS



Born 100 years ago, Russian physicist Andrei Dmitrievich Sakharov was a complex man who achieved stardom in the Soviet Union for his role in the development of the USSR's nuclear weapons but then became one of the world's most outspoken activists for human rights. One of the most prestigious prizes awarded by the APS bears his name.

To recognize Sakharov's achievements as a physicist and peace campaigner, several APS units came together with the Russian-American Science Association (RASA) to organize "Sakharov-100: Physics, Peace, Human Rights—Celebrating his contributions to science and humanity." Meeting support and assistance was provided by APS.

"The 'Sakharov-100' webinar reached 396 people from 31 countries distributed on each continent including the US, Russia, and Europe," said Vladimir Shiltsev (Fermilab), a member of the organizing committee. "It was a true celebration of an amazing human being."

The conference was the work of members of the APS Forum on the History of Physics, the APS Forum on International Physics, the APS Forum on Physics and Society, and the APS Committee on the International Freedom of Scientists, in collaboration with RASA. The Organizing Committee of the "Sakharov-100" event included Luisa Cifarelli (U.Bologna, APS FIP and SIF), Christine Darve (ESS, APS FIP), Paul Halpern (U.Sci., APS FHP), Alan Hurd (LANL, APS FIP), Alexander Kabanov (UNC, RASA), Stewart Prager (Princeton, APS FPS), Roald Sagdeev (UMD, RASA), Vladimir Shiltsev (FNAL, APS DPB and RASA), Cherrill Spencer (SLAC, APS FPS).

The first session of the meeting focused on Sakharov's scientific contributions to the physics of fusion and energy generation, chaired by Roald Sagdeev. Dmitri Ryutov (Lawrence Livermore National Laboratory) reviewed the first steps to controlled fusion energy based on Sakharov's ideas. Bruno Coppi (Massachusetts Institute of Technology) discussed aspects of current fusion research and large-scale research collaborations. Kristel Crombé (Ghent University) gave an overview of the International Thermonuclear Experimental Reactor (ITER) project, which would not have been possible without the work of Sakharov.

In the second session, chaired by Luisa Cifiarelli (University of Bologna), the speakers turned to Sakharov's work in astrophysics. Andrei Linde (Stanford University) talked about Sakharov's fundamental contributions to cosmology and his early thoughts about an expanding universe. Valery Rubakov (Institute of Nuclear Research, Moscow) discussed Sakharov's work on the vexing problem of matter-antimatter asymmetry. Grigory Trubnikov (Joint Institute of Nuclear Research, Dubna) reviewed current research on the physics of nuclear matter at extreme conditions.

Sakharov's work in nuclear arms control was the topic of the third session, chaired by Cathy Campbell (CRDF Global and US State Department, retired). Richard Garwin (IBM), Frank von Hippel (Princeton University), Siegfried S. Hecker (Los Alamos National Laboratory and Stanford), and Susan Eisenhower (Eisenhower Group, Inc.) all discussed aspects of Sakharov's efforts to collaborate with his colleagues in the West to end the US-USSR competition in nuclear weapons.

The final session was a round-table discussion, chaired by Cherrill Spencer (SLAC) with contributions from Boris Altshuler (Lebedev Physical Institute in Moscow), Tatiana Yankelevich Bonner and Marina Sakharov-Liberman (video recording), Zafra Lerman (Malta Conferences Foundation), Alexander Kabanov (University of North Carolina at Chapel Hill), and Peter Vorobieff (University of New Mexico, APS CIFS). The wide-ranging conversation touched on Sakharov's humanity and achievements, with reminiscences from family and colleagues.

"The Sakharov Centennial event opened my eyes to the scope and breadth of his impact on our world. His story is a must-know for students of history, science, and physics," said Alan Hurd, a member of the organizing committee.

A list of sessions and a video recording of the entire conference is available at engage.aps.org/fip/resources/activities/sakharov.

FYI CONTINUED FROM PAGE 4

to use NSF as a vehicle.' That is not the same as saying, 'How can we leverage and build upon NSF strengths?'"

Committee leaders from both parties have said they believe it is possible to reach a compromise. The bills are not as far apart in their targets for NSF's total annual budget, with the House proposing Congress increase it from the current level of $8.5 billion to $18 billion over five years while the Senate proposes $21 billion.

The House plans to push for DOE and the National Institute of Standards and Technology to be assigned a larger role in the final package. For instance, its DOE Science for the Future Act proposes Congress increase the Office of Science's current annual budget of $7.0 billion by 60% over five years and includes detailed program-level guidance, whereas the USICA contains no policy direction for the office.

In any event, funding to reach such targets will have to be secured through future appropriations legislation. The exception is that the semiconductor funds in the USICA are structured as a mandatory appropriation, meaning no further legislative action would be required for them to be allocated. As of June, the House had not advanced a counterpart semiconductor proposal, though the funding could be added later or included in a final compromise bill.

The author is Director of FYI.

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CHAIRS CONTINUED FROM PAGE 3

Continuing the first day's theme, the final plenary featured a talk on creating inclusive departmental culture by Nadya Mason, the Rosalyn Sussman Yalow Professor in Physics at the University of Illinois Urbana-Champaign. Mason spoke from the perspective of a faculty member, sharing both positive and negative experiences with departmental culture as a Black woman in physics.

The second day of the conference focused on how to support the people in a physics department, including students, junior faculty, tenured faculty, and staff members. Plenaries focusing on supporting physics majors through key transitions and developing personnel which broke into small groups for discussion allowed attendees to reflect on the needs of each of these groups.

The emphasis on discussion rather than long presentations was a highlight of the 2021 meeting, helping limit "zoom fatigue" and increase connection between attending chairs.

"The best part of the conference is getting to interact with chairs from all over the country—it really is a unique experience to talk with chairs from so many different types of institutions, to see what we have in common both in terms of challenges and aspirations, and seeing how we're really different," said Kress.

APS PRIZE CONTINUED FROM PAGE 3

When you first started working in quantum research in 2003, what was your lab's motivation?

Quantum technology was far less hot then, and we had much less funding. Our motivation was not so ambitious as to build a practical quantum computer, but to investigate fundamental questions in quantum technology. We studied how to connect these devices to build quantum networks and quantum logic gates, and how to realize simple toy models of algorithms.

What experiments did you work on?

As a master's student, I worked on many different projects. Professor Pan assigned me to entangle six individual photons for the first time. We experimentally demonstrated Shor's algorithm—the single most shocking algorithm in quantum technology—using photons. [*Editor's note:* Shor's algorithm is a quantum computing algorithm for factoring numbers that is anticipated to be a threat to current encryption systems.] At that time, we used four photonic qubits to factor 15 into 5 and 3. It was extremely simple, but we were the first to do it with entangled photons.

We demonstrated how to encode the state of a single photon into the entangled state of multiple photons. Then, even if a photon gets lost during transmission, we could still recover some quantum information. We also created a quasiparticle called an anyon out of photons and proved that the anyons are neither bosons nor fermions, but something in between.

Now, your team is very much focused on building a practical quantum computer. When did the shift toward technology happen?

2011 was a big year, because the Chinese government officially approved US$100 million in funding for the Micius satellite project. In 2013, they approved another major project for a similar amount of money, to build a fiber optic backbone to connect Beijing to Shanghai. [*Editor's note:* Lu's team has used this infrastructure to conduct experiments related to quantum key distribution, a method for encrypting information that uses single photons.]

In one recent milestone, your group demonstrated quantum advantage using photons, following a similar announcement from Google in 2019 where they performed a different algorithm using superconducting circuits. What is the significance of these quantum advantage experiments?

They are experimental results that will allow us to believe that a quantum computer can solve a problem which a classical computer cannot solve.

After Google announced quantum advantage in 2019, other researchers later claimed they'd devised a clase sical method that outperformed their quantum computer. What's the point when quantum advantage is a constantly moving target?

Quantum advantage is not a single-shot achievement. It will be the result of long-term competition between quantum devices and classical simulation. I see it as a game between quantum scientists and computational scientists. Computational scientists are clever, so they will continue to come up with faster classical algorithms to challenge quantum scientists.

So it's still possible that someone could develop a classical algorithm that outperforms what your quantum computer achieved?

Yes, in principle. We expect people to come up with better classical algorithms. But I also think that eventually we will outpace classical algorithms through hardware improvements and larger quantum processors, whose computing power grows exponentially as you add qubits. In this spirit, we recently [posted arXiv papers on] upgraded quantum computers, one with 113 photonic qubits, and another one with 56 superconducting qubits.

What are the big challenges ahead for quantum computing?

I see three goals ahead. Our first goal is to make a quantum computer that cannot be simulated by any classical computer. The second goal is to make near term applications in quantum chemistry. And the last goal is to have a fault-tolerant quantum computer. Achieving the first goal will give us confidence for the second and third. We also deliver meaningful intermediate results for government and funding agencies. It's what in Chinese we call *yantu xiadan*, laying eggs along the way. The idea is to place milestones along the ascent to Mount Everest.

So Everest is building a fault-tolerant quantum computer, and the eggs are smaller achievements along the way.

This strategy will keep the field healthy. If we lay eggs along the way, we are delivering honest results of what our quantum computers can do. This way, we can avoid hype and disappointment.

Is there a problem with hype in China about quantum computing?

I think the hype is everywhere, as startups are launching throughout the world.

What's your assessment of the startups in China?

So far in China, I am not sure whether startups have a clear strategy to building successful and practically useful quantum computers.

What is the next egg that quantum computing should lay?

The next egg is an application using a noisy intermediate scale quantum device [*See APS News,* May 2019]. Some of the most promising and nearest term applications of quantum computers is to study quantum mechanics itself—many-body problems, quantum chemistry, and quantum materials.

What are you working on now?

A company in Canada called Xanadu has proposed a number of applications related to boson sampling. These applications are linked to graph-based problems, quantum chemistry, and machine learning. We are looking at whether these applications can actually work. Last year, I also started a new lab focusing on atomic arrays in optical tweezers.

You did your PhD at the University of Cambridge. What is your perspective on the different working styles in China versus the UK?

There is not much difference. A vast majority of our faculty has spent time overseas, and when we return to China, we bring working styles from Cambridge, Heidelberg, Stanford, and so on. One difference is that in China, our culture is more Confucius-like. We call it *zhong yong*—seeking balance. Students are more modest and self-preserving, and they challenge their professors less.

You've been working in this field for nearly two decades now. How much has it met your expectations?

Looking back 10 years, I'm surprised at what our community has achieved. There is a saying in Chinese: People are usually overly optimistic what they can do in the next year, but overly pessimistic about what they can do in the next 10 years. I'm very optimistic about the next 10 years.

This interview has been edited and condensed for clarity.

The author is a freelance science writer based in Columbus, Ohio.

PHYSTEC CONTINUED FROM PAGE 5

He started a Science Olympiad club on campus and encourages students to compete at the state level. He also supports student participation in AAPT contests such as Physics Bowl and the High School Physics Photo Contest.

In addition to his work at Millennium High School, Wirth also teaches physics courses at Estrella Mountain Community College. He has also been developing a middle school STEM program with Jeff Andretti (son of racing legend Marco Andretti) to inspire learning about physics through the medium of racing.

The PhysTEC Teacher of the Year National winner receives special recognition at the PhysTEC conference, funding to attend two professional physics conferences focused on education and teacher preparedness, and a grant for classroom materials of $1,000.

Local PhysTEC Teachers of the Year will receive a certificate of recognition as well as a spotlight on the PhysTEC website and in local press. These winners are:

Bree Barnett Dreyfuss: Amador Valley High School, California State University, East Bay

Laura Ernst: Perryville High School, Southeast Missouri State University

Kayla Lewis: Wachusett Regional High School, Bridgewater State University

Wesley Morgan: Springville High School, Brigham Young University

Mimi Pho: Peachtree Ridge High School, Georgia State University

Bruce Ratcliffe: Edison High School, California State University, Fresno

Craig Uhrich: Depew High School, State University of New York (SUNY) Buffalo State College

Paul Wolf: Haas Hall Academy, University of Arkansas

Thomas Zook: Marina High School, California State University, Long Beach

EDUCATION CONTINUED FROM PAGE 1

Do our instructional activities and techniques help build classroom environments that promote diversity and inclusion, as well as enjoyment and appreciation of science? How can we support faculty who would like to implement research-based instructional approaches in their classrooms? High school teachers are critical for shaping the future of the physics community, what do we need to do to prepare and support them better?"

While PER represents a relatively young sub-field of physics, it is one of the most well-established areas of discipline-based education research, more mature than corresponding education research in other STEM fields like biology, chemistry, and engineering. GPER was established in 2014 with the goal of integrating the rapidly expanding PER field into the broader physics community. Since then, the field has continued to thrive and expand, both in size and scope. "It is not uncommon anymore to see a physics education researcher on a faculty roster in a department of physics," according to Kryjevskaia. "Often, PER faculty contribute substantially to the health of the department by bringing in knowledge in education to the department, as well as contributing to generalized knowledge about teaching and learning physics."

Mirroring the growth of the PER field, GPER is a fast-growing unit, with membership consistently above 600. Notably, almost half of GPER's members are students or early career scientists, signifying the vibrance of this new field and foreshadowing continued growth of the PER community. At more than 30%, GPER also boasts one of the highest proportions of female membership across all APS units.

GPER has a strong presence at the annual APS April Meeting, sponsoring or co-sponsoring at least two sessions every year, often in collaboration with the Forum on Education (FEd; see *APS News* June 2020). "APS meetings are a great opportunity for me to engage in conversations with other APS members who do not specialize in physics education research," noted Kryjevskaia. "When a GPER-sponsored session is full of faces I do not recognize, I consider it to be a great success." After all, even physicists who are not directly involved in undergraduate teaching have a stake in physics education, whether that takes the form of mentoring graduate students and post-docs or training new hires in industry.

In the age of coronavirus, many APS members may be thinking especially deeply about physics education—particularly the urgent issue of how to optimize pedagogy for remote learning. To this end, several of this year's GPER-sponsored sessions focused on pandemic-related topics, including recent research on impact of remote learning in the physics classroom, strategies for teaching physics online, and perspectives on how the graduate admissions process might be re-thought in the post-COVID world.

For APS members interested in learning more about physics education research in general, the *Physical Review Physics Education Research* (PRPER) journal published by APS is an excellent resource. The most recent edition of PRPER highlights issues ranging from student experimentation decisions in introductory laboratories to the effects of transforming homework assignments using the principles of deliberate practice and to the effect of culture on women physicists' career choices.

Additionally, many findings from GPER researchers are synthesized in the Effective Practices for Physics Programs (EP3) Project, an initiative led by APS in collaboration with the American Association of Physics Teachers (AAPT) to document evidence-based recommendations and best practices for undergraduate physics education. The aim of EP3 is to develop a resource that will help a wide variety of physics programs strive for excellence within their particular opportunities and constraints, recognizing that what makes for a thriving physics program at a private university is not necessarily the same as that for a liberal arts college, a large state school, or a community college.

Going forward, the GPER executive committee's goals for the unit are two-fold: Looking inward, to continue the advancement of PER as a sub-discipline of physics; looking outward, to advocate for further integration of PER into the broader physics community. "We need to sustain and develop venues that foster new conversations between researchers in physics education and APS members who do not specialize in PER," explained Kryjevskaia. "I would like GPER to continue promoting an environment that welcomes and supports everyone, particularly those who are just beginning a new journey and who rely on our community for support, regardless of whether that support is needed in the areas of research, teaching, mentoring, or career development."

Overall, GPER stands out a vibrant community for sharing ideas, resources, and research about physics education. More information on this unit can be found here: aps.org/units/gper.

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METHANE CONTINUED FROM PAGE 4

process to reverse the rollback of methane emissions regulations.

Supported by a strong grassroots effort from APS members, Sen. Martin Heinrich (D-NM), Majority Leader Chuck Schumer (D-NY), Sen. Ed Markey (D-MA), and Sen. Angus King (D-ME) successfully advanced the resolution in the Senate in May in a bipartisan manner, joined by Republican Sens. Lindsey Graham (R-SC), Rob Portman (R-OH), and Susan Collins (R-ME).

"Climate change is among the chief priorities identified by APS members, and they have responded in force to this effort. Nearly 800 APS members took action to contact their representatives and senators when we sent out the call to action, which is a phenomenal showing of support," said Callie Pruett, APS Senior Strategist for Grassroots Advocacy.

"Furthermore, when we asked for members in Ohio to make extra calls to Senator Robert Portman (R-OH), many responded and did so. It is a sign of our members' impact that Senator Portman was a supporter of this resolution."

According to a report by the Climate & Clean Air Coalition in conjunction with the United Nations Environment Programme, "cutting human-caused methane by 45% this decade would keep warming beneath a threshold agreed by world leaders."

The report further notes multiple benefits of reducing methane, including a rapid reduction of warming to help prevent dangerous climate tipping points; an improvement in air quality that can save hundreds of thousands of lives; the prevention of crop losses, leading to better food security; and the creation of jobs through mitigation efforts.

The APS Panel on Public Affairs and the Optical Society (OSA) are doing their part to address the methane issue via a joint study covering the technological gaps in sensing and monitoring methane emissions from oil and gas companies. The report will also identify the role of basic and applied physics in enhancing or developing new sensors and sensing platforms required to detect emissions.

Raymond L. Orbach, former Undersecretary for Science in the US Department of Energy during the George W. Bush Administration and retired professor at UT Austin, who serves as co-chair of the study, said the report is timely because of the need to respond to the IPCC greenhouse gas reduction targets. Failure to respond will exacerbate the effects of climate change on lives around the world, said Orbach.

"The APS/OSA report is important because the data makes it clear that methane is an important greenhouse gas, and its growing atmospheric concentration poses a real danger to our planet. Fugitive methane emissions from oil and gas production, in combination with flaring of natural gas, are adding to the concentration of greenhouse gases in the atmosphere. The resulting impact on climate change makes reduction of methane emissions essential if we are ever to meet the goals set by the Paris Climate Agreement," he said.

APS members still have time to take action on the methane issue. The letter remains active for House members, and APS members can continue to show their support by contacting their congressional representatives concerning this important matter.

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

BANGLADESH CONTINUED FROM PAGE 3

most active researchers from the Bangladesh Universities of Dhaka, Chittagong, Jahangirnagar, Rajshahi, Engineering and Technology (BEUT), and the Atomic Energy Commission (BAEC).

The organizing committee selected the conference sessions with three objectives: (i) to highlight current physics research in Bangladesh and in the US for prospective collaborations, (ii) to present available opportunities for studying at US universities to students and research exchange programs to Bangladesh researchers, and (iii) to inspire and motivate students and researchers with a Nobel Laureate's public lecture. Due to the COVID-19 pandemic, the conference convened on zoom and was streamed live through nine Facebook accounts. The program ran for four and a half hours both days during the evening hours in Bangladesh and morning hours in the US. The presentations were viewed by thousands all over Bangladesh and by many from Pakistan, India, Turkey, Malaysia, Japan, Germany, Ireland, and the US.

The Minister of Education of Bangladesh, Dipu Moni, inaugurated the conference. Earl R. Miller, US Ambassador to Bangladesh, spoke on US educational and research opportunities for Bangladeshi students and researchers. Cornell (JILA) explained Bose-Einstein condensation for a general audience, and the other US and Bangladeshi speakers covered large areas of physics and astronomy. Clark spoke on how neutrons, which can travel through matter easily, enable imaging structures in dense matter, testing quantum entanglement and studying matter-wave optics. Anil Pradhan (OSU) spoke about modeling of exo-planets, and I presented a spectroscopic interpretation of observation of lanthanides following the detection of gravitational waves created during the merger of two neutron stars. M. Zahid Hasan (Princeton) discussed topological concepts of quantum phases of matter with experimental verification of a topological insulator whose surface hosting an unpaired Dirac fermion can give rise to topological superconductors with helical Cooper pairing. Khandker Muttalib (Florida) spoke on the study of thermoelectricity for possible use in green energy production. Sheikh A. Akbar (OSU) spoke about ceramic nano-heterostructures in materials design that can be platforms for sensing and biomedical applications and presented results on the successful creation of various nanofibers and nanostructures in his lab without the use of lithographic techniques.

Among the Bangladeshi speakers, two presented new findings that have not been observed before: A. A. Mamun (Jahangirnagar) discussed identification of new nuclear-acoustic waves in cold degenerate quantum plasma. Khondkar Siddique-e-Rabbani (Dhaka), founder of the Department of Medical Physics at the University of Dhaka, spoke about imaging techniques that he has developed for the study of the stomach, lungs, and any small region inside the body and the characterization of breast tumors to determine malignancy. Syed M. Hossain (BAEC) described the nuclear infrastructure in Bangladesh. Golam Mohammed Bhuiyan (Dhaka) reported his theoretical study of the behavior of liquid metallic binary alloys. M. Idris Miah (Chittagong), who does his research in Australia whenever the opportunity arises, spoke on multiphoton spin generation and detection in semiconductors. M.A. Hakim (BUET) presented results on size dependent properties of nanostructured materials. Saleh H. Naqib (Rajshahi), who is currently collaborating with researchers at Cambridge University, spoke on the study of the pseudogap in hole-doped cuprates, which show superconductivity at high temperatures.

The session devoted to helping students and researchers find information on US universities, exchange programs, and relevant funding sources was introduced for the first time at a Bangladesh Physics conference. This session included EducationUSA Director Iqbal Sohel (US State Department). At the concluding ceremony, Cornell, Clark, Nahar, and Hasan were honored as new Fellows of the BPS by its President Mesbahuddin Ahmed.

The impact of the conference was very inspiring. Audience questions indicated high interest in opportunities to study in the US and exchange research programs. However, students and researchers often find their qualifications, particularly in research, do not match the standards of the universities they would like to attend or visit. It would be highly beneficial to initiate an International School of Young Physicists (ISYP), similar to the International School for Young Astronomers run by International Astronomical Union (see *APS News*, October 2019), for students and young researchers in developing countries.

Sultana Nahar is a research professor of astronomy at The Ohio State University, co-author of the textbook Atomic Astrophysics and Spectroscopy, creator of the NORAD-Atomic-Data, co-director of the STEM ER Center, and adjunct professor of physics at Aligarh Muslim University and Cairo University. She has introduced over a dozen educational and research programs in Bangladesh.

University of Dhaka CREDIT UNIVERSITY OF DHAKA

THE BACK PAGE

Two Points of Light

BY S. JAMES GATES, JR., ROXANNE HUGHES, LAURA H. GREENE, AND PAUL COTTLE

The underrepresentation of Blacks and women in physics, from the undergraduate level all the way through to the senior ranks, is among the most stubborn and frustrating issues facing the physics community.

According to the AIP Statistical Research Center [1, 2], Black students received 3% of the 2018 physics bachelor's degrees in the US, falling from 5% in the 1990s. The number of Black students earning PhDs in the 2018-19 academic year was only half of what is in 2011–2012. Today, fewer than 1% of new physics PhDs are Black.

The number of women earning physics degrees has stagnated. The percentage of women earning bachelor's degrees has been below 23% since 2000. There was a slow increase until 2012, but since it has remained at 20%.

There are no easy, sweeping solutions to this stunning lack of representation. If we are to make progress, work needs to be done at multiple educational and career levels including middle and high schools where students are determining what careers fit with their interests and identities. Educators and science engagement experiences outside of school have great potential for sparking youth's interest in STEMM (science, technology, engineering, math, and medicine), and maintaining that interest as they begin to make decisions on careers. Through these supportive and engaging physics experiences, the goal is for all students to feel like welcomed members of the physics community—where they can learn to identify themselves as aspiring physicists.

Orlando's Jones High School

The British computer scientist Alan Turing once said, "Sometimes it is the people no one imagines anything of who do the things that no one can imagine."

Jones High School in Orlando, Florida, is one of the most socioeconomically challenged schools in its county. Of its 1600 students, more than 250 took on learning physics during the 2020-21 school year. As one of us found (Cottle), the percentage is higher than any other high school in that county, and one of the highest in the state.

Why is this important? With the tremendous pandemic uncertainties in the state and national economies, it is more important than ever that students be given the opportunity to pursue careers in economically resilient fields like engineering, computer science, the physical sciences and the health professions. To ensure four-year graduation rates and be well-prepared to major in STEMM fields, students need to take challenging high school-level math and science courses, including physics.

Those raised in the traditional hierarchical nature and culture of STEMM might portray these fields as spaces where only a small percentage of the privileged few can succeed, putting students from low-income families at a disadvantage from seeing themselves as succeeding in high-powered STEMM careers. As a result, students and even high school counselors do not see higher-level courses like physics and calculus as necessary. But that way of thinking never had a place at Jones High School, where one of us (Gates) graduated in 1969.

Academic excellence, including in physics classes, has a long history at Jones. As Gates attended Jones in the late 1960's, legal segregation was ending—but that did not matter. Perseverance and striving for excellence were held in high esteem. His high school geometry teacher, Ms. Edna Williams was Gates' first "intellectual drill instructor in logic," and there were many demanding but supportive teachers: Ms. Thelma Dudley, Ms. Lessie Weaver (English), Mr. William Sanders (Algebra), Mr. Ruben Patrick (French), and Mr. Freeman Coney (Physics) are memorable.

Jones High School in Orlando, Florida, is one of the most socioeconomically challenged schools in its county, yet the percentage of students taking physics is higher than any other high school in that county, and one of the highest in the state. CREDIT: ORANGE COUNTY SCHOOL SYSTEM

The influence Mr. Coney had on Gates' life was the most profound, but many Jones High School teachers laid the foundation that led to his being awarded the National Medal of Science in 2011 and his current role as President of the American Physical Society (APS).

The credit for success and ambition of present-generation Jones students goes to current Principal Allison Kirby and the outstanding teachers and counselors she leads. They follow in a long line of school officials and teachers in this effort. Even in the face of the pandemic, Principal Kirby and her faculty kept their students focused on the prize of academic excellence and opportunities that their hard work will open for them in the future.

Gates continues to assist this drive. Since 2004 annually he has supported a prize award for top performance in mathematics/physics classes. Former JHS Principal Dr. Bridget Williams stated, "When he returns to the campus of Jones High School, he spends the day there with those kids. It empowers the entire community." The 2021 prize recipients, Je'Nyia Burton and Kendersley Marcellin, are among the 250 students in physics classes.

By taking on the challenge of physics, the students now learning from the educators at Jones have brought new energy to the school's illustrious legacy and have shown the value of taking on big challenges as a supportive and tight knit community. Jones High is showing other high schools how to create physicists in a space that otherwise one could not even imagine. The plan for the next academic year is for every senior student to take physics!

Does the example of Jones High School and the engagement of the 2021 APS President suggest the possibility of other effective ways for university and research physicists to effectively generate positive outcomes in high school physics education? Can the APS community create more examples of such "HS ambassadorship programs" working with teachers and administrators?

SciGirls at the National High Magnetic Field Laboratory

SciGirls started in 2006 at the MagLab in partnership with our local public television station WFSU, funded by a small grant from the National SciGirls organization at Twin Cities Public Television. This enabled 20 middle school students from the Tallahassee area in Florida to participate in the first year. Since then, the program has expanded to over 400 students, with 30% from underrepresented groups in STEMM (Black, Hispanic, Pacific Islander, Indigenous Peoples) and three separate summer camps, including the SciGirls Coding Camp. Alumni who have kept in touch (about 12%) have pursued careers that include industrial engineering, science education, applied mathematics, and other STEMM fields.

The goals of the camps are: (1) To provide a safe space for girls to do science (authentic, relevant, hands-on, and interactive activities where they gather evidence to solve problems); and (2) to introduce participants to a diverse array of careers and role models in STEMM. Throughout the camp, the majority of the activities are led, and designed, by women scientists, graduate students, and postdocs, with help from the SciGirls' lead educators led by one of us (Hughes). Highlights over the years include designing a Rube Goldberg machine, extracting DNA, and visits to labs on local college campuses. Each year the camp begins with an informal luncheon with women STEMM professionals, and concludes with a panel discussion which includes students' families.

Her skills in STEMM education research allowed Hughes to measure the impact of this program on students' STEMM identity. She also gathers many of the girls' stories about their camp experiences, specifically the empowering impact of sharing space with women interested in and succeeding in STEMM. One young woman explained: "I have a very clear memory of sitting at one of the lunch panels that we had where women scientists [came] to talk to us...I don't remember what they did or who they were, but I remember sitting in there and being like, 'Oh, this is really cool!'"

Other young women have expressed the value of the authentic and relevant activities that they engaged in during the camps. One alumna highlighted the motivational aspect of the camp, indicating that without SciGirls, "I don't think I ever would have taken an advanced science class. SciGirls took complex material and simplified it down into something that's interesting, and easy to comprehend".

The SciGirls program has expanded to over 400 students, with 30% from underrepresented groups in STEMM (Black, Hispanic, Pacific Islander, Indigenous Peoples) and three separate summer camps, including the SciGirls Coding Camp. CREDIT: NATIONAL HIGH FIELD MAGNET LABORATORY

And yet, even with these empowering stories, some of our alumnae have told us about negative experiences in high school that made them question whether they could succeed, or if they even belonged in STEMM. Their stories reinforce the need for programs that help to maintain interest and a sense of belonging throughout middle and high school to persist in STEMM careers. It also points to the need for enhanced teacher training such as that provided by the PhysTEC and the APS STEP UP programs. One of us (Greene) is also inspired by the SciGirls program, and notes that in her high school years, no such programs existed, and she had no mentors for her to pursue a career in science.

Both women and people of color struggle to feel they belong even if they persist through high school into college. The intersectionality of marginalized identities makes their reasons for not persisting different [3] as Greene and Gates' stories show. For women, even if they persist to a physics major in college, they have to overcome sexual harassment [4, 5] and the isolation of sometimes being the only women. For women and men with multiple marginalized identities (e.g., race, income, class, ethnicity, sexual orientation), their isolation in multiple realms makes it difficult for them to feel like they belong in a majority White, middle class, and male field, like physics. This means that to help students and early career scientists thrive and make physics inclusive we need to incorporate multiple strategies [6, 7].

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