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APS NEWS

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MEMBERSHIP UNIT PROFILE

The APS Division of Quantum Information

BY ABIGAIL DOVE

The APS Division of Quantum Information (DQI) is a home for those interested in the cutting edge of quantum information: its foundations, its physical manifestations, and the usefulness of, feasibility of, and progress toward quantum computing. Specifically, this spans quantum entanglement, quantum communication, quantum cryptography, quantum algorithms and simulations, physical implementation of qubits (the basic unit of quantum information), the conceptual and mathematical foundations of quantum theory, and more.

Quantum information is one of the newest fields in physics. It was born in the 1980s when physicists began considering how to apply the unusual behavior of quantum systems to computation. DQI got its start in 2002 when APS members formed the Topical Group on Quantum Information, Concepts, and Computation (or "Quicc"). This eventually evolved into the Topical Group on Quantum Information (GQI) in 2005. After a decade of work growing its membership and increasing the visibility of quantum information, this group achieved full division status in 2017, becoming DQI.

Now 2,400 members strong, DQI ranks among the largest divisions at APS. DQI secretary/treasurer Emily Pritchett, a research scientist at IBM, said that the vibrancy of the division today represents an important symbolic victory for the field in general.

"A decade ago, typical for a new subfield of physics, there was doubt as to whether quantum information was a credible field that belonged in academic physics departments" she explained, "Of course, one only has to compare the job opportunities now to those a decade ago to see that this [field] has been enormously successful."

A large part of DQI's success lies in its interdisciplinary nature. Quantum information engages not only physicists but also mathematicians, computer scientists,

Emily Pritchett

and engineers, making DQI an important entry-point to APS for researchers with an academic home outside of physics. Furthermore, within physics, the many proposals for and prototypes of quantum computers build on research from several other areas of the field. In particular, many DQI members also have a home in the Divisions of Atomic, Molecular, and Optical Physics (DAMOP) and Condensed

DQI CONTINUED ON PAGE 6

INTERNATIONAL AFFAIRS

The African Physics Newsletter Celebrates Its First Anniversary

BY J. E. GUBERNATIS

With its December issue, the *African Physics Newsletter* (bit.ly/africanphysicsarchive) concludes its first year of publication. It has been a formative year for the newsletter during which it saw a doubling in subscribers, an expansion of its Editorial Board, and a refinement of its format and content. The newsletter steps into its second year primed to continue its *de facto* role as the voice of physics in Africa.

APS agreed to support the newsletter in response to a survey of African physicists, summarized in the December 2017 issue of *APS News*, that revealed a need for a Pan-African communication vehicle. The newsletter has a novel publication model, and it is noteworthy that the news items are being gathered, selected, and composed by a volunteer editorial board of African physicists. APS is providing the final copyediting, formatting, and distribution.

The launch of the newsletter was timely; a lot is happening in the African physics community. Several successful schools, such as the African School on Electronic Structure Methods and Applications and the School on Fundamental Physics and Applications are having their tenth anniversaries. There is now an African Materials Research Society. In the past three years, the number of African national physical societies has increased

AFRICA CONTINUED ON PAGE 7

EDUCATION

The 2019 IGEN National Meeting: Connecting the Threads of Graduate Education and Inclusion

BY BRIÁN CLASH

The sweeping campus of the University of Central Florida (UCF) provided the backdrop for the first national meeting of the Inclusive Graduate Education Network (IGEN), which took place from October 25 to October 27 in Orlando, Florida. IGEN is a partnership between scientific societies, including APS, and institutions of higher education with the goal of increasing the number of physics PhDs earned by underrepresented minority students. The 2019 IGEN National Meeting focused on bringing together professional scientists, underrepresented minority students, and scholars of equity and inclusion in graduate education.

Over 160 attendees joined for the weekend's events, which officially began on Friday evening. IGEN Project Director Theodore Hodapp gave a brief overview of IGEN and welcomed attendees to the meeting before introducing the speaker of the hour, APS Vice President Sylvester James Gates, Jr.

A room that had been abuzz with conversation quickly became

Participants in the 2019 IGEN Conference.

silent as Gates, a theoretical physicist, walked the audience through the story of his life and accomplishments. From his accidental completion of two bachelor's degrees in physics and math to his National Medal of Science, awarded by President Obama in 2013, Gates' life has been one of determination and courage to try new things. He concluded his talk with a message he hoped each person would remember as they continued on their own journey: He urged listeners to acknowledge the sacrifices of their family members that came before them and the effects of those sacrifices on what they have achieved.

On Saturday morning, attendees filled the Fairwinds Alumni Center at UCF for breakfast and the opening plenary. Geraldine Cochran, Assistant Professor of Professional Practice at Rutgers University, centered her talk on defining the terms diversity, equity, and inclusion and emphasized the need for IGEN affiliates to create a shared language. Her discussion of diversity, equity, and inclusion, which can often be seen as an uncomfortable topic, tackled implicit bias, microaggressions, and historical and present injustices. Cochran's talk asked individuals to take stock of their

IGEN CONTINUED ON PAGE 7

GOVERNMENT AFFAIRS

The United States is Losing the Ability to Attract International Students Due to Visa Obstacles

BY TAWANDA W. JOHNSON

A significant portion of APS international student members say they have experienced delays in processing their visas to study in the United States, according to a recent survey (go.aps.org/2D6hIf9) carried out by the Society in conjunction with the Forum on Graduate Student Affairs (FGSA) and the Forum for Early Career Scientists (FECS).

Conducted in the summer of 2019, the survey covered international students who came to the US to earn advanced degrees and international students who chose not to come to the US. More than 700 international members were surveyed. APS also continued its survey of more than 60 department chairs graduating 10 or more PhDs per year. That survey revealed that American universities outside of the top tier experienced a two-year decline of 22% in international applications to physics PhD programs at US institutions. That is a serious problem because universities outside the top 15 generate more than 70% of the nation's PhDs in physics.

According to the surveys, international students are experiencing numerous challenges in coming to the US and are noticing growing opportunities elsewhere. Attracting the best students in the world provides a critical competitive advantage that is essential to innovation and the STEM workforce. However, the recent decline in applications from physics PhD students to American universities represents an advanced warning of rising economic risk to the US.

Of those students who are trying to come to the US to study, nearly 30% report having challenges obtaining a student visa, and of those reporting challenges:

- 85% experience delays in processing their visas; and
- 20% have trouble proving "intent to leave" after getting a degree.

Of those students who choose not to come to the US:

- 32% believe the US is "unwelcoming to foreigners;"
- 21% believe they have better educational opportunities outside the US; and
- 20% believe they have better long-term employment opportunities outside the US.

"I find the current situation to be very disappointing," said Tiffany Nichols, FGSA chair. "Science does not function when there are geographic hindrances. Professors Matthew Stanley and Daniel Kennefick have written works analyzing similar policies put in place during World War II, which prevented [wider knowledge] of general relativity. I urge lawmakers and community members to read these works, as borders

VISA CONTINUED ON PAGE 7

Revised 12/16/19

DIVERSITY

Travel Support, Skills Seminar, STEP UP, and NMC Conference

The Braslau Family Travel Grant program provides support for degree-seeking students and early career physicists to attend an APS March or April Meeting. Grant amounts are based on the availability of resources, with special consideration given to students who lack personal or institutional financial support. Awards typically range from $500 to $1,000. Applications are open from November 11, 2019 to January 3, 2020. For more information visit go.aps.org/2l7OjbV.

Communication and Negotiation Skills Seminar for Women

With support from the National Science Foundation, APS has trained women in physics to conduct professional skills seminars for students and postdocs at APS-sponsored meetings and at universities and institutions. Professional Skills Development Seminars are highly interactive workshops where participants will learn and practice communication and negotiation skills. For more information, please visit go.aps.org/2oF3InD.

Give Future Physicists a STEP UP

STEP UP designs high school physics lessons that empower teachers, create cultural change, and inspire young women to pursue physics in college. With your help, we can make an even greater impact to prevent the loss of talented minds in physics. Please consider making a gift to help young minds discover new career pathways, recognize traditionally underrepresented people in physics, and sharpen problem-solving skills. Donations can be made at go.aps.org/31md7z6.

National Mentoring Community Conference

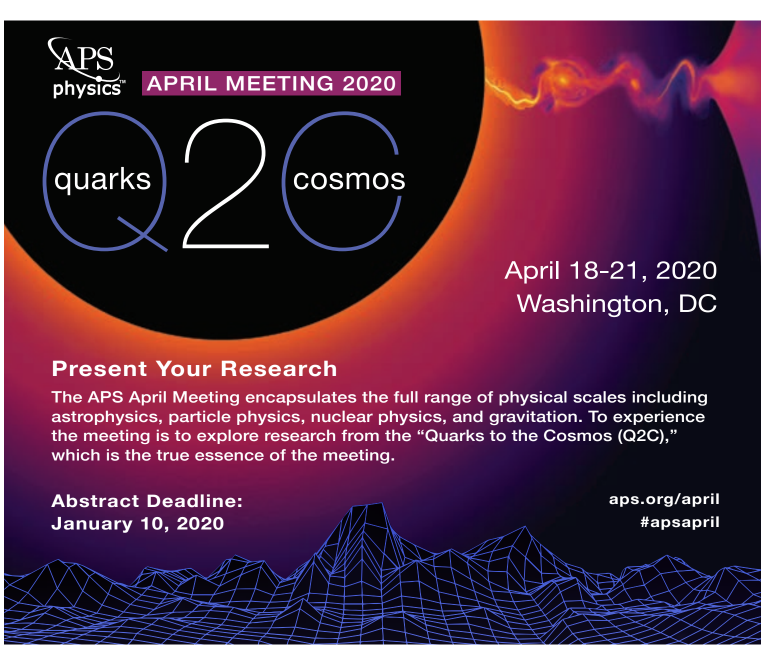
We are excited to invite you to the 2020 APS National Mentoring Community Conference (go.aps.org/nmc2020), which will be held February 6-8 at the University of Central Florida in Orlando, Florida. Registered NMC Mentees and Mentors are eligible for discounted registration and travel funding! Register at go.aps.org/33bwU5x.

This conference is hosted in partnership with the National Society of Black Physicists and the National Society of Hispanic Physicists and will feature:

- Plenary talks by prominent scientists
- Optional NASA Kennedy Space Center tour
- Career workshops and professional development for students
- An opportunity to showcase your program at the Research Experience for Undergraduates and Graduate School Fair
- Sessions on strategies for effectively mentoring underrepresented minority physics students
- Opportunities to connect with other physics students and faculty
- An undergraduate Research Poster Competition

And much more!

You won't want to miss this exciting conference! Be sure to check the conference website for updates.



THIS MONTH IN

Physics History

December 17, 1902: First Radio Message to Cross the Atlantic from North America

Today we take our ability to transmit and receive radio signals wirelessly across long distances for granted. Many scientists in the late 19th century contributed to the development of this critical technology, most notably an Italian inventor named Guglielmo Marconi.

Marconi was born into Italian nobility in 1874. (His Irish-Scottish mother was the granddaughter of whiskey distiller John Jameson.) He had no formal schooling, but was educated by private tutors in math and science. As a teenager visiting Livorno one winter, he found a mentor in physics teacher Vincenzo Rosa, who introduced young Marconi to what were then new theories about electricity. Marconi was also allowed to attend lectures at the University of Bologna by a physicist named Augusto Righi, who introduced him to the work of Heinrich Hertz.

In the 1890s, Marconi began working on developing so-called wireless telegraphy, a system capable of transmitting telegraph messages without the electric telegraph's connecting wires. He was not alone in this endeavor; scientists had been scheming about ways to accomplish this for decades. But Hertz's 1888 demonstration of radio waves (initially called "Hertzian waves") had inspired physicists, including Marconi's mentor, Righi, who wrote a review of Hertz's discoveries.

Marconi was just 20 years old when he began conducting experiments in his attic at home in Bologna, Italy, with his butler serving as his assistant. In the summer of 1894, he devised a storm alarm with a battery, a "coherer" (a tube with metal filings that passed a current in response to radio waves), and an electric bell, which rang in response to radio waves from lightning. After building the storm detector, Marconi devised a way to generate radio waves at the push of a button. He claimed to have invented his "black box"—essentially a spark transmitter with an antenna—in December 1894.

With his father's support, the young inventor developed portable transmitter and receiver systems capable of operating over longer distances. Initially he could only manage a distance of half a mile, but in the summer of 1895, he transmitted and received signals over two miles, including over hills, by raising the antenna height and grounding the transmitter and receiver. Recognizing the potential of his wireless system for commercial and military communications, he wrote to the Italian ministry requesting funding to further develop it. The minister never replied, dismissing the request as the ravings of a lunatic.

Marconi traveled to London in 1896 with his box, where the Italian ambassador assured him it would be easier to get the funding he needed. He entertained audiences with a "conjuring trick": making a bell ring on the other side of the room using radio waves instead of a cable. And he proved his system could transmit Morse code signals across 3.7 miles. On May 13, 1897, he sent the first wireless communication over open sea, across the Bristol channel: it simply read, "Are you ready?" That same year, he founded the Wireless Telegraph & Signal Company in the United Kingdom.

Next Marconi turned his attention to wirelessly transmitting a signal across the Atlantic Ocean from a station he set up at Marconi House in County Wexford. He supported his antenna with

RADIO CONTINUED ON PAGE 3

Marconi demonstrating apparatus he used in his first long distance radio transmissions in the 1890s. The transmitter is at right, the receiver with paper tape recorder at left. IMAGE: WIKIMEDIA COMMONS

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RADIO CONTINUED FROM PAGE 2

a kite to get better reception, and on December 12, 1901, claimed he had made a successful transmission between a power station in Cornwall to Newfoundland—a distance of 2,200 miles.

But there was reason to be skeptical of this claim. The test was conducted in daylight, which hinders long-distance transmission of radio waves, and Marconi was expecting to hear the Morse code taps for the letter "S." So Marconi tried again, first in February 1902 while aboard the *SS Philadelphia*. This time he sent the transmission at night, achieving an audio distance of 2100 miles, compared to the 700-mile distances achievable during daylight. Finally, on December 17, 1902, he successfully transmitted the first trans-Atlantic radio signal from a station in Nova Scotia.

It took several more years before wireless telegraphy was fully developed. But thanks to the wireless telegraph, famed arctic explorer Robert Peary was able to tell the world about his discovery of the North Pole via radiotelegraphy in 1909. And in April 1912, the supposedly unsinkable Titanic set out on its maiden voyage across the Atlantic and hit an iceberg, creating a deep gash in the ship's hull. The wireless telegraph operator sent out a series of increasingly frantic Morse Code messages, including the now-famous distress signal: dot dot dot dash dash dash dot dot dot (SOS).

Radiotelegraphy even helped apprehend an escaped murderer in England. Early in 1910, Dr. Hawley Crippen chopped off his wife Cora's head and tossed it into the English Channel, burying the rest of her body under the floorboards of his house. He then ran off with his lover, Ethel LeNeve. On July 22, Scotland Yard received a wireless telegraph message from the captain of the *SS Montrose*, bound for Quebec, reporting two suspicious passengers. It was Crippen and Ethel in disguise. Crippen was ultimately convicted of murder and hanged.

Marconi's work was not without controversy. Serbian inventor Nikola Tesla made a public demonstration of radio communication in St. Louis, Missouri, around the same time as Marconi, and the two men fought for recognition as the primary inventor and patent holder of wireless telegraphy. Although Tesla patented a wireless device as early as 1897, it was Marconi who became known as the "father of wireless communications." He shared the 1909 Nobel Prize in Physics for his contributions with Karl Ferdinand Braun, who invented the phased array antenna in 1905. Tesla was not a co-recipient.

Marconi infamously joined the Italian Fascist party in 1923 and was rewarded by Mussolini with the position of president of the Royal Academy of Italy in 1930. But his health was failing, and he suffered nine heart attacks over three years. The final, fatal attack occurred on July 20, 1937. Shops in Italy were closed for a day of national mourning, and as his funeral commenced, the BBC and Post Office wireless systems observed two minutes of silence in his honor.

Further Reading:

Weightman, Gavin. *Signor Marconi's Magic Box: the Most Remarkable Invention of the 19th Century and the Amateur Inventor Whose Genius Sparked a Revolution.* (Da Capo Press, Cambridge, MA, 2003).

JOURNALS

APS to join Phase III of SCOAP^3 in 2020

APS has committed to participating in Phase III of the Sponsoring Consortium for Open Access Publishing in Particle Physics (SCOAP^3), an international collaboration that facilitates the large-scale open access publishing of high energy physics (HEP) research. SCOAP^3 is convened and managed by the European Centre for Nuclear Research (CERN), based in Geneva, Switzerland.

The SCOAP^3 consortium was first launched in 2014 and pools journal subscription fees for high-energy physics papers, then compensates publishers to make articles open access at no cost to authors. APS joined SCOAP^3 in January 2018, and to date over 4,400 HEP articles have already been published in APS journals under the initiative.

The new agreement signed earlier this year extends APS's commitment to the SCOAP^3 initiative for a further three years covering the period from 2020-2022. This means that all HEP papers published in three APS journals—*Physical Review Letters*, *Physical Review C*, and *Physical Review D*—will continue to be made available open access with a CC-BY license immediately upon publication without the need for authors to pay any costs.

In order to qualify for publication under the SCOAP^3 initiative, articles appearing in one of the three participating APS journals must have been posted as a preprint on arXiv in one of the four primary 'hep' categories at the time of publication.

Announcing the Society's commitment to a further three years scheduled participation in the scheme, APS Publisher, Matthew Salter said "APS's continued involvement in the SCOAP^3 initiative aligns with our objective of thriving in an increasingly open access environment as outlined in the APS Strategic Plan 2019, and reaffirms our commitment to offering a range of publishing options for the research community in the *Physical Review* journals."

APS Editor in Chief Michael Thoennessen also expressed his approval of the development. "This is very good news for the *Physical Review* journals and the high-energy physics community. Participating in Phase III of SCOAP^3 demonstrates APS's ongoing commitment to the community and to our mission to support the research community and advance and diffuse the knowledge of physics" he said.

2019 APS President David Gross, a world leading theoretical physicist and 2004 Physics Nobel Laureate, welcomed the announcement. "I am delighted that APS will be continuing its participation in SCOAP^3 as it moves into its next phase," he said. "APS is the largest international publisher of high-energy physics research and this move is a strong signal of APS's support for this community and also for the principles of open access."

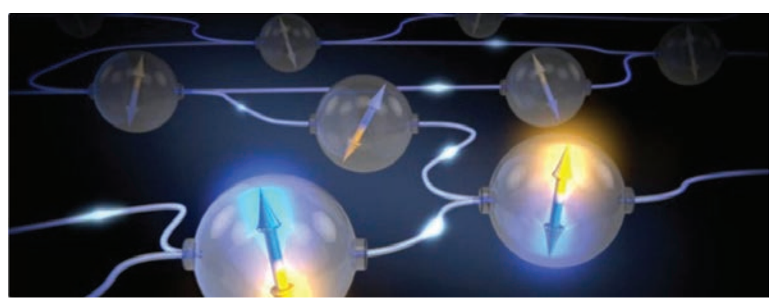
For more information on the APS journals, visit journals.aps.org. Additional information about SCOAP^3 can be found at scoap^3.org.

MEETINGS

Qubits on the Move: QuTech and the Quantum Internet

BY LEAH POFFENBERGER

The 2019 Frontiers in Optics/Laser Science meeting in Washington, DC, jointly hosted by the Optical Society (OSA) and the APS Division of Laser Science (DLS), featured many visionary speakers with big ideas for developing new technologies. One such idea was the focus of a plenary at the conference: the creation of a quantum internet.



Qubits entangled over long distances will form the quantum network of the future.
IMAGE: QUTECH

Ronald Hanson, Scientific Director at the QuTech research institute and a professor at the Delft University of Technology, spoke about an ambitious project to create a global quantum internet, starting in the Netherlands. The ultimate vision is a network that enables qubit exchange from anywhere in the world, requiring the ability to transmit states of quantum entanglement across long distances.

In October 1969, the first message was sent between distant interconnected computers: the "L" and "O" of "login" were transmitted from the University of California, Los Angeles, to Stanford University before the system crashed. Over just 50 years, this breakthrough has evolved into today's internet.

Since then, a number of research groups have sought to harness the peculiarities of quantum physics for long-distance communication and computing. In quantum computing, entanglement refers to an interaction between two or more particles that causes them to share a common quantum state and influence each other's quantum behavior.

In 2017, Chinese scientists showed that photon entanglement could be maintained over 1,200 kilometers between a satellite and ground stations. Other groups have demonstrated that encryption keys generated by quantum processes can be distributed between cities, and there are even commercially available systems to do this. However, these applications rely on classical components.

Now, the goal is to create a truly quantum network with end-to-end quantum technology. The advent of a fully quantum internet would be an important step for quantum computing, allowing quantum processors to transmit information from quantum bits, or qubits, to one another instantaneously.

"We want to make the first entanglement-based internet, and to do that we have to assemble a brilliant, interdisciplinary group of people," said Hanson in his talk. "It's a testimony to the type of challenge we have: It's not just an optics challenge or just a physics challenge. You need people from different disciplines to work together."

To create such a talented braintrust, Delft University and the Netherlands Organisation for Applied Scientific Research (TNO) joined forces to create QuTech. This advanced research center for quantum computing and the quantum internet provides a place for physicists, computer scientists, and optics engineers to realize the ultimate goal of a network of quantum computers.

QuTech has demonstrated the viability of a fully quantum internet on Delft University's campus, stretching the entanglement distance from just 3 meters in 2013 to 1.3 kilometers in 2015. And Hanson says they have their sights set on a longer distance for 2020: demonstrating quantum entanglement over 30 kilometers, spanning from the university in Delft to The Hague city center making use of pre-existing telecommunication infrastructure.

To create this interaction from qubits that exist meters to kilometers apart, QuTech is using photons transmitted by fiberoptic cables—the same cables that carry regular internet—to mediate entanglement between particles. These entangled states are what allow for the quantum internet to act as a vehicle for cryptographic key distribution, which allows two quantum computers to trade information in an ultra-secure way.

"The idea here is that you would distribute the sequence key between two parties, and the security of the key actually comes from the physical principles [of the system], and this is something you can't do in classical machines," said Hanson.

While there is some focus on creating entanglement over increasing distances, like the 2020 goal, two other areas are also crucial to advancing the quantum internet. Past tests show areas for growth in both entanglement speed—or

QUBITS CONTINUED ON PAGE 7

APS National Mentoring Community Conference 2020

In Partnership with
National Society of Black Physicists and National Society of Hispanic Physicists

February 6 - 8, 2020
University of Central Florida, Orlando, FL

Highlights include:
Plenary talks on mentoring & physics research
Panels & workshops on mentoring best practices
Career workshops & panels
Undergrad research experiences and grad schools fair
Networking opportunities
And much more

APS physics National Mentoring Community
Alfred P. Sloan Foundation
UCF

Register now! go.aps.org/nmc2020

CAREERS

Beyond the Cold Call: How to Supercharge Your Career Network

BY CRYSTAL BAILEY

You've probably heard the phase, "it isn't what you know, but who you know" when referring to finding new professional opportunities. And even though it might fly in the face of what you have experienced as a physics graduate student—where you're used to being evaluated primarily on your physics knowledge—who you know is indeed the single most important factor when it comes to furthering your career, whether in or out of academia.

Crystal Bailey

It has been estimated that approximately 70 percent of people have gotten their professional breaks through their network [1]. This means that your chances of being successful at connecting with a potential employer or with someone whose career you're interested in learning more about in an informational interview depends greatly on how well you've been able to build and leverage your own professional network (for more information about informational interviews, please visit our Online Professional Guidebook at go.aps.org/2KIfjvC).

Why "Cold Calling/Emailing" Seldom Works

These days we are all constantly bombarded with requests for our attention through phone calls and emails. Busy professionals are constantly having to decide where to focus their energy based on the return on investment of a response. Some requests merit immediate action (such as those tied to that person carrying out their job responsibilities). Others are less immediate and can be responded to when, or if, the person has time. Still others offer no direct benefit to the person for responding; these requests may be ignored. The problem with cold calls/emails is that they usually fall in the last category—if the person doesn't stand to gain something from the interaction, they are less likely to respond. The challenge facing job seekers who wish to reach someone in a company is standing out above the "noise" of the requests that bring little to no return on investment for that person.

However, one thing that works to your advantage is our natural tendency to respond to those we have something in common with. Imagine meeting someone at a conference who grew up in your same hometown, was advised by one of your collaborators, or was a friend of one of your friends, as opposed to someone without that common background. Perhaps you would feel more drawn to the person with whom you had a shared experience. The truth is that when we are able to reach out to someone through a shared connection—a mutual friend, membership in a society, or shared alma mater—we rise above the "potential energy barrier" which keeps all those other requests the other person is dealing with at bay. This makes that person more likely to help us by giving us information, or by helping us find the right contact for insights into a job opportunity.

How to Build a Useful Network

One way to build a professional network is to take advantage of membership in professional societies or alumni groups. As an APS member you have access to the

CAREER CONTINUED ON PAGE 6

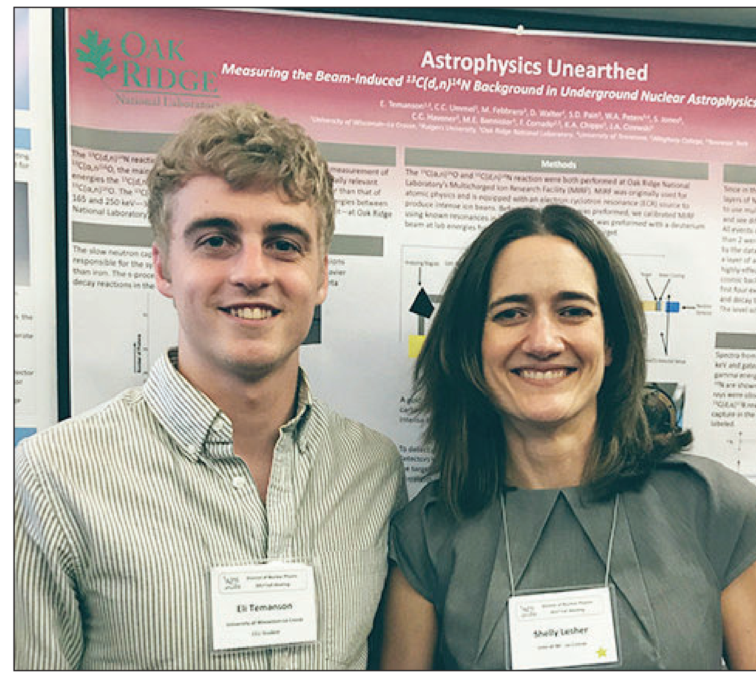
MEETINGS

A Place for Undergraduate Students in Nuclear Physics

BY LEAH POFFENBERGER

When looking around the room at an APS Division of Nuclear Physics (DNP) meeting, one might notice something out of the ordinary: A high concentration of bright, young faces, experiencing their first physics conference. This is no accident, as DNP makes a special effort to welcome undergraduate physics students and integrate them into division meetings through the Conference Experience for Undergraduates (CEUs) program.

Since its launch in 1998, the CEU program has brought hundreds of undergraduate physics students to DNP meetings and funded their entire conference experience from registration to travel, thanks in part to funds from the National Science Foundation and some of the many national labs in the US. This year, 148 students traveled to Crystal City, VA, to participate in the annual DNP meeting, receive mentoring, and present their research to the nuclear physics community.



CEU poster session at the 2017 APS Division of Nuclear Physics conference in Pittsburgh. (L-R): Student Eli Temanson with CEU director Shelly Lesher.
IMAGE: PHYSICS TODAY/AIP

The CEU program was created to fill two gaps at DNP meetings: a dearth of physics students and the absence of a poster session. Now, the CEU poster session, dedicated completely to undergraduate research, is a highlight of DNP meeting, held jointly with the APS Meet the Editors event and drawing large crowds of conference attendees.

"As far as I know, we're the only division that makes a concentrated effort to solicit and support such a large number of undergraduate students, and I think we're the only division that has a dedicated undergraduate poster session," says Shelly Lesher, Associate Professor of Physics at the University of

NUCLEAR CONTINUED ON PAGE 6

FYI: SCIENCE POLICY NEWS FROM AIP

Panel Urges NSF to Elevate Status of Materials Research

BY MITCH AMBROSE

With the US facing increasingly formidable international competition in materials research, an expert panel has proposed (go.aps.org/35u8Kon) that the National Science Foundation elevate its work in the field to the directorate level. Currently, NSF's Division of Materials Research (DMR) is one of five divisions within its Mathematical and Physical Sciences (MPS) Directorate.

The panel was one of the "committees of visitors" that NSF periodically forms to review divisions' grantmaking procedures. But given the recent publication of a materials research decadal survey (go.aps.org/37xIj30) by the National Academies, the panel opted to also comment at length on broad strategic matters, arguing the survey demonstrates a "business as usual" approach to funding the field is untenable if the US wishes to maintain a leadership role.

Presenting their conclusions at the October meeting of NSF's MPS advisory committee, the chair of the study panel, Cornell University professor Melissa Hines, stressed the intention is not to siphon funding from other divisions.

"I know I feel like I'm standing up here saying we need to secede from the union. And that's really not what I'm saying," Hines said. "We're trying to figure out how to increase funding for everyone."

Hines contrasted the trajectory of DMR's budget, which has increased by about 2.5% per year over the past two decades, with that of the materials research budget of China's National Natural Science Foundation, which has rapidly climbed close to parity with DMR. Citing a recent analysis in the journal *Nature* (go.aps.org/2D3QupF), she added that China now publishes far more materials science papers than the US.

Arguing the structure of MPS is a barrier to spurring a national focus on materials research, Hines remarked, "Just politically, there is no way that Congress is going to reach down in NSF through MPS and grab DMR and say 'you get more funding.'"

"Quite frankly, we didn't see how this would work unless we are able to articulate some big change that needed to be made," she continued. "And we thought that the idea of pulling DMR out and then having two places to fund chemistry in, two places to fund physics, two places to fund engineering, was not bad for the community either."

However, NSF officials at the meeting were cool to the idea. The head of the MPS directorate, Anne Kinney, questioned whether the division deserves special treatment, suggesting one could make "exactly the same argument" for each of the other divisions.

She continued, "What I struggle with in terms of that recommendation [is] should we split into five? Or do we do better as a group that does profound fundamental science, where there's a lot of relations between what the different parts of this group does?"

The advisory committee later raised the subject with NSF Director France Córdova, who is nearing the end of her six-year term at the agency. Córdova said she would likely revisit how the directorate is structured if she were starting over at the agency but did not offer support for the idea of spinning off DMR.

"It's really a much broader topic than just [DMR] going off on their own. It's really about how you think about science, and the science of the future," she continued. "It's not about taking them apart, but how do you bring them together in new ways."

"I hope that [DMR] stays in the fold," she later added, noting her emphasis has been on encouraging more collaboration across NSF's divisions and directorates through the "Big Idea" (go.aps.org/33cqsuV) initiatives the agency rolled out in 2016.

"We keep having to break down our silos," she said.

The author is Acting Director of FYI.

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MEETINGS

Profiles in Versatility: Diverse Careers for Nuclear Physicists

BY LEAH POFFENBERGER

Physics training can take one far in life, and for three speakers at this year's Division of Nuclear Physics meeting in Crystal City, VA, it's taken them to interesting places outside of academia. Nancy Jo Nicholas (Los Alamos National Lab), Clair J. Sullivan (GitHub), and Elaine Luria (US House of Representatives) each spoke at the meeting, describing how their training in nuclear physics prepared them for their jobs.

National Labs for Nuclear Science and Beyond

Los Alamos National Laboratory (LANL) is one of the three national-security-focused labs in the US Department of Energy lab system, along with Sandia National Laboratory and Livermore National Laboratory. LANL was created for the singular goal of building the first atomic bomb, but since its founding in 1943, it has blossomed into a vibrant scientific community, with projects beyond weapon design.

"In addition to promoting basic science and research, we do very mission-driven science, technology, and engineering," said Nicholas, Associate Director for Global Security at LANL. "Some unique scientists have come to work here for many years and it's a hybrid scientific community, but it's also a very artificial community: It's all alone in the middle of the desert."

Many of LANL's missions still revolve around national security, in the area of non-proliferation—as Nicholas said, "it takes a weapons lab to find a weapons lab." But LANL continues a rich tradition of fundamental nuclear physics research and even has a place for theoretical physicists: LANL has the only division dedicated to theoretical nuclear physics in all 17 national labs.

Nicholas was herself a graduate student when she first arrived at LANL to work on the linear accelerator (LINAC), which is where she did her thesis experiment. The trip across the country, from her home institution of George Washington University in Washington, DC, to LANL came with many firsts.

"We didn't have an accelerator, so we would get to go out to Los Alamos to work on the LINAC—that was really exciting," said Nicholas. "It was the first time I'd ever been West of the Mississippi river, the first time I ever rode in the back of a pickup truck, and I got to see a real-live tumbleweed blowing in the wind. It was an exciting place to go for the summer."

After receiving her master's degree from GWU, Nicholas opted to not pursue a PhD, thinking she would teach high school—but this was out of reach without additional training in education. Rather than immediately go back to school, she opted to return to LANL to work on the Strategic Defense Initiative (aka the Star Wars program), which was to deploy a space-based system to counter nuclear missile threats from the Soviet Union.

"I thought [the program] sounded interesting, so I went through the process of getting a security clearance, but by the time my clearance had come through, the Soviet Union had dissolved, the Star Wars program went away, and I had to come up with something new," recalled Nicholas.

Nicholas became involved with arms control projects, helping to train inspectors from the International Atomic Energy Agency who monitor nuclear facilities all over the world.

"The reason we are able to do this [training] at Los Alamos is that we have a lot of nuclear physicists who are working to develop radiation detection instrumentation, designing those instruments, building prototypes, developing algorithms, troubleshooting those detectors and deploying them out into the field," said Nicholas. "There are lots of areas where science is really focused on serving society, and even though we're a mission focused lab and our mission is national defense and national security, there are lots of opportunities to pivot the capabilities that we come up with to apply to society uses."

Dreaming Big (Data)

LANL also played a role in Clair Sullivan's career as one of the first stops on her journey from nuclear engineering to machine learning: "[Nancy Jo Nicholas] was actually my first boss," she recounted. Sullivan conducted her PhD research in nuclear engineering at LANL and worked there as a staff scientist before spending several years working for the US government. She then transitioned into a career in academia at the University of Illinois as a professor, where her research would catapult her into the world of data science and machine learning.

"The research that my group was getting involved in [at the University of Illinois] was looking at a lot of, I don't like this term, "big data"—looking at what happens when you have more data than fits into the memory of one computer," said Sullivan. "But I'm a nuclear engineer, I'm not a data scientist, I've got to learn something about data science. I got into a boot-camp and I said 'wow, I really like this.'"

Using that experience, Sullivan started her own company doing data analytics for the ski industry before ending up at the software development tech firm GitHub as a machine learning engineer. In her talk, she reflected on how this happened—partially a tendency to "go with the flow"—and why physicists are well suited to careers in data analytics.

"The first thing I will tell you is that as a physicist—a nuclear physicist, astrophysicist, whatever, fill-in-the-blank physicist, we're always learning," said Sullivan. "And sometimes we get to learn some really cool stuff.

She also cites the tendency of physicists to get excited about new science as an influence, and many people were starting to get excited about data science while she was a professor. A citizen-science-based project called SafeCast using portable detectors that could be ordered from the internet to monitor radiation levels became the first so-called big data project Sullivan worked on: A network of these detectors was generating 2 terabytes of data a day, meaning Sullivan had to learn how to manage and analyze a data avalanche.

Nancy Jo Nicholas

Clair J. Sullivan

Elaine Luria

Another factor in data science is the need for collaboration, which is something Sullivan says physicists are used to. For the radiation detection project, Sullivan's group collaborated with the geography department at the University of Illinois to extract meaningful data from the radiation detectors. To further advance her skills, she participated in a data science incubator.

"[The incubator's] job to take people with degrees in physics, chemistry, statistics, economics and turn them into data scientists in seven weeks. It was incredibly intense," said Sullivan.

Sullivan then shared advice for physicists interested in jumping to a data analysis role. She said many physicists already have some prerequisites, like math and statistical modeling skills, computer programming, and experience with technical presentations. Physicists may not, however, have experience with some of the software engineering aspects of data analysis.

"Software engineers and computer scientists that I worked with were just way more efficient at putting code into production. That's not my skill-set," said Sullivan. "These are the people you should be making friends with—they're going to show you how to do what they do."

From the Navy to Capitol Hill

The final speaker of the session has also seen her career transform from nuclear physics to something different: After retiring from 20 years of service in the Navy as a nuclear engineering officer, Elaine Luria is now a member of the US House of Representatives representing the Second District of Virginia. When Luria was elected in 2018, she was in good company: She was part of a record 102 female representatives elected. But she recalls a time when this wasn't the case, as she was the only female physics major in her class at the Naval Academy, and one of the first to enter the Naval Power program.

"As my time at the Naval Academy was ending, we could do what's called service selections where you pick what field you want to go into in either the Navy or the Marine Corps. Only recently, the Navy's nuclear program opened up to women. When I had started at the Naval Academy it had not been, but by the time I graduated, I had the opportunity to serve as a surface warfare officer and nuclear engineer," said Luria. "So what does that mean? I drove ships, I operated nuclear reactors on aircraft carriers for 20 years."

Luria's naval career took her from her first post, stationed in Japan where she was in charge of manning weapons systems, to operating eight nuclear reactors simultaneously aboard aircraft carriers. She also served as assistant to the Admiral of the Second Fleet, traveling to countries all over the world, among other posts in her two-decade-long career.

"I commanded in combat the 400 sailors and all of the amphibious landing craft on the East Coast, and all of that started out with a physics degree and going into the Navy Nuclear Power Program," said Luria. "It's a nice example of how those analytical skills that you learn through physics can translate into a future of career developments and ideas."

About a year after retiring from the Navy, Luria decided to run for Congress in Virginia. Now as a member of the House of Representatives, and one of the few with a technical degree, Luria uses her background in science to promote evidence-based policies as co-chair of a task force on climate change, and as a representative for a district bordering the Chesapeake Bay.

EDUCATION

PhysTEC Names Five Schools as Grant Recipients

BY LEAH POFFENBERGER

As the US faces a shortage of qualified high school physics teachers, the Physics Teacher Education Coalition (PhysTEC) continues to support the growth of programs across the country focused on creating physics educators. To assist in this mission, PhysTEC awards Recruiting Grants to PhysTEC member institutions to increase their recruitment, retention, and graduation rates of would-be physics teachers. This year's Recruiting Grant recipients are: St. Mary's College of Maryland; University of North Georgia; Lewis University; California State University, San Bernardino; and Bridgewater State University.

"We were very pleased with the quality of proposals that were submitted—it shows that PhysTEC's efforts to support the larger community are bearing fruit, and we are especially happy to be working with these five awardees," says Monica Plisch, Director of Programs at APS. "Each of them carefully assessed their current program for preparing teachers, and proposed initiatives that would strategically leverage the strengths of their department and institution."

Each awardee will receive $25,000 for the purpose of undergoing a two-year improvement plan to implement best practices found in the Physics Teacher Education Program Analytics (PTEPA) Rubric. This rubric arose from a PhysTEC project that studied highly successful physics teacher education programs and suggests ways that other PhysTEC institutions can improve their programs.

"Although the grant recipients are relatively small institutions, each of them has the potential to increase significantly the number of qualified physics teachers it prepares," says Plisch.

PhysTEC is a partnership between APS and the American Association of Physics Teachers, with a network of over 300 institutions dedicated to creating a new generation of qualified physics teachers. PhysTEC has provided funding to more than 40 postsecondary educational institutions across the US through the Recruiting Grants and Comprehensive Grants to improve physics teacher education.

"We really pleased to see so many proposals from Bachelor's-granting departments," says Plisch. "Collectively, these departments educate over half of the well-prepared physics teachers in the nation, and they are critical to solving the K-12 physics teacher shortage."

For more on PhysTEC visit phystec.org.

DQI CONTINUED FROM PAGE 1

Matter Physics (DCMP; see *APS News* April 2019).

DQI also boasts an especially strong connection to industry. Its members are exposed to opportunities outside of academia—particularly for graduate students and early career scientists.

The main driver in quantum information research is the advantage quantum computers may hold over classical computers. Whereas classical computers use bits (which are binary, either 1 or 0), a quantum computer uses qubits (simultaneous superpositions of states 1 and 0). Because the qubits are all connected by quantum entanglement, in principle quantum computers could outperform classical supercomputers. The general scientific consensus is that large scale quantum computers will be able to perform certain tasks exponentially faster than classical computers but will require millions of high precision physical qubits and quantum error correction. With 20-50 qubit devices currently available to researchers, Pritchett describes the field as being in the Noisy Intermediate-Scale Quantum (NISQ) era (see *APS News*, May 2019). A great deal of DQI-sponsored research focuses on demonstrating and characterizing the quantum behavior on these devices.

This issue is especially timely (and increasingly visible in the wider world of popular science) given Google's late-October claim that it had demonstrated the first experimental realization of what Caltech physicist John Preskill has called quantum supremacy (see *Nature* October 2019). Google claims that its 53-qubit quantum device performed a calculation in 3 minutes and 20 seconds that they estimate would take over 10,000 years for a classical supercomputer to complete.

According to Pritchett, herself involved in IBM's rival quantum computing work, this announcement has sparked even more enthusiasm in the field, and many researchers are now involved in verifying Google's claims. Some researchers at IBM and elsewhere have argued that the claim is exaggerated, saying that the calculation Google's quantum device performed was contrived, and that the most powerful supercomputers would take on the order of two days (as opposed to 10,000 years) to complete it. But many researchers agree that this is an important proof-of-concept that quantum computing is possible, though wider use of quantum computing outside the research setting is still years away.

Other hot topics in the quantum information field include development of quantum software and the possibility of topological quantum computers, which would encode information into a complicated state of matter analogous to the twists and turns in a braided rope.

"Even though creating topological qubits is hard and hasn't been done yet, the hope is that when you have a qubit encoded topologically you need less error correction—so fewer qubits are needed to do the same task," said Pritchett.

This excitement in the quantum information field is reflected in DQI's growing presence at the APS March Meeting. At the 2019 meeting DQI sponsored over 90 invited talks and received over 900 contributed abstracts (up about 25% from 2018). Numbers are expected to grow further for next year's March Meeting in Denver. DQI already has 18 focus sessions planned for this upcoming meeting, including quantum machine learning, quantum error correction theory, and quantum computation for networking and information security.

DQI has a great deal to offer its members, as shown by its long history of work to bolster what is now one of the most vibrant areas of physics. The division curates a productive and collaborative March Meeting experience every year, sponsors awards and fellowships to elevate researchers in the field, and hosts roundtable discussions and tutorials for early-career members to build their skills and professional networks.

DQI's executive committee also prides itself on its political advocacy for more quantum information research funding along with the APS Office of Government Affairs and other scientific societies. In December 2018 the US Congress passed the National Quantum Initiative (see *APS News*, October 2018), allocating \$1.2 billion for research into quantum information science over five years and creating a National Quantum Coordination Office at the White House Office of Science and Technology Policy.

More information about the division can be found at the DQI website: aps.org/units/dqi/.

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NUCLEAR CONTINUED FROM PAGE 4

Wisconsin-La Crosse and Director of the CEU program. "Then [the division] supports all the students that present at that poster session, which I think is pretty cool, and also says something about the commitment that our community has to undergraduates and undergraduate research."

Aside from being undergraduate-only, the CEU poster session is also distinct in that it isn't a poster competition: No awards are given out.

"I think every year someone suggests we give an award. But [nuclear physics is] a very collaborative community, and if you have a poster award that breeds competition," says Lesher. "We want our undergrads to see that our community is collaborative… they have plenty of opportunities to be competitive in the rest of their lives."

In addition to providing a space to practice presenting research at the poster session, the CEU program provides other tools to students to help get themselves established within the physics community, from mentorship to advice about grad school. Students are encouraged to attend speaker sessions at the DNP meeting, but the CEU program seeks to make sure they know how to get the most out of a professional conference.

"Students have a meeting with me [in which we discuss] how a professional conference works, what they should get out of a professional conference, why we attend professional conferences," says Lesher. "The students also each have a mentor that's assigned to them to help them navigate the conference or to answer questions about graduate school. It's a whole experience that we've developed to help them during a professional conference."

The CEU program has been hugely popular, blossoming from around 64 students in its inaugural year to 198 at the DNP meeting in 2017. Due to the large amount of interest, the CEU program has become more selective about what posters are accepted, but they have also been able to add new opportunities for students. For the first time this year, a selection of students spoke at a dedicated CEU speaker session during the DNP meeting.

According to Lesher, CEU students often pursue a variety of careers, with past students going on to become anything from researchers at national labs to professors to medical doctors—and one has gone on to be a professional poker player. However, many CEU alumni (including Lesher, who was a student during the first year of the CEU program) who stick to nuclear physics return to the DNP meeting each year to act as mentors for the next batch of undergraduate physicists.

"The CEU program has a history of populating all of physics: Many of our students will go on to earn PhDs in physics, not just in nuclear physics, but in all physics fields," says Lesher. "We have students that have gone into [atomic, molecular, and optical physics]—you'll see them everywhere in physics."

For more about the DNP CEU program visit uwlax.edu/ceu/, and see the article by Shelly Lesher, "Introducing undergraduates to the conference experience," *Physics Today* 71, 3 (2018).

CAREER CONTINUED FROM PAGE 4

membership database, which you can use to search for other members by company, government lab, and other types of affiliation—you can even narrow the search down to your state to identify local contacts. Through your institution's alumni office, you can gain access to information about what former physics graduates of that institution are doing, along with their contact information. Contacts gathered through either of these means would be a great first step in building more professional relationships. When you reach out to these individuals, be sure to mention your shared connection through APS or your institution.

You should also take advantage of professional society meetings to expand your network. Most of these meetings have built-in opportunities for attendees to meet each other (e.g. receptions, lunches, happy hours). Attend these kinds of events whenever possible, and be prepared to talk to everyone you meet about your professional goals. You will be amazed at how many opportunities you can uncover through informal conversations.

Lastly, you should take advantage of resources such as LinkedIn®. LinkedIn® is a powerful tool because it can give you access to all of your 1st degree (people you know directly) and 2nd degree (people who your 1st degree connections know) connections at a glance. Let's say you wanted to find someone in a specific company to contact for an informational interview. You could go into LinkedIn® and perform a people search, typing the company name in the "Current Company" field, and checking the 1st and 2nd degree connection boxes in the search window. Each of these search results would show you your shared connections to that person, i.e. your 1st degree connections who could provide an email introduction for you. Having that mutual contact introduce you to this new person takes the guesswork out of how to reach out—and as we've already discussed, it will also increase the likelihood that they will respond to your request for help.

Taking advantage of your professional network is the best way to learn about opportunities outside of your immediate sphere of experience. However, if all else fails, and you find yourself in a position where a cold call or email is the only option, do your research and try to contact the person who has experience most relevant to your interests—and if possible, try to offer something in return for the exchange, for example helping them to solve a technical problem or providing them with information on a topic that you have some expertise in. With patience, and through trying a variety of techniques, you should successfully be able to forge a variety of personal connections that will benefit your professional development for years to come.

1. Peter Fiske, "Putting Your Science to Work: Practical Career Strategies for Scientists," APS March Meeting 2018.

The author is Careers Program Manager at APS. This article was originally published in the APS Forum on Graduate Student Affairs newsletter. For more career resources, visit aps.org/careers.

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IGEN CONTINUED FROM PAGE 1

own commitment to act against oppression and inequity in all arenas, not just in the sciences.

Her talk echoed the main goals of the IGEN initiative and the key themes of the conference program: the importance of considering the cultural, racial, and social identities of students and employees and the need to create inclusive spaces in graduate education. Provided with a takeaway slide, attendees were able to leave the plenary with a much clearer understanding of diversity and what they can do to create change.

The conference goers were then able to attend several concurrent breakout sessions on a variety of topics. In one session, Julie Posselt and Casey Miller talked about creating more holistic review practices in graduate admissions in an effort to enable more equitable outcomes. Attendees were also able to learn how common admissions practices inhibit access for underrepresented groups.

As the program continued, there were ample opportunities for networking among students, leaders in graduate education, and those committed to diversity. Undergraduate and graduate students participated in a poster session that yielded one first-place winner and two second-place winners. All three awards went to students from the APS Bridge Program, the Society's effort to increase the number of physics PhDs awarded to underrepresented minority students.

The graduate student panel, led by UCF graduate student and Bridge Program Fellow Brian Zamarripa Roman, provided the opportunity for panelists to share real-life perspectives and lessons learned. The panelists—some currently in graduate programs and others recently graduated—provided tips for other students such as practicing humility, balancing work and self-care, and being prepared to network. It was a timely message, as the program transitioned into the networking portion of the afternoon.

During the networking fair, the room swirled with a harmony of voices engaging in thoughtful conversation, seeking knowledge about employment opportunities, and creating connection over shared interests. Attendees were able to find out more information about national labs, industry leaders, educational institutions, and IGEN professional societies such as the American Chemical Society, the American Geophysical Union, and APS.

Sunday, the final day of the conference, found attendees filled with plenty of knowledge from the day before but still seeking more. APS Education and Diversity Programs Manager Erika Brown provided tools for building self-confidence and using this confidence to address imposter syndrome in oneself and in others. Her workshop ended with a reminder of value and an encouragement to attendees: "You belong here, I belong here, we all belong here."

As the conference came to a close, Hodapp thanked everyone for their attendance and for making the meeting a success. He left all with the reminder that IGEN is about making personal connections through relationships. Those relationships cause us to be better students, educators, champions for diversity, and most of all, better people.

For more information about the Inclusive Graduate Education Network, please visit igenetwork.org.

The author is Senior Coordinator and the Bridge Program Manager at APS.

AFRICA CONTINUED FROM PAGE 1

from nine to fifteen. Five of the recent six have also united to form the West African Physical Society. The Abdus Salam International Centre for Theoretical Physics (ICTP) opened its first institute in Africa, the East African Institute for Fundamental Physics in Rwanda.

However, large communication gaps often exist among physicists within a nation, between nations, and between African and non-African physics communities. For example, of the 15 African physical societies, it appears that only two regularly publish a newsletter. Bridging these gaps by reporting on events such as those mentioned above was a motivation for starting the newsletter.

A number of published articles have been noteworthy. An article by Sekazi Mtingwa (Chair of the Commission on Development of the International Union of Pure and Applied Physics) entitled "Physics on the Move in Africa" highlights how over the past twenty years the groundwork was laid for new organizations, collaborations, and large infrastructure projects. Cairo University celebrated the Silver Jubilee of the National Institute of Laser Enhanced Science (NILES). Physicists in Tanzania reported on a successful program for high school girls that improved the performance of STEM training at the university. Reported in the soon to be distributed December issue is an announcement of the Portuguese-speaking countries forming a physics union.

Perhaps the most interdisciplinary article appeared in the May issue and described how mass accelerator spectrometry is being used to determine the age and study the causes of the recent deaths of several baobab trees, the Trees of Life, that are native to African Savannahs and can live for millennia. In addition, there have been numerous reports and announcements of various schools, awards, workshops, and conferences, and several articles have described notable physics. For example, one article reported how the MeerKAT, the radio observatory that is the first phase of the Square Kilometre Array telescope in Africa, was used to search for the puzzling, missing hydrogen gas in the NGC1316 galaxy. The puzzle was solved: The vast majority of the neutral hydrogen is not in the center of the galaxy but is largely in two tail-like complexes north and south of the galaxy.

With each issue, the newsletter news sources have become more diversified and inclusive. The editorial board now has at least one editor representing each of the North, South, East, West, and Central regions of Africa, and a network of contacts (news reporters) is being established. With articles such as the one you are reading now, the newsletter is also reaching out to others, particularly to those in the African diaspora, to become readers and contributors.

The newsletter is a quarterly email. Subscriptions are free and open to all. To subscribe, simply go to go.aps.org/africanphysics. The coming December issue also has information on how to contribute news articles. Whether you are from Africa or just interested in African physics, we encourage you to subscribe and emphasize that by reading, and especially by contributing, you will be strengthening the voice of physics in Africa.

The author is a computational physicist at Los Alamos National Laboratory, a member of the APS Committee on International Scientific Affairs, and an APS Fellow.

VISA CONTINUED FROM PAGE 1

have been historically shown to hinder science."

Added Jason Gardner, chair of FECS, "if international students are turned off or turned away during the visa application process, we are only hurting our industries of the future."

Raju P. Ghimire, FGSA's secretary, explained that when students earn their degrees in the United States and then are forced to take their talents and skills back to another country, it hurts the US innovation pipeline.

The survey probed ways to reverse the downward trend in applications and to have a significant impact on international students' decisions. Of the respondents who indicated they do not anticipate being able to obtain a green card or permanent residency to stay in the US:

- 85% say that it is more likely that they will apply to a school if the country it is in provides options to stay and work after graduation

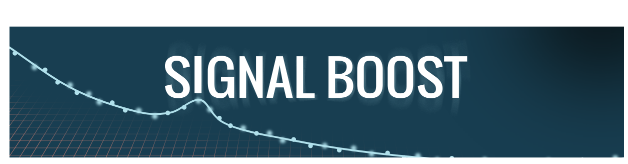
While no one action can overcome all the challenges, *the surveys indicate that two policy responses can have an immediate and substantial impact*:

- Allow students applying for an F-1 visa to indicate they would like to stay in the US after receiving their advanced degree
- Provide students a path to a green card upon earning an advanced degree from a US institution

The APS Office of Government Affairs, with support from APS members, is working diligently to address the decline in applications by supporting the Keep STEM Talent Act of 2019. The legislation would enable highly skilled international students to declare their intent to both study at US universities, and then, after graduation, pursue a career in the US, with a path to a green card if they secure job offers from US employers.

"We are committed to getting more congressional support for this legislation through a variety of advocacy initiatives. We understand that our nation's ability to thrive in an increasingly competitive world rests on our ability to invest in our highly talented domestic students and to attract the best and brightest international students to our universities," said Francis Slakey, APS Chief Government Affairs Officer.

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



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.**

QUBIT CONTINUED FROM PAGE 3

how quickly the qubits are able to interact—and entanglement fidelity, the stability of the qubit interaction.

"In 2015...we actually got three world records in one experiment: We got the largest distance between two entangled qubits, the entanglement fidelity was the highest anyone had seen," said Hanson. "But we also got the slowest entangling that anyone had ever done, and that's not a good record to have."

Since then, QuTech has been able to increase entanglement speed, leading to higher quantum link efficiency—a term that describes the speed of entanglement happening versus its fidelity—which is a crucial step in creating multi-node networks. QuTech has also made strides towards transmitting entanglement-mediating photons over longer distances by changing their wavelengths.

"We have seen quite some progress in the past years. We can now generate entanglement faster than we lose it, and we have a way of connecting through to the telecom [infrastructure]. And that brings us through the goals for next year: The first goal will be to actually create the first multi-node network. The second goal is to make entanglement between Delft and The Hague—it will be for us the first test case of creating entanglement outside the university," said Hanson. "Maybe in the long run, we can look back at this time, the experiments that we and other people are doing, and talk about it the same way as we talked about 1969: That these were all crucial steps towards the global quantum internet that we're all enjoying."

Further Reading

S. Wehner, D. Elkouss, and R. Hanson, "Quantum internet: A vision for the road ahead," *Science* 362, 303 (2018).

THE BACK PAGE

A Growth Mindset Levels the Playing Field

BY CHANDRALEKHA SINGH

When students struggle to solve challenging physics problems, they often respond in one of two ways. Some question whether they have what is needed to excel in physics. Others enjoy the struggle because it means that they are tackling new physics and learning. The negative reaction is a manifestation of a fixed mindset (i.e., believing that intelligence is immutable and struggling is a reflection of a lack of intelligence), whereas the positive reaction is the sign of a growth mindset (the fact that your brain's capabilities can grow with deliberate effort and you can become an expert in a field by working hard) [1].

Unfortunately, societal stereotypes [2] can have a detrimental psychological impact on women and ethnic and racial minority students who are severely underrepresented in physics [3-13]. They are more likely than majority students to fall prey to the fixed mindset trap and view their struggle with challenging physics problems in a negative light. This is not surprising because compared to any other STEM field, the societal stereotypes are the strongest in physics, a field whose history is often told through the stories of brilliant men. These stereotypes contribute to a lower sense of belonging for women and racial and ethnic minority students in physics learning environments [3-13].

To help players excel in any game, such as tennis, coaches must ensure both good defense and offense. Likewise, helping students learn physics well requires that instructors equip all students with both defensive and offensive strategies. In particular, instructors should consider strengthening students' defenses by creating learning environments where all students have a high sense of belonging, promoting and emphasizing a growth mindset, and ensuring that all students have the internal drive to excel in physics. Only if students have strong defenses pertaining to physics learning can they effectively engage with the offense, that is, by tackling challenging problems and developing physics problem solving, reasoning, and meta-cognitive skills.

The challenges of becoming a physicist can be overcome with a mindset like that of tennis star Naomi Osaka, who said she would fall on her "face 18 million times and [get] up 18 million times." IMAGE: WIKIMEDIA COMMONS

Students with weak defenses are unlikely to risk struggling with challenging physics problems. Without strong defenses, tackling challenging physics problems can collapse a student's "wavefunction" into a state in which the outcome is negative and the student thinks: "I am struggling because I do not have what it takes to do well in physics. What is the point of even trying?" These kinds of negative thoughts can lead to a lack of engagement, even with effective approaches to learning physics, and can increase students' anxiety.

This, in turn, can start a detrimental feedback loop in which negative thoughts about struggling lead to increased anxiety, procrastination, disengagement from effective learning approaches, and failure to take advantage of resources for learning. Moreover, anxiety robs students of the cognitive resources while taking tests. Performance deteriorates, which can then lead to further negative thoughts and anxiety. Having been bombarded by societal stereotypes and biases from a young age [2], women and ethnic and racial minority students are less likely than majority students to have strong defenses when they enter physics classes. Therefore, if the instructor does not make a concerted effort to bolster student defenses and inoculate students against stereotype threats (i.e., fear of confirming a negative stereotype about one's group), the situation is more likely to hurt women and minority students [2].

Fortunately, instructors and advisors can empower students and reinforce their defenses by creating an inclusive and equitable learning environment. With proper coaching, all students can have a high sense of belonging, be unafraid to struggle and fail, and use their failures as stepping stones to learning [14-16]. Although physics instructors have traditionally not considered it to be their responsibility to serve as coaches for their students, these issues are central for equity and inclusion in physics. Moreover, short classroom activities that take less than a class period at the beginning of the course can go a long way in improving students' sense of belonging and confidence, particularly for those who need it the most [14-16].

We implemented a short intervention that shows great promise toward these goals [14]. Implementation could hardly be simpler, and only requires half of a single recitation class period at the beginning of the semester. Our exercise was conducted in a required introductory calculus-based physics course, which is taken by physical science and engineering majors typically in their first year first semester in college. Two female physics graduate students were trained to facilitate the half-hour activity at the beginning of the semester in half of the recitations that were randomly selected. The facilitators introduced it as an activity that would help the physics department understand student concerns and how to foster better learning environments.

At the beginning of the first recitation class in which the activity took place, students were handed a piece of paper and asked to write down their concerns about being in the physics course. Then they were shown some quotations from both male and female students from previous years who did very well in physics but also had similar concerns. The quotes emphasized the importance of working hard and working smart, learning from one's mistakes, and taking advantage of all of the learning resources, because that is the way to perform well in physics.

Then students were asked to get together in small groups to discuss what they wrote; during this session, they generally learned their peers in the class had similar worries. A general class discussion followed in which the groups summarized their discussions, with explicit emphasis on the fact that adversity is common in college physics courses, but it is temporary. The facilitators re-emphasized that students should embrace challenging physics problems and use their failures as bridges to learning. Finally, using the principle of "saying is believing" [15], students were asked to write a short letter telling a future student about strategies for excelling in their physics class.

What is heartening is that this short intervention fully closed the gender gap in performance compared to the group in which this short intervention did not take place [14]. A student's sense of belonging and motivation are strongly intertwined with cognitive engagement and learning [1,2].

Such a mindset is exemplified by tennis player Naomi Osaka who, just after winning the US Open in 2019, proclaimed on Twitter that she might "fall on my face 18 million times and I'm gonna get up 18 million times. Just wanted to say I'm probably gonna fall down a couple dozen times in the future but hey, the kid is resilient."

Without improving students' defenses, it is impossible for them to use their cognitive resources appropriately and excel in physics. Physics instructors should consider activities similar to the one we implemented [14] that strive to create classrooms that are inclusive and equitable and give all students an opportunity to develop a solid grasp of physics. Last but not least, it is important to remember that the authenticity and credibility of the facilitator of the activity (e.g., instructor or teaching assistant) is extremely important for students to trust the message underlying the activity and benefit from it.

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References

1 C. Dweck, *Mindset: The New Psychology of Success* (Random House Inc., New York, 2006).

2 C. Steele and J. Aronson, "Stereotype threat and the intellectual test performance of African Americans," *Attitudes and Social Cognition* **69**, 797 (1995).

3 M. Lorenzo, C. Crouch, and E. Mazur, "Reducing the gender gap in the physics classroom," *Am. J. Phys.* **74**, 118 (2006).

4 Z. Hazari, R. Tai, and P. Sadler, "Gender differences in introductory university physics performance: The influence of high school physics preparation and affective factors," *Sci. Educ.* **91**, 847 (2007).

5 V. Sawtelle, E. Brewe and L. Kramer, "Exploring the relationship between self-efficacy and retention in introductory physics," *J. Res. Sci. Teach.* **49**, 1096 (2012).

6 A. Traxler, X. Cid, J. Blue, and R. Barthelemy, "Enriching gender in physics education research: A binary past and a complex future," *Phys. Rev. PER* **12**, 020114 (2016).

7 J. Nissen and J. Shemwell, "Gender, experience, and self-efficacy in introductory physics," *Phys. Rev. PER* **12,** 020105 (2016).

8 E. Marshman, Z. Y. Kalender, C. Schunn, T. Nokes-Malach, and C. Singh, "A longitudinal analysis of students' motivational characteristics in introductory physics courses: Gender differences," *Can. J. Phys.* **96**, 391 (2017).

9 E. Marshman, Z. Y. Kalender, T. Nokes-Malach, C. Schunn, and C. Singh, "Female students with A's have similar self-efficacy as male students with C's in introductory courses: A cause for alarm?," *Phys. Rev. PER* **14**, 020123 (2018).

10 N. Karim, A. Maries, and C. Singh, "Do evidence-based active-engagement courses reduce the gender gap in introductory physics?," *Eur. J. Phys.* **39**, 025701 (2018).

11 A. Maries, N. Karim, and C. Singh, "Is agreeing with a gender stereotype correlated with the performance of female students in introductory physics?," *Phys. Rev. PER* **14**, 020119 (2018).

12 M. Good, A. Maries, and C. Singh, "Impact of traditional or evidence-based active-engagement instruction on introductory female and male students' attitudes and approaches to physics problem solving," *Phys. Rev. PER* **15**, 020119 (2019).

13 Z. Y. Kalender, E. Marshman, C. Schunn, T. Nokes-Malach and C. Singh, "Gendered patterns in the construction of physics identity from motivational factors," *Phys. Rev. PER* **15**, 020119 (2019).

14 K. Binning et al., "Changing social norms to foster the benefits of collaboration in diverse workgroups," unpublished manuscript, on the web at d-scholarship.pitt.edu/36006/.

15 D. Yeager and G. Walton, "Social-psychological interventions in education: They're not magic," *Rev. Educ. Res.* **81**, 267 (2011).

16 L. Aguilar, G. Walton, and C. Wieman, "Psychological insights for improved physics teaching," *Phys. Today* **67**, 43 (2014).

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