IGEN takes the APS Bridge Program to the Next Level
By Leah Poffenberger
APS has joined forces with four other scientific societies—the American Chemical Society, the American Geophysical Union, the American Astronomical Society, and the Materials Research Society—to increase participation of underrepresented students in graduate physical science programs. The five societies make up the Inclusive Graduate Education Network (IGEN) that will be funded with a five-year $10 million grant from the National Science Foundation.

By supporting more underrepresented racial and ethnic minorities in graduate school, IGEN will build on foundations laid by the APS Bridge Program. For the past six years, the APS Bridge Program has been testing and implementating ways to eliminate a participatory gap between undergraduate and graduate students in physics from underrepresented groups. The lessons learned through the APS Bridge Program student Michelle Loile at Indiana University in 2016. APS Bridge Program will now be more broadly applied to other science, technology, engineering, and mathematics (STEM) fields through IGEN.

When we started the APS Bridge Program six years ago, we had no idea how much community support would materialize,” said Theodore Hodapp, IGEN Project Lead and Director of Project Management.

PHYSICAL REVIEW
covering particles, fields, gravitation, and cosmology

Physics at the Shortest and Longest Scales
By Urs Heller and Erick Weinstein
The first issue of The Physical Review, with five articles, appeared in July 1893. Over time the journal grew in both size and stature, becoming the world’s leading physics journal. In 1970, moti-vated by the continued growth, the single all-encompassing journal was divided into a family of four journals, Physical Review A, B, C, and D, with the shared title denoting a pledge to maintain the standards for which The Physical Review had become known.

Physical Review D (PRD) was to cover physics at the shortest—sub-nuclear—and the longest—cos-mological—distances and timescales. The close connections between these two regimes were perhaps not as well appreciated in 1970 as they are today. The journal was divided into two parts. D1, focusing on the more experimental and experimentally-oriented theory papers, appeared on the first of the month, while D5, containing articles on more formal theoretical topics, was published on the fifteenth. Today articles are published online as soon as they are ready, rather than in semi-monthly batches, but the designations D1 and D5 remain.

The early years of PRD coincided with the development and acceptance of the Standard Model of particle physics. Indeed, in its first year one of the journal’s most cited articles, the Glashow, Iliopoulos, and Maiani (GIM) paper on the fourth quark and the GIM mechanism appeared. Another top-cited paper, “Confirmation of Quarks” by Kenneth Wilson was published four years later.

In those years the journal was almost entirely devoted to particle physics. In the first two issues of 1970 only two articles, out of 95, were concerned with gravitation, cosmology, or astrophysical physics. By comparison, 40% of the papers published in PRD in 2017 were devoted to these subfields. A notable precursor, Bekenstein’s “Black Holes and Entropy,” appeared in 1973. Eight years later Guth’s paper on the inflationary universe, PRD’s all-time most

Parker Probe En Route to Solar Rendezvous
By Amanda Babcock
On August 12, 2018 NASA’s Parker Solar Probe blasted off on its seven-year journey to observe the Sun. The spacecraft is named after 2018 APS Medal recipient and APS Fellow Eugene Parker. Parker’s name is familiar to APS members and plasma physicists alike. In addition to receiving this year’s APS Medal for Exceptional Research, he received the 2003 APS James Clerk Maxwell Prize for Plasma Physics and the 1989 National Medal of Science. His lifelong work in solar physics, especially his theoretical hypoth-eesis for the superheating of the solar corona, led to his recognition by NASA.

When asked about his reaction to getting a phone call about the honor, the first time a NASA mis-sion has been named after a living person, Parker expressed surprise at the decision. “The call ended, and I sat there staring at the wall, beginning to feel what had transpired,” he said.

At a later date, the news began to sink in. “I felt immensely flattered, particularly so after two decades of retirement,” Parker said.

Quantum Information Science in the National Spotlight
By Leah Poffenberger
Quantum information research has become a hot topic in physics circles, but physicists aren’t the only ones to see its potential. Recent movements to prioritize research into quantum technologies by international players, like China, Europe, and Canada, has spurred a response from US lawmakers in the form of the National Quantum Initiative Act (NQI). The House and the Senate have recently introduced bills to create the NQI, a 10-year commitment to advancing quantum information research in the United States. Putting such a long-term program onto the front burner comes with a hefty price tag for developing experimental technology into powerful tools that can impact the economy, industry, and national security.

Quantum information research has already become a top priority for government agencies like the US Department of Energy and the National Science Foundation, but the passage of NQI will continue to emphasize the importance of these new technologies. In September, the House of Representa-tives passed their version of the bill—a version that has been heavily influenced by grassroots efforts by stakeholders from academia and industry.

The initial draft NQI bill established the framework, but without providing any additional funding—all funds would come at the expense of other research programs. Improvements to the bill that restore new funding have since been made, thanks to efforts of the quantum science community through the National Photonics Initiative, the Optical Society, SPIE, and APS.

For its part, the APS approach involved direct member grassroots interaction with Congress. “A lot of our work and a lot of our success comes from working with APS members in order to change this bill,” says Francis Slakey, APS Chief Government Affairs Officer. “In this case, it was two APS members who walked into offices in their states and asked direct ques-tions to get the language that we wanted included in the bill.”

Several scientific organizations have been urging the US govern-ment to embrace quantum tech-nology. But why devote so many resources to a new type of comput-ing instead of using resources to keep up our classical computational capabilities?

“Quantum computing is often misconstrued as being just the next generation of computers that we use, but it’s more fundamental than that,” says Christopher Monroe, co-founder of IonQ, a quantum computing start-up company. Monroe is also a professor at the University of Maryland, part of a community which he says has more people doing quantum research than anywhere else in the coun-try. “Quantum computers offer the potential for solving problems, that are not only harder than what we can currently do, but problems that could never be solved otherwise.”

The kinds of problems that could be solved with quantum information processing tend to deal with a large number of configura-tions—so large that traditional computers don’t have the capacity to process them—like factoring a very large number or searching a huge database. Increased comput-ing power afforded by quantum mechanics comes from quantum bits—the qubits. Regular bits—the fundamental processing units of computers—can only exist in one state at a time, either as a zero or a one, in order to represent numbers. Qubits, on the other hand, can exist as both zero and one at the same time, a condition known as superposition.

“There is what people stay up late at night thinking about: What does it mean to be in two states at the same time?” says Monroe. This question is difficult to answer thanks to another quantum quirk: the system only works as long as
Small Box, Big Physics: Putting Together PhysicsQuest

By Leah Poffenberger

Every year at the end of August, a small army of high school students descends on the headquarters of Educational Innovations Inc. (EI) in Bethel, Connecticut for a box-packing extravaganza. Over three days, 20,000 cardboard containers are assembled, crammed with experimental mate-
rials, and labeled, and shipped out to middle schools across the country. Thanks to the expertise of EI, the packing party runs like a well-oiled machine, but coming up with what goes inside the boxes takes some trial and error.

Creating innovative physics demonstration kits for under $20 to send to 20,000 physics classrooms is no easy feat. Thankfully, the dynamic duo of EI’s Ted Beyer and APS Head of Outreach Rebecca Thompson have the process down to a science.

For 13 years, Thompson and Beyer have been collaborating on PhysicsQuest, the APS program that sends educational materials to middle school classrooms to inspire engagement in physics. Each activ-
ity that goes in a PhysicsQuest kit demonstrates a concept found in the accompanying Spectra comic books, which are written by Thompson, and make use of fairly easy to find parts. Beyer’s specialty is finding the right stuff at the best price.

“There’s usually a normal set of classroom activities that you can find—experiments everyone will talk about and everybody will see,” says Thompson. “You can’t find the activities in PhysicsQuest kits anywhere else—these are all from scratch. It’s taking an idea, some experiments people have done before, some classroom activi-
ties and totally redesigning them in a way that makes them cheaper, or more accessible or maybe way more instructive.”

To create these out-of-the-

ordinary classroom activities, Thompson takes classroom concepts likediffraction or conduc-
tivity and comes up with ideas for experiments mostly using common things like wires or straws. Then it’s up to Beyer to find the mate-
rials at the best price, propose a better alternative, or sometimes send Thompson back to the draw-
ning board.

 “[Thompson] used to call me up and say ‘I want, or I need, or KITS continued on page 4

This Month in Physics History

October 2006: Definitive Discovery of Element 118 Announced

At the turn of the last century, physicists dis-
covered the process of nuclear transmutation, whereby one chemical element can be converted into another, or decaying decay chain. Ernest Rutherford and Frederick Soddy found that the radioactive thorium they kept in the lab spontaneously decayed into radium. Soddy proclaimed they had discovered transmutation. “For Christ’s sake, Soddy,” Rutherford purportedly snapped in reply. “They’ll have our heads off as alchemists.”

By 1919, Rutherford successfully converted nitrogen into oxygen with this process. And in 1957, physicists figured out that heavier elements were created in the final throes of supernovae. When the age of particle accelerators dawned, physicists realized they could be used to create even heavier elements.

Lawrence Berkeley National Laboratory (LBNL) helped pioneer the field of superheavy elements, creating berkelium, californium, lawren-
cium, and seaborgium in its cyclotron. By the early 1990s, the Gesellschaft für Schwerionenforschung (GSI) Laboratory in Darmstadt, Germany, was dominating the discoveries, creating bismuth, hassium, and meitnerium, along with the as-yet-unnamed elements 110, 111, and 112. Not to be outdone, Russian scientists at the Joint Institute for Nuclear Research (JINR) in Dubna, headed by Yuri Oganessian, created element 114 in 1998. So LBNL scientists were keen to re-establish their leadership role, and were confident they could find the elusive element 118 with a new gas separator detection device.

In 1999, LBNL scientists spent five days bombarding a lead target with a beam of krypton nuclei. The debris passed through the separator where detectors could record the energy, position, and trajectory of each particle. All the raw data was processed by LBNL team member Victor Ninov who was originally trained at GSI. He looked for evidence of a decay pattern consistent with krypton. LBNL and lead fusing the particle to a nucleus of element 118. Ninov found not one, but three such events. Two weeks later, after a second run, he found five more events.

The published their results in Physical Review Letters. The next step was to confirm the discovery by reproducing it in other cyclotrons. GSI scientists tried and failed to do so that summer; scientists at the Riken Institute in Japan were also unable to reproduce the result. When LBNL scientists tried to replicate their own experiment in 2000, they couldn’t do it either. An independent review com-
mittee was able to rule out the most likely sources of experimental error, and the team spent much of the year upgrading their detectors.

In 2001, they made another run, and once again Ninov claimed to have found evidence of the 118 decay chain, but nobody else on the team could find it in the data. Nor could a second review commit-
tee find the pattern in the original raw data from 1999. At that point, LBNL submitted a retraction to Physical Review Letters. When the researchers reviewed the analysis software log files for the 2001 data run, initially it seemed to show the decay chain. But a second analysis of events logged just a few hours later in the run showed no such pattern. Initially given was changed. Some people had cut and pasted lines from elsewhere in the data and changed a few numbers. The 1999 records also showed similar tampering for one of the three reported events.

LBNL determined that Ninov was the most likely culprit, since he had responsibility for trans-

lating the raw data into readable results. And his computer account was used to access the files. Ninov vehemently denied any wrongdoing, but he was fired from the lab. His former colleagues expressed bafflement as to his motives. The review committee also censured the rest of the group for its lack of vigilance.

Nuclear physicists at JINR in Dubna led by Oganessian, along with colleagues from Lawrence Livermore National Laboratory (LNLN) continued the hunt for element 118. After additional experi-
ments in 2002 and 2005, they found three more signature decay patterns. This time no one person was responsible for the data analysis, and the find-

ings passed rigorous scrutiny. Finally, on October 9, 2006, JINR and LNLN officially announced they had definitely discovered the elusive element.

By 2006, the International Union of Pure and Applied Chemistry officially named it “oganesson,” after Oganessian. “For me it was an honor,” Oganessian later commented, in no small part because the suggestion had come from his colleagues at LNLN.
Applications to U.S. Physics PhD Programs

APS Addresses Decline in International Student Applications to U.S. Physics PhD Programs

By Twanada W. Johnson

In the wake of a decline in applications from international students to physics PhD programs in the United States, APS leadership recently met with congressional staff on Capitol Hill as part of a larger effort to reverse the trend.

"Physics students want to come to the United States from all over the world because they know their educational and career opportunities here will be extraordinary," said APS President Roger Falcone. "Our country’s research in physics, technology, and economy have been enormously strengthened by a positive attitude toward such immigration of students. We should continue to be a welcoming place, and to embrace open and global mobility for all departments.

Added Francis Slakey, Chief Government Affairs Officer in the APS Office of Government Affairs (OGA): "The US is at high risk of no longer attracting the best and brightest minds in physics."

During the 2018 APS March Meeting in March, APS leaders and members informed APS OGA that their physics departments had experienced lower applications in the number of applications from non-US-based students to their respective PhD physics programs between 2017 and 2018.

To help inform the Society's response, APS OGA worked with department chairs of US physics PhD programs that reported graduating 10 or more students per year to gather data concerning the number of international student applicants. A total of 74 department chairs were contacted, and 49 responded to the inquiry.

Among the questions asked to the survey represent 40% of all international physics graduate students enrolled in the US. Approximately 40% of all physics graduate students enrolled in the US were at one of the 49 respondent departments.

According to the data collected in the report, there was an overall decrease of almost 12% in the number of international applicants to the physics PhD programs that responded to the survey.

Although some institutions did not see a decline in their international applications, there were a handful of programs that experienced increases of more than 40%.

Among the questions asked in the study were: "How has the general decline in applications impacted your 2018 cohort?" "Has the overall class size changed?"

And "Did you accept more domestic students?"

The replies, which were reportedly anony mously to protect the integrity of the PhD physics programs, included the following:

"I've admitted more domestic students, so as to fill our program."

On the other hand, many of the bet ween applicants in the past were inter national students, so our sense is that the overall quality of the applicants we admitted this year was somewhat lower than in the past."

Respondents were also asked, "Could you comment on what countries had the largest declines in terms of applicants, from 2017 to 2018?" For schools reporting their Chinese applicant numbers, the average decline was 16.4%.

Some department chairs speculated about the possible reasons for the decrease. "There is speculation among the faculty, but it is not necessarily evidence based: That Chinese institutions have arrived in terms of quality, meaning many Chinese students prefer to stay home rather than go to the US for graduate study," replied one department chair.

Another department chair stated, "Anecdotal evidence and rumors suggest that China has been investing heavily in training young scientists, particularly in the area of condensed matter physics, and so many talented students may be choosing to stay at home for their postgraduate studies rather than go abroad..."

To address these concerns, APS OGA is implementing a strategy that entails making the F-1 visa— the standard method international students use to enter the US to study at colleges and universities—a "dual intent." Under current law, international students have to prove that they will return to their countries after they have been educated in the United States. That can be an extremely high burden of proof for students who may have to demonstrate that they have a spouse, a child, an ill relative, or property to care for back home.

With an F-1 "dual-intent" visa, students would no longer be required to provide proof that they are only in the United States temporarily and have the ability to declare that they plan to live and work in the United States permanently, giving them a smoother pathway to a science, technology, engineering, and mathematics (STEM) visa in the US.

Historically, the United States DECLINE continued on page 7

The goal of Spectrum hits close to home with Snider, who has faced her own challenges. "I've thought about leaving at various points, and I certainly did consider the possibility that I might need to leave as a result of coming out as transgender," Snider says. "At the moment that you decide to do this, make the social transition, you have to accept that you could lose everything. That’s a possible outcome."

Still, Snider speaks optimistically about her coming out and the reception she got from her colleagues at Fermilab. "When I started that exploration in the workplace, you know, I found the world did not collapse," she says with surprise in her voice. "I enjoy the science, I enjoy the work and I enjoyed the laboratory environment and I like being at Fermilab. So, once I discovered that nobody here seems to care all that much about my coming out, then it made it much easier to decide [to stay in physics]."

Snider describes the pictures on the walls throughout the lab of scientists conducting experiments at Fermilab. "All of that imagery reflects the culture. Not just the culture that we have, but the culture that we want to have here," she says, reflecting on the diversity of the people in those images. "The type of people who should think of themselves in these roles as scientists and technitians."

Last year, Fermilab debuted a Pride flag in the atrium of its main building alongside the flags representing the many countries and cultures that participate in research at the lab. "I thought it was really important that the laboratory be visibly welcoming to the [LGBT+] community," Snider says of the addition. "You can’t tell when you were there was little to no machine learning in astronomy," he describes. "There was the romantic view of astronomy, that you look through the telescope and decide what to do next. We were one of the first groups to figure out what the human-driven work flows around the data."

Soon he wanted to build systems that not only collected and analyzed data but also provided insight and suggested actions for smart decision-making. He was surprised to learn that this need was not being fulfilled by existing companies. IOT continued on page 7

The Industrial Internet of Things is Upon Us

By Alaina G. Levine

In manufacturing, oil refining, and other industries around the world, a new approach to solving problems and leveraging data is changing the way we make business decisions. The Industrial Internet of Things (IIoT) combines smart gadgets and data collection on grand scales. You’ve heard of smart refrigerators, smart cars, and smart homes—now imagine a smart power plant, where hundreds of thousands of sensors take data across the entire system, and software, driven by machine learning (ML) and artificial intelligence (AI), provides intelligent information to workers, allowing them to make the right operating choices.

This is the realm of Josh Bloom, a physics professor at the University of California, Berkeley, who also serves as vice president of data and analytics at GE Digital. The former astronomist started his career examining gamma-ray bursts, the brightest explosions in the cosmos. But when he realized that an explosion of astro data was imminent, he gravitated toward data science. The problems he was trying to solve in understanding the origin of the universe had relevance for industry as well.

As a new faculty member in Berkeley’s astronomy department in 2005, Bloom started thinking about how to make good use of all of the data he expected in the coming decade,” he recalls. He was quick to realize, and in the practice of physics, he enjoys the work and I call the science, I enjoy the work and I enjoyed the laboratory environment and I like being at Fermilab. So, once I discovered that nobody here seems to care all that much about

Out in Physics: Gaining Visibility and Acceptance

By Amanda Babcock

Scientists around the world participated in the first International LGBT STEM Day on July 5, 2018 to promote the visibility and acceptance of LGBT+ individuals in STEM fields. Acceptance, in turn, directly impacts retention of LGBT+ physics students and professionals of all levels. From the undergraduate level to established physicists, acceptance and retention affect everyone, including Erica Snider, a staff physicist at Fermi National Accelerator Laboratory (Fermilab); Kerstin Nordstrom, an assistant professor of physics at Mount Holyoke College; and Ansel Neuzaert, a graduate student in physics at the University of Michigan.

Snider works with Spectrum, a resource group at Fermilab aimed at fostering a welcoming environment for the LGBT+ community. The goal of Spectrum hits close to home with Snider, who has faced her own challenges. "I’ve thought about leaving at various points, and I certainly did consider the possibility that I might need to leave as a result of coming out as transgenders," Snider says. "At the moment that you decide to do this, make the social transition, you have to accept that you could lose everything. That’s a possible outcome."

Still, Snider speaks optimistically about her coming out and the reception she got from her colleagues at Fermilab. "When I started that exploration in the workplace, you know, I found the world did not collapse," she says with surprise in her voice. "I enjoy the science, I enjoy the work and I enjoyed the laboratory environment and I like being at Fermilab. So, once I discovered that nobody here seems to care all that much about

Profiles in Versatility

Josh Bloom moved from astrophysics to working on artificial intelligence and machine learning.
As a follow-on to its recent assessment of greenhouse gas (GHG) emissions, APS is taking steps to address the impact of the emissions from its largest GHG sources, including emissions from member travel to and from select APS national and annual meetings. “APS has demonstrated its commitment to addressing climate change through this critically important assessment of the Society’s carbon footprint. Moreover, the Society isn’t just talking, but is moving quickly on five fronts by embracing solutions to climate change—one of the most pressing issues of our time,” said William Collins, Director for the Climate and Ecosystem Sciences Division at Lawrence Berkeley National Laboratory. “APS serves as a member of the APS Panel on Public Affairs (POPA) and participates in the new Climate APS initiative.”

In 2016, after issuing its Statement on Earth’s Changing Climate, APS conducted a GHG inventory of its daily operations and select associated activities. The first portion of the assessment focused on two emission categories: Scope 1 (direct emissions from APS-owned sources) and Scope 2 (indirect emissions from purchased energy). An independent firm audited the results, which were publicly posted online, making APS the first scientific society in the United States to broadly assess and publish its emissions.

The GHG Inventory Advisory Committee, overseen by the POPA, manages the inventory project. Additionally, APS selected Anthesis—a global specialist in sustainability and climate change initiative development—to support the committee and assist the Society in determining its inaugural carbon footprint.

APS previously released results from Scopes 1 and 2 last year. Scope 3 results have now been released and include emissions from member travel to and from six of the largest APS national and annual meetings. Since these meetings are nearly 15 times larger than those of the Society’s daily operations. Given the GHG impact of APS’s Scope 3 activities, the advisory committee offered a list of recommendations for mitigation. APS is already acting on a number of these recommendations.

“Although there is no way to make air travel a ‘green activity,’” APS has developed an opportunity for its meeting attendees to mitigate their travel emissions. Rather than purchasing carbon offsets, which have often been criticized as being insufficient, the Society will provide members with an estimate of their carbon footprint and encourage them to donate to an environmental organization of their choice. If they prefer, APS offers members a suggested place for their donations.

In September, the APS Meetings Department will incorporate language in their request for proposals to future host cities, asking that they provide information related to their environmental and sustainability policies. APS will also provide meeting site selection teams estimates of the GHG emissions for attendee travel to and from the list of proposed meeting locations. These steps will help the selection of locations that, in addition to providing the necessary lodging, meeting space, and logistical requirements, also enable lower GHG emissions.

“That information will be provided to the site selection teams. Our aim is to help inform them of the potential GHG impact of hosting a meeting at various cities and venues,” said Mark Elsesser, APS Office of Government Affairs.
Millie Dresselhaus Fund for Science and Society

This Fund will support the Dres-

cellaneous, a biological science,

The 60th anniversary edition of the Review of Particle Physics (RPP) is now online in Physical Review D. The biennial compilation of particle properties, topical reviews, and physics facts is part textbook and part encyclopedia.

For the full story, visit aps.org/publications/rpd/updates/anniversary60. cfm and go to journals.aps.org/rpdabstract/10.1103/PhysRevD.98.030001 for access to the RPP.
LGBT continued from page 3

walk into a place, you can’t tell by looking at people, you can’t tell by talking to people unless you sort of explicitly bring it up.” Though it may seem like a simple observation, even just that visible reminder of inclusivity is enough to alleviate someone’s anxiety.

Kerstin Nordstrom highlighted the isolation felt by LGBT+ individuals, both in social and work environments. “It’s an extremely isolating environment for building a support system for LGBT+ students within the physics community,” Nordstrom said. “It actively works on creating inclusive environments which can be a challenge for LGBT+ students. It’s one of the issues of their LGBT+ students. People need a safe way to report harassment and other issues, says Nordstrom. Harassment is not exclusive to supervisors and subordinates: it’s also a peer-to-peer issue. “Faculty members and other scientists need to know that it’s happening,” says Nordstrom.

“Here it is and it is building big climate issues. Still, she advised students to find creative ways to stay engaged and not give up. If “you’re a new graduate student, and you’re feeling like a little faculty member, it’s very likely you moved from somewhere else to be at your current position. And that can be emotionally isolating,” she says, describing a situation common to academia. Pioneering itself is isolating which only compounds the problem for LGBT+ physicists. “Often our work is collaborative, but a lot of real work and social work is mental. It’s in our own heads,” Nordstrom says.

“We have to write code or analyze data or just run through equations and that’s very solitary and a lot of us are very introverted, too.” To fight the isolation, many of Nordstrom’s undergraduate students, graduate students, and post-doctoral associates come to school, but she cautions them to find one they love and stick to it. “Once you get to grad school, you’re stuck in that role to do outside things but that doesn’t mean do not do outside of school,” she says. “Find one activity outside of school that you like and then aren’t in any trans people in the room.”

Even so Nordstrom stays focused on the joy of physics and on continuing the hunt for quantum supremacy, like the Hunt for the QCD community. “I don’t take off my gender and leave it at home when I come to work.”

LGBT STEM Day website: prideinstein.org/lgbtstdemoday

The author is the Science Writing Intern at APS in College Park, Maryland.

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Quantom continued from page 1

it’s not observed.

While the exact details how qubits behave may be difficult to understand, the usefulness of their bizarre behaviors is apparent: for every qubit that’s linked together to form a single quantum system, there’s an exponential increase in the number of possible configurations and paths of quantum computation. The connections between multiple qubits are made without actual, physical wires, thanks to the concept of entanglement, which gives quantum computers their power. The point at which quantum computing can outperform classical computing technology is being called “quantum supremacy.”

“From a qubit, if you have two qubits there is a difference in two to the power of three, which is three,” says Monroe. “If you have 300 qubits—we think we’ve seen a few years from having control of 300 qubits, another few years for a device which is more than the number of particles in our universe.”

Harnessing the power of quantum computers could transform many of the kinds of practical uses, which draws the interest of government agencies like the National Geospatial-Intelligence Foundation, the National Institute of Standards and Technology, and even the National Security Agency. Quantum computing could potentially be used for a variety of applications, which may be ideally suited for optimized challenge scenarios such as the traveling salesman problem. What’s the shortest path connecting hundreds of cities on a map?

“This is a classic, really hard math problem—it’s a classic logistics problem that companies like FedEx and UPS are very interested in,” says Monroe. “For a sufficiently large number of cities, it can’t be solved.”

The potential of quantum computation can also be applied to materials science to model binding energy of molecules and other properties of the many possible configurations.

“Quantum computing is a potentially new way to attack certain problems, but things are in the infant stages,” says Monroe. “We don’t have the technology to do some of these things yet, but there are paths to getting there.”

One of quantum computing’s biggest potential uses, and a critical issue for companies investing in the field, is in code-breaking. This means that quantum research becomes a national security issue.

“A lot of times we start from scratch when persuading people to invest in one area or the other—year after year they ask ‘What in the world do we need to number one in this?’” says Mark Ellesseer, Manager of Military and Government Sales at IonQ. It comes to things that have to do with national security—like quantum computing—in those areas we can afford to number one, number two. Quantum information science as both part of national security and a civilian endeavor has become a priority in the White House, both during the Obama Administration and continuing in the Trump Administration: In June, the Office of Science and Technology Policy created a new subcommittee led by NIST physicist Jacob Taylor (see APS News, February 2018), to coordinate the national agenda on quantum information science.

The stimulus for government support of QNI comes from continued heavy investing in that area, especially China, which just devoted $10 billion to build a new quantum computing center. Canada and parts of Europe are on in the race, too, but the hope is that QNI will us help and early in their career development. “Propagating underrepresented student groups to other people that you’re trans. And so, it’s also a peer-to-peer ethic. You can’t afford not to be number one.”

“Best Practices for Establishing a Diverse and Inclusive Workplace” as an APS April Meeting earlier this year. “I don’t think I could ever be a physicist who just ignores social issues and only does math,” Monroe says. “I’ve been in rooms where people are debating trans issues as if there aren’t any trans people in the room.”

Evolve the system in very flexible ways and what they think is going on to be the winning technology and ‘they’re heavily investing in that area.”

“I try to just look very confident at the point where we can invest in a broad portfolio of technologies because we don’t know what the winning technology is going to be,” Monroe says. “We don’t want to lose what we may have a way to figure the system in very flexible ways. We don’t know exactly what quantum mechanics tells us is going to be useful for, but with a reconfigurable architecture like trapped atomic ions, when someone finds a good use, we will be able to recom-34

igent continued from page 1

mation science that still has many unknowns, both about how the process works and what it can be used for, there’s room for even more new ideas.

“We need a marketplace of companies playing with new ideas and designing new systems,” says Monroe. “At places like Boeing and Facebook—they should know quantum physics, they will need it for the future, but there’s the problem: Industrial engineers are not generally comfortable with quantum physics, and that’s a work-”

Part of the NQI legislation aims to address this workforce gap, encouraging bright scientific minds to venture into quantum mechanics—a field that, according to Monroe, isn’t just for physicists anymore, as software developers and other “non-quantum people” join in on the research and turn it into useful devices.

Development at APS. “Propagating this thorough physical science discourse and encouraging people to think about confronting how admissions and retention issues are addressed in graduate education was an obvious next step to both expand the impact of this strategy and sustain it for the long run.” Catherine Mader, pro-
has been able to attract the best and brightest students to its universities and research facilities. And those students have had a positive effect on the United States economy. From 2016-17 academic year, for example, international students and their families at US universities and colleges contributed an estimated $36.9 billion to the US economy. Moreover, American innovation is being defined by international talent. Of the 87 startup companies valued at least at $1 billion in 2016, more than half were founded by immigrants, with founders of 21 companies having first come to the US as international students.

In recent years, the United States’ overseas counterparts have ramped up their research programs, and that, coupled with a desire to maintain a critical mass of international students at US universities and colleges, has been able to attract the best and brightest students to our universities and research facilities. And those students have had a positive effect on the United States economy. From 2016-17 academic year, for example, international students and their families at US universities and colleges contributed an estimated $36.9 billion to the US economy. Moreover, American innovation is being defined by international talent. Of the 87 startup companies valued at least at $1 billion in 2016, more than half were founded by immigrants, with founders of 21 companies having first come to the US as international students.

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Building a Better World Through Science Diplomacy

By Laura H. Greene

Note: This article is adapted from an address delivered to the APS Leadership Convocation in February 2018. During 2017 my theme as APS President was “Science Diplomacy”—using the words and actions of science to build a better world beyond the realm of any politics; using scientific collaborations among nations to address common problems and to build bridges with international partnerships. To repeat: beyond the realm of any politics.

In January 2017, the President of the United States and I each gave our inauguration speeches during the same week and in the same city. On Friday of that week, the Trump administration’s executive travel ban was announced during the APS “April in January” meeting in Washington, DC, and I realized that my science diplomacy efforts must now be applied within our own borders. We need to do it in two important ways. First, we quickly issued a statement (a letter from APS Chief Executive Officer Kate Kirby and me) simply re-affirming our values. We quoted a 2003 APS (the Sakharov Prize) and AAAS (Scientific Freedom). The letters to the Iranian government could then show that over 100,000 scientists were aware of him. Nothing political—just to point out we were very worried about him (he was in very poor health). He was released in 2016. It was years of work, building up the case and getting the word out. A current case in Iran is Ahmadreza Djalali, an Iranian medical scientist who was working in Sweden, and was detained upon a visit to Iran. He was charged with being a spy and sentenced to death. We are currently monitoring the case and writing letters. In December 2017 the first letter to the Iranian government co-signed by the APS and AAAS presidents was sent. We are monitoring, waiting, and worrying.

A theme here—whether science diplomacy or human rights, I only promote them outside of politics. One can be most effective in these areas by being non-partisan. As the 2017 APS President, with my background, I felt I was ready to keep our members, as much as possible, from trying to make APS partisan. It was a challenge!

All of these projects, and more, were only possible because our APS journals are strong and healthy; the revenues from our journals are re-invested back into the Society’s activities. As APS proceeds with strategic planning this year, it will be vital to consider the future of the dissemination of scientific information and what scientific information is going to look like. The face of publishing is changing dramatically and at an accelerating pace, open access being one component. It is clear to me that under the leadership of APS Editor in Chief Michael Thoennessen, APS Publisher Matthew Salter, and our team of editors, we are assuring the strength and quality of APS journals.

I want to now turn to you, our leadership and our members. APS needs your help. Now, not all of our members need to be engaged—I was pretty much a full-time lab rat until I was 49, and that is fine—we need that diverse segment too! But I urge you to encourage your membership units to at least promote young people and underrepresented minorities. We need all minorities do our best, but we need all of you white males to help—you are the majority in our fields. I want each of you to invite worthy women or underrepresented minorities to give talks and nominate them for APS Fellowship or for an APS prize or award.

Now on to human rights. When I was a graduate student, one of my professors at Cornell, Kurt Gottfried (co-founder of the Union of Concerned Scientists, and winner of the 2017 AAAS Scientific Freedom and Responsibility Award) asked me if I would mentor Elena Sevilla, a physics graduate student who was a medical scientist who was working in Sweden, and was released from prison. We are currently monitoring the case and writing letters. In December 2017 the first letter to the Iranian government co-signed by the APS and AAAS presidents was sent. We are monitoring, waiting, and worrying.

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I urge you to see the work CIFS did in this case—(it is posted at aps.org/about/government/committees/cifs/).

“Why work to make the world smaller? I have two answers: diversity and human rights.”

With our domestic challenges, I had less time for international science diplomacy, but I did help lay foundations and strengthen connections between international societies. Our ties with the Cuban Physical Society (CuPS) began almost three years ago when the US opened up to Cuba, and the APS Panel on Public Affairs (POPA) charged me with reporting on the state of Cuban physics. With help from Myriam Sarachik, a past APS president who lived in Cuba, I had the delightful experience of becoming involved with CuPS. I have been greatly impressed by the enthusiasm of President Tania M. Alonso, and the US did so. My response was “hell yes!” We went to the Ithaca airport to pick them up—Elena and her two-year-old son. This case was monitored by APS, the National Academy of Sciences in human rights; and Amnesty International; and that was how I learned how effective Amnesty was at saving lives. That was 41 years ago, this marks my 41st year as a member of Amnesty, and Elena and I are still great friends!

The APS Committee on the International Freedom of Scientists (CIFS) is responsible for monitoring concerns regarding human rights for scientists throughout the world. Over the past few years I have worked with CIFS, AAAS, and the National Academy of Sciences in human rights; and I hope to do more. It is difficult to see your wins and not difficult to see your losses. We think a win was the case of Omid Kokabee, an Iranian graduate student at University of Texas at Austin, who was returning to his home country to see his family in 2011, was detained because he did not want to do weapons work. Scientific societies monitored this case—and I urge you to see the work CIFS did in this case—it is posted at aps.org/about/government/committees/cifs/).

“I want each of you to invite worthy women or underrepresented minorities to give talks and nominate them for APS Fellowship or for an APS prize or award.”

In 2014, Kokabee received prestigious awards from both APS (the Sakharov Prize) and AAAS (Scientific Freedom). The letters to the Iranian government could then show that over 100,000 scientists were aware of him. Nothing political—just to point out we were very worried about him (he was in very poor health). He was released in 2016. It was years of work, building up the case and getting the word out. A current case in Iran is Ahmadreza Djalali, an Iranian medical scientist who was working in Sweden, and was detained upon a visit to Iran. He was charged with being a spy and sentenced to death. We are currently monitoring the case and writing letters. In December 2017 the first letter to the Iranian government co-signed by the APS and AAAS presidents was sent. We are monitoring, waiting, and worrying.

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APS Past President Laura Greene was the Society’s President in 2017. She is Chief Scientist of the National High Magnetic Field Laboratory and professor of physics at Florida State University. Her research focuses on experimental condensed matter physics and strongly correlated systems in particular.