Neural nets in physics

By Gabriel Popkin

2017 APS April Meeting — If the 2016 APS April Meeting was a champagne-soaked celebration for gravitational wave scientists, the 2017 meeting was more like spring training—there was lots of potential, but the real action is yet to come.

The Laser Interferometer Gravitational-Wave Observatory, or LIGO, launched the era of gravitational wave astronomy in February 2016 with the announcement of a collision between two black holes observed in September 2015. “I’m contractually obligated to show the slide [of the original detection] at any LIGO talk for at least another year,” joked Jocelyn Read, a physicist at California State University, Fullerton, during her presentation at this year’s meeting.

The scientific collaboration that operates the two LIGO detectors netted a second merger between slightly smaller black holes on December 26, 2015. (A third “trigger” showed up in LIGO data on October 12, 2015, but ultimately did not meet the stringent “five-sigma” statistical significance standard that physicists generally insist on.)

The detectors then went offline in January 2016 for repairs and upgrades. The second observing run began on November 30, but due to weather-related shutdowns and other logistical hurdles, the two detectors had operated simultaneously on only 12 days as of this year’s meeting, which limited the experiment’s statistical power. Collaboration members said they had no new detections to announce. Instead, scientists focused on sharpening theoretical estimates of how often various events occur. In particular, they are eager to see collisions involving neutron stars, which lack sufficient mass to collapse all the way to a black hole. Neutron star collisions are thought to be plentiful, but would emit weaker gravitational waves than do mergers of more massive black holes, so the volume of space the waves would explore have been greatly reduced.

Neutron star collisions are thought to be plentiful, but would emit weaker gravitational waves than do mergers of more massive black holes, so the volume of space the waves would explore have been greatly reduced. (Image: LIGO/G.W. Carney)

In particular, they are eager to see collisions involving neutron stars, which lack sufficient mass to collapse all the way to a black hole. Neutron star collisions are thought to be plentiful, but would emit weaker gravitational waves than do mergers of more massive black holes, so the volume of space the waves would explore have been greatly reduced. (Image: LIGO/G.W. Carney)

Finding the ground state of a system of many quantum particles is a challenge for even the best numerical simulation methods. But what if scientists used the idea behind machine learning and unleashed “computer players” to learn about and solve the ground state of quantum many-body systems, much like computer programs that play chess or Go? Writing in Science (doi:10.1126/science.aag2302), Giuseppe Carleo and Matthias Troyer describe an artificial neural network that acts as a computer player. So far, this tactic appears to be beating out the competitors—solving the ground states of quantum many-body systems faster than most numerical methods used in quantum calculations. Using a reinforcement-learning scheme, the team demonstrated that their method was capable of both finding the ground state and describing the evolution of complex interacting quantum systems over time. Although Carleo and Troyer only examined a few problems with known solutions, their program’s ability to outperform state-of-the-art numerical methods in accuracy might give other scientists reason to expand upon their work in the future.

A supernova is born.

A supernova explosion in its first stages is challenging. In our galaxy, these are rare events, and young supernovae even rarer. As reported in Nature Physics (doi:10.1038/ nphys4025), scientists at the iPTF observed supernova SN 2013fs a mere three hours after explosion, and they were able to record its optical spectra as early as six hours after explosion. By characterizing the spectral lines corresponding to emissions of ionized oxygen, nitrogen, iron, helium, and hydrogen, the team shed light on both the environment surrounding the star prior to explosion and the star itself. Their analysis indicates that SN 2013fs is a type II supernova originating from a red supergiant star, and that it was surrounded by a dense shell of gas, which could have been produced by instabilities during the supergiant’s terminal years.

Hairdressing with Physics

Hairdressers are quick to give their tips for applying shampoo and other treatments. Now physicists have chimed in with their own RESEARCH continued on page 6

Data from the Green Bank Telescope in West Virginia (shown) and Arecibo Telescope in Puerto Rico help researchers use pulsars to study gravitational waves. (Image: LIGO/G.W. Carney)


data from the Green Bank Telescope in West Virginia (shown) and Arecibo Telescope in Puerto Rico help researchers use pulsars to study gravitational waves. (Image: LIGO/G.W. Carney)


data from the Green Bank Telescope in West Virginia (shown) and Arecibo Telescope in Puerto Rico help researchers use pulsars to study gravitational waves. (Image: LIGO/G.W. Carney)


data from the Green Bank Telescope in West Virginia (shown) and Arecibo Telescope in Puerto Rico help researchers use pulsars to study gravitational waves. (Image: LIGO/G.W. Carney)


data from the Green Bank Telescope in West Virginia (shown) and Arecibo Telescope in Puerto Rico help researchers use pulsars to study gravitational waves. (Image: LIGO/G.W. Carney)


data from the Green Bank Telescope in West Virginia (shown) and Arecibo Telescope in Puerto Rico help researchers use pulsars to study gravitational waves. (Image: LIGO/G.W. Carney)


data from the Green Bank Telescope in West Virginia (shown) and Arecibo Telescope in Puerto Rico help researchers use pulsars to study gravitational waves. (Image: LIGO/G.W. Carney)

"Science is Not Just For Scientists"

By Rachel Gaal

2017 APS April Meeting — Amid the political turmoil after U.S. President Donald J. Trump’s election, scientists have started debating the future of science. As part of that discussion, three physicists spoke to a nearly full house at a plenary session titled Science Policy in the 21st Century at the 2017 APS April Meeting in Washington, D.C.

Rush Holt, CEO of the American Association for the Advancement of Science, a physicist and former member of Congress, captured the worries of many. “I have never seen the scientific community so uncertain, concerned, or so anxious ... We [scientists] have a reverence for evidence, but now [people] see evidence as willfully denounced and banned in principle,” said Holt.

Yet the problem, he emphasized, does not lie in people’s capability to understand scientific evidence. “[Scientists] should switch from communicating the right answer to communicating the right process,” Holt proposed. “[A] change will not be done by asserting the facts, it will be done by empowering people to handle evidence for themselves, no matter their level of expertise. They can demand evidence and make judgments about its value ... It’s their job to do it for themselves ... Science is not just for scientists.”

Cherry Murray, former Director of the Department of Energy’s Office of Science in the Obama administration and former APS President, showed the numbers behind science research funding in past years and discussed the division of discretionary and non-discretionary spending in the U.S. budget. Her personal take on the data: expect across-the-board cuts.

“I predict that the federal funding for [science] research will be going down. And it’s not because the government believes that research is not a good investment,” assured Murray. “It’s because discretionary research and budgets are being highly strained ... it’s better to come together as all of science, rather than pointing fingers at other disciplines and saying ‘we should be funding this and not that’.”

To successfully change things on any political level, the speakers agreed that getting involved in public policy is the way to make a difference. That message was driven home by Congressman Bill Foster, 11th congressional district representative from Illinois. Foster is the

Polycrystalline alumina films on a silicon wafer. (Image: I. M. R. Maddalena)

Physical Review Materials

APS has launched Physical Review Materials, a broad-scope international journal for high-quality papers from physicists, materials scientists, chemists, engineers, and researchers in related disciplines. The initial call for papers is scheduled for mid-March 2017, and APS expects to publish the first issue in mid-2017.

In a message to the leadership of member units, APS Editor in Chief Pierre Meystre and APS Publisher Matthew Bletter noted that: “The decision to launch PRMaterials was made following intensive consultation with a wide variety of stakeholder groups within APS and the broader materials research community.”

“Behind every giant technological development we can find a number of new materials,” said Mu Wang, an editor of the new journal. “Materials physics, in fact, are strongly associated with condensed matter physics, chemistry, materials, crystallography, and so forth. It is interdisciplinary.”

“I believe there is a unique value to a materials research journal with the same high standards for peer review as the other Physical Review journals,” said Managing Editor Aftanasios Chandris. “Physical Review Materials will give APS a chance to play a leading role in this area.”

“I am delighted to welcome PRM Materials to our family of APS journals,” said 2017 APS President Laura Greene. “As a materials physicist myself, I have felt the need for this journal. Pierre and Matthew worked closely with the APS Division of Materials Physics, the Division of Condensed Matter Physics, and many other relevant units to determine a well-defined scope and business model that will serve our community very well.”

Watch for updates at journals.aps.org/prmaterials
This Month in Physics History

March 19, 1800: von Humboldt Hunts Electric Eels

Friedrich Wilhelm Heinrich Alexander von Humboldt is often listed as one of the most influential naturalists in history, a polymath who traveled around the world and carefully recorded his observations in many published books. Among his many known achievements was an account of the unusual behavior of electric eels.

Humboldt was born in 1769 to Alexander Georg von Humboldt, a former major in the Prussian Army and von Humboldt's second wife—a former baroness by marriage who had inherited a considerable fortune upon her first husband's death. This new wealth gave von Humboldt the love of nature that was evident from the start. He even earned the nickname “the little apothecary” as a child, given his penchant for collecting plants and insects, all carefully labeled and preserved.

Our immediate need is additional financial support for the production of this report. We will analyze the essential role of physics as a source of technology for economic growth, similar to a study of industrial physics in the United States. Our goals, however, are much greater, and we encourage the use of this report to catalyze a broader range of APS activities in partnership with industry leaders, government agencies, and universities. We want to ensure U.S. leadership in industrial physics in the coming decades in order to support the vital technology base essential to a strong economy.

Economic Impact of Industrial Physics

The death of Humboldt's mother in November 1796 meant that he now had the financial resources to travel the world on scientific expeditions. He prepared with a naturalist and physician Aimé Bonpland and received permission from the royal Bourbon court in Spain to travel to the Spanish holdings in Central and South America. Their ship landed in Cumaná, Venezuela, on July 16, 1799.

While exploring Venezuela in 1799, Alexander von Humboldt observed wild horses being shocked by electric eels.

Edgar Lee Catania, the APS Councilor for Education, Agriculture and Veterinary Medicine, suggests that understanding animal behavior may help in understanding human behavior.

The natives suggested “horse fishing”—corraling several wild horses and forcing them into the shallow water. According to Humboldt’s account, the alarmed animals stampeded and snorted, rigging up the eels and compelling them to attack by pressing their long bodies to the horses’ bellies, releasing a series of electric shocks. Surprisingly, this worked, although some of the horses drowned in the process. The eels quickly exhausted themselves and were much easier to catch with small harpoons on ropes.

Many scientists thought this was just a tall tale—one naturalist memorably called it “tommyrot”—because nobody had observed such behavior since. But in 2016, a biologist and neuroscientist at Vanderbilt University named Kenneth Catania published a paper reporting on a series of lab experiments with electric eels. His findings lent credence to Humboldt’s account of eels aggressively lumping up and stunning the horses with a series of high-voltage discharges.

Catania argued that, under certain conditions, this mode of attack might be more efficient than simply discharging electric shocks in the surrounding water. In 1838, Michael Faraday conducted his own experiments with electric eels and experienced only mild shocks, presumably because water in nature, with its copious dissolved salts, is a good conductor of electricity. Catania’s work suggests that Humboldt’s account would be especially plausible during the onset of the dry season, when eels are more likely to become stranded in shallow bodies of water.

Humboldt’s first excursion was a smashing success, and he organized more expeditions, including one to Russia in 1829. Humboldt became one of the most famous men in Europe, in part because he published so much of his work, including several lavishly illustrated popular accounts. He certainly influenced other scientists, such as Charles Darwin, who told Humboldt how much the naturalist’s writings had inspired him to want to travel to distant lands. Humboldt is cited frequently in Voyage of the Beagle. And in a letter to Joseph Dalton Hooker, Darwin declared Humboldt to be “the greatest scientific traveler who ever lived.”

The cost of all those expeditions, as well as publishing more than thirty volumes about his work, gradually depleted Humboldt’s fortune. In later years, he depended on a pension awarded him by the EELS continued on page 3
Congratulations to Cal Poly San Luis Obispo for sending the highest number of undergraduate women to CUWiP! Cal Poly San Luis Obispo sent 20 undergraduate women to the 2017 APS Conference for Undergraduate Women in Physics (CUWiP) at UCLA.

Phys21: Preparing Students for 21st Century Careers

A new report provides information about the skills and knowledge that employers of physicists are seeking, and describes ways in which physics departments can help students acquire those skills and stand out in their field. Learn more at compadre.org/UTRRP.

Woman Physicist of the Month—January 2017
Laura Sinclair is a physicist in the Applied Physics Division at the National Institute of Standards and Technology (NIST). She is recognized for pioneering new robust optical tools based on fiber frequency combs that operate outside well-controlled laboratory environments. Sinclair’s internationally acclaimed comb research has been applied to large distances and precision measurements of airborne contaminants in turbulent environments, dramatically increasing observation periods from hours to femtoseconds. When not wrangling optics equipment, Sinclair organizes a monthly “Awesome Women in Science” coffee hour to connect technical women across the NIST Boulder campus. Since 2008, she has served with the Rocky Mountain Rescue Group.

Woman Physicist of the Month—February 2017
Rae Robertson-Anderson is Associate Professor and Chair of the Physics and Biophysics Department at the University of San Diego (USD), where she has been a faculty member since 2009. In 2012, she was awarded a Department of Defense Air Force Office of Scientific Research Young Investigator Program Award for her work with entangled DNA molecules. A few months later, she earned a National Science Foundation Career Award for her research on developing a novel fluorescence force-measuring optical tweezers diagnostic with which she can track single molecules in complex actin networks. Anderson created an advanced biophysics laboratory course where undergraduate students learn to assemble optical tweezers and then pursue research projects. She has built a thriving undergraduate research program, and was invited to give a talk at the 2016 APS March Meeting about its successes. She has also sparked an increase in female students declaring majors in bio-physics, bringing the overall percentage of female physics majors at USD up to 40%

Nominate the next Women Physicist of the Month at www.womeninphtics.org

EELs continued from page 2

by Gabriel Popkin

2017 APS April Meeting

The Manhattan Project culminated in August 1945 with the dropping of atomic bombs on Hiroshima and Nagasaki, bringing World War II to a sudden and dramatic close. More than 70 years later, historians, scientists, and the public continue to study and discuss the project’s origins, genesis, impact, and legacy. That debate took the stage at the 2017 APS April Meeting, where a series of sessions highlighted how the singular and storied project laid the groundwork for massive public and private investments into nuclear arms and reminded attendees of the very real dangers nuclear weapons still pose.

Yale historian of science Daniel Kevles said the atomic bomb project dramatically enhanced physicists’ role in society. “In the wake of Hiroshima and Nagasaki, the members of the Los Alamos generation were … a new power group in American society, thought to hold the key to keeping the peace with their hands,” he remarked. The wartime project’s infrastructure—described by Kevles as a “nuclear-industrial complex”—remained intact because it had vast wartime bureaucratic offices. The project’s Office of Naval Research was controlled by the Atomic Energy Commission, which continued to grow in scope and funding. (The AEC’s functions were eventually subsumed into the Department of Energy in 1977.)

Physicists used their elevated status to both promote and try to disassociate nuclear weapons from the complex. Most famously, Edward Teller argued for the development of the hydrogen bomb and led its development at the Lawrence Livermore National Laboratory. In 2009, he was awarded a Department of Defense’s Laura Sinclair

Rae Robertson-Anderson

Winter (left), a dolphin that lost her tail after being caught in a net, swims with a prosthetic tail—show that there is rich physics in how animals move through the water.

The benefits of schooling

Many fish such as sardines and snapper swim together in tight-knit groups. This schooling behavior may reduce drag and help the animals evade predators. Researchers from the Massachusetts Institute of Technology (MIT) shared new simulations of how schooling fish might be able to move more efficiently by sensing and using vortices shed by their neighbors.

The team of engineers ran computer simulations of two fish swimming one after the other in a line. The lead fish created a wake as it swam, and the researchers investigated how the rear fish sensed that water movement, and simulated the use of its body to optimize its forward momentum.

Biologists have shown that fish are able to sense local perturbations in the water. Most fish have a “lateral line” running along their sides, a unique sensory organ containing mechanosensory hair cells similar to those in our ears. A pressure gradient across the body of the fish causes the neuromasts to bend very slightly, which the fish can perceive. “Using just this signal, fish can identify small vibrations from prey and even localize where their prey are,” said Amy Gao, a graduate student involved in the research at the Tow Tank Laboratory at MIT. “You can’t sneak up on a fish.”

Using numerical simulations, Gao and her collaborators showed that this ability to sense the local flow allowed the rear fish to essentially slalom around the vortices shed by the lead fish. “The rear fish adjusts its motion to take advantage of vortices along its entire body,” said Gao.

Fragments of bomb prototypes. (Image: John Niessen)
Solar Eclipse Offers Up a Scientific Bonanza

By Gabriel Popkin

2017 APS April Meeting—Some things stand out best when the story behind them is examined. When the total solar eclipse on August 21, 2017 nature will turn down Earth’s brightest light of all, when the shadow from a total solar eclipse will fall across a large portion of the United States. From Newport, Oregon to McClellanville, South Carolina, this total eclipse will plunge parts of 12 states into darkness lasting up to nearly three minutes. We are trying to persuade people how wonderful it will be to travel into the path of the eclipse,” said Jay Pasachoff, a physicist at Williams College in Williamstown, Massachusetts. “It is something that is in a conference at the 2017 APS April Meeting in Washington, D.C. “This goes for the general public, for physicians, and for teachers and their students.”

Solar eclipses have played important roles in the history of science. According to Pierre Janssen’s discovery of the sun’s corona method of a new structure. He was that moment. The author is a freelance science writer in Mount Rainier, Maryland.

Nobel Laureate Dan Shechtman: Advice for Young Scientists

Dan Shechtman and the Blech model pattern is in, and I said “ein chaos kazo”, which is Hebrew for “There ain’t no such animal!” So I looked around, and I learned that I have a machine, how to use the machine properly. I studied the theory and practice. I became an expert in transmission electron microscopy. What is an expert? Somebody who can teach. I taught many classes in the The moment in 1982 and the

Nobel Laureate Dan Shechtman: Advice for Young Scientists

Dan Shechtman and the Blech model pattern is in, and I said “ein chaos kazo”, which is Hebrew for “There ain’t no such animal!” So I looked around, and I learned that I have a machine, how to use the machine properly. I studied the theory and practice. I became an expert in transmission electron microscopy. What is an expert? Somebody who can teach. I taught many classes in the

DS: My grandfather brought to me the first facts of science and he encouraged me. He also bought me a very important present that later shaped my life—a magnifying glass. I was 7 years old, just starting school. I was walking in this magnifying glass looking at insects and flowers and everything small, and I fell in love with the world of small things. This was the start. When I was 10 years old, [one of my teachers] said to the class “We have a microscope in school.” and I jumped and asked “Can you bring it to class?” and I kept asking “Fine,” and then the local government of asking, he brought it to class and he said “Dan, You’re the most interesting boy in the world!” and I bought the microscope and I could not leave the microscope. It was amazing, amazing! So the teacher said “Sit down and let others try” and I said “Wait, wait! nooo!”

In 1966 or 67, while I was doing my degree at the Technion, they bought the first transmission electron microscope. I sat by the technician who assembled the microscope, day and night. He was Japanese. He spoke [no] English, but he taught me how to operate the machine, how to use the machine properly. I studied the theory and practice. I became an expert in transmission electron microscopy. What is an expert? Somebody who can teach. I taught many classes in the AGL: You were 41 when you made your discovery. Tell me about what led up to it. DS: On April 8, 1982, I looked in the microscope, about a half year after I arrived at NBS for my sabbatical and I said, “Hmm, that’s interesting”. You know how Archimedes shouted Eureka? You don’t do that anymore. Today when you make a discovery, usually the first mention is, “Hmmm, that’s interesting” or “Hey! What’s going on here?”

At that moment, I said here is the phase and let’s see what the diffraction pattern is, and I said “ein chaos kazo”, which is Hebrew for “There ain’t no such animal!” So I looked around, and I learned that I have a machine, how to use the machine properly. I studied the theory and practice. I became an expert in transmission electron microscopy. What is an expert? Somebody who can teach. I taught many classes in the AGL: You were 41 when you made your discovery. Tell me about what led up to it. DS: On April 8, 1982, I looked in the microscope, about a half year after I arrived at NBS for my sabbatical and I said, “Hmm, that’s interesting”. You know how Archimedes shouted Eureka? You don’t do that anymore. Today when you make a discovery, usually the first mention is, “Hmmm, that’s interesting” or “Hey! What’s going on here?" This may be a discovery. At that moment, I said here is the phase and let’s see what the diffraction pattern is, and I said “ein chaos kazo”, which is Hebrew for “There ain’t no such animal!” So I looked around, and I learned that I have a machine, how to use the machine properly. I studied the theory and practice. I became an expert in transmission electron microscopy. What is an expert? Somebody who can teach. I taught many classes in the
Jodi Cooley, Vernita Gordon and Carlos Bertulani. APS members spoke with their representatives on Congressional Visits Day on Capitol Hill with the 115th Congress, and according to the APS members who participated, congressional staffers responded positively to the Society’s messages.

The meetings, held in late January, were part of the APS Leadership Convention, an annual gathering of unit officers that provides an opportunity to meet and interact with APS elected leadership and staff. Attendees learn about APS programs and services, as well as network with and learn from each other.

The APS Office of Public Affairs, working with the Physics Policy Committee and the Board Executive Committee, identified five key issues for the Hill meetings. All participants were asked to discuss the federal research budget and scientific infrastructure; they were also provided optional information on science education, clean energy jobs, and managing the cost of helium.

“I was surprised and pleased at the response we received from about eight offices we visited, especially on the issues of education and science infrastructure,” said E. J. Zita, a physicist at The Evergreen State College and a port commissioner in Port of Olympia, Washington.

Added Maria Spiropulu, physics professor at the California Institute of Technology and chair of the Forum on International Physics for APS, “The visit was very successful; the follow-up is important for APS, “The visit was very successful; the follow-up is important for APS, “The visit was very successful; the follow-up is important for APS, “The visit was very successful; the follow-up is important for APS...

APS was the first scientific organization to coordinate a “congressional visits day” on Capitol Hill with the 115th Congress, and according to the APS members who participated, congressional staffers responded positively to the Society’s messages.

The meetings, held in late January, were part of the APS Leadership Convention, an annual gathering of unit officers that provides an opportunity to meet and interact with APS elected leadership and staff. Attendees learn about APS programs and services, as well as network with and learn from each other.

The APS Office of Public Affairs, working with the Physics Policy Committee and the Board Executive Committee, identified five key issues for the Hill meetings. All participants were asked to discuss the federal research budget and scientific infrastructure; they were also provided optional information on science education, clean energy jobs, and managing the cost of helium.

“I was surprised and pleased at the response we received from about eight offices we visited, especially on the issues of education and science infrastructure,” said E. J. Zita, a physicist at The Evergreen State College and a port commissioner in Port of Olympia, Washington.

Added Maria Spiropulu, physics professor at the California Institute of Technology and chair of the Forum on International Physics for APS, “The visit was very successful; the follow-up is important for APS, “The visit was very successful; the follow-up is important for APS, “The visit was very successful; the follow-up is important for APS, “The visit was very successful; the follow-up is important for APS...

APS members spoke with their representatives on Congressional Visits Day.

L-R: George Leonardo, staffer in the office of Sen. John Cornyn (R-TX); Jodi Cooley, Vermila Gordon and Carlos Bertulani.

News from the APS Office of Public Affairs

APS Leads in Capitol Hill Meetings with New Congress

By Tawanda W. Johnson, APS Press Secretary

By Rachel Gaal

Kavli Foundation Keynote Plenary: From Quarks to the Cosmos

The 2017 APS April Meeting featured a keynote plenary session sponsored by the Kavli Foundation with three outstanding speakers on topics ranging from the smallest particles to the entire universe. (L to R): Barbara Jacak of the University of California Berkeley spoke on the properties of quark-gluon plasma created by heavy ion collisions; Cora Dvorkin of Harvard University covered the latest results in cosmology; and S. James Gates of the University of Maryland, Baltimore County presented his results on supersymmetry and its many potential connections to error-correction codes, card games, and music. This and other plenary sessions can be viewed at aps.org/meetings/april.

International Firsts in Physics

By Rachel Gaal

2017 APS April Meeting—After 14 years of slingshotting electrons around the ring magnets of the BESSY-I accelerator was due for an upgrade. The synchrotron radiation source, once housed at the Helmholtz-Zentrum Berlin (HZB), was set to be decommissioned at the end of 1999, in favor of its successor, BESSY-II. While it seemed that BESSY-I was headed for the junkyard, Germany had other plans—to donate it to a growing effort outside of Europe, a joint synchrotron radiation facility that would be built somewhere in the Middle East. Worth $60 million at the time, this donation was a key step forward to foster a radical type of scientific collaboration in the Middle East.

Now known as SESAME, the Synchrotron-light for Experimental Science and Applications in the Middle East, the third-generation light source is housed in Allan, Jordan, with the new and improved BESSY-I serving as the injector for the main ring. SESAME recently reached another milestone in mid-January 2017, successfully circulating its first beam.

“SESAME started in 1997, and the facility is finally completed,” Herman Winick of SLAC and member of SESAME’s Advisory Committee announced at the 2017 APS April Meeting. “The first beams are finally going around the 2.5 GeV storage ring, which is the first in the Middle East.”

Modeled after the cooperative framework of the European Organization for Nuclear Research (CERN), the SESAME synchrotron is supported by nine members: Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, the Palestinian Authority, and Turkey. Before becoming its own independent intergovernmental organization in 2004, it was established under the auspices of UNESCO.

“The 2.5 GeV machine is small at 133 meters in circumference,” Winick continued. “But it can support 28 simultaneously operating beamlines, and it’s been designated by UNESCO to see Middle East engineers working on this . . . countries that might not normally recognize each other want to train their students here and do research. [They] are discovering they can do world-class research at home.”

This type of scientific collaboration is designed to combat the notorious “brain drain” in developing countries, where many talented scientists are recruited outside of their home country to conduct research—rarely returning due to lack of state-of-the-art facilities and research opportunities.

Many Middle Eastern countries, including more developed areas such as South Africa, fall victim to the drain. Neil Turok, director of the Perimeter Institute for Theoretical Physics and founder of the African Institute for Mathematical Sciences (AIMS South Africa), described his experience with this quandary at the 2017 APS April Meeting:

“Tens of thousands of undergraduates graduated from African countries, but they don’t have the quality of education to allow them to do research . . . and there is always encouragement for [graduates] to come to the U.S. or the U.K., but they never come back. We want to change that.”

Focused on training postgraduates across Africa, AIMS South Africa has been in operation since 2003, and has expanded its original center in South Africa to operate in Senegal, Ghana, Cameroon, Tanzania, and Rwanda. The centers feature 247 learning environments for the students, with resident tutors, libraries, and computer facilities at their fingertips. Turok called it the “epitome of a university.”

“No matter the scientific areas our students go into, we designed a center that would allow them to go into any area of science and technology,” Turok said. “The students way exceeded our expectations [when we started]. We had students that came out of the Congo—those are very gifted, young intellects—as those that took full advantage of our system.”

In 2008, Turok was awarded the TED prize for his Next Einstein Initiative: a push to harness the creativity and knowledge that African students needed, who were “starved of opportunity” and in need of a better future.

“We ran for five years . . . and then I gave a TED talk that made me publicly commit to finding the next ‘African Einstein.’ And so, I want to set up 15 AIMS centers in Africa,” explained Turok. “We are slowly getting there: each [center] has between 50-100 students, with postgraduate and Ph.D. students. We get over 4,000 applications per year. . . . our progress is truly exciting.”

So far, 70 percent of graduated students have stayed local—working, teaching, or pursuing advanced degrees in African countries. New science initiatives in Africa, such as the Square Kilometer Array and the Quantum Leap Africa Research Centre, will keep well-trained students and graduates in their native countries for research and collaborator opportunities.

Another international pursuit was announced at the 2017 APS April Meeting—two efforts to detect dark matter, at new underground labs in Africa and South Korea. Zebib Z. Vilakazi of the University of the Witwatersrand is looking to establish a Southern African Underground Laboratory, one of few in the southern hemisphere.

We propose to extend Moneong Gold Mine, a sister gold mine to TauTona, down to 4500 meters, which would be the deepest mine in the world,” Vilakazi announced. “The deeper underground . . . provides [more] natural shielding that attenuates all the cosmic background.”

Zita and Spiropulu were among 53 APS members from 23 states who participated in 82 congressio- nal meetings. Staffers in the APS Office of Public Affairs (OPA) prepared the members for the meetings via a video presentation, web conferences, in-person training, and one-page issue briefs.

“APS set up these meetings in an organized way and prepared with coherent messages that were really useful and helped us to be more effective,” said Zita.

Spiropulu said it’s imperative for scientists to meet with their congressional representatives.

“We live in times of exponential progress in science and technology. Scientists need to take the time to explain their work and the impact of their work,” she said.

Helping members maintain contact with their congressional representatives is crucial to becoming effective science policy advocates, said Greg Mack, APS government relations specialist who oversees the Society’s grassroots program.

“We want them to continue having those conversations about science policy. Sending emails, making phone calls, and holding meetings are all ways they can continue to keep the connection strong,” said Mack.

He added he plans to follow up with APS members in key congressional districts to develop advocates to focus on state-based meetings.

Francis Slakey, interim director of OPA, said the APS members’ comments from the January meetings would be put to good use.

“We are assembling feedback from members, and the information will be used to fine-tune our messages and ask,” he said. “We’ll also be sharing this information with other scientific societies to help inform their congressional visits.”

To learn more about getting involved with grassroots advocacy, contact Greg Mack at mack@aps.org.
POLICY continued from page 1
only Ph.D. scientist that remains
in Washington, D.C. Dr. Ruth Holt, who also
served as New Jersey’s 12th district
representative, served alongside
Foster until his resignation in 2015.
“People ask me, ‘why does
anyone want to take this job as [a
congressman]?’,” explained Foster.
“Well, there’s this thing
they give you … a voting card …
and you take this card, you take
it across Independence Avenue,
onto the floor of the U.S. House
of Representatives, and you take
the card, put it in a slot, and you
press the red [‘no’] button or the
green [‘yes’] button, and the world
changes a little bit—and that’s why
you take the job. The rest is just
noise.

Although the three speakers do
not expect every physicist to run
for office, as that task itself is
too full for many, their advice was
to contact local representatives to
convey the importance of science-based
value and the evidence in science in
everyday life.

WAVES continued from page 1
underground. We are [also] fab-
ulous underground in terms of quality …
the University of Witwatersrand.
Military Academy, EARTH
helps society … that would be a
‘green’ button, and the world
of possible excitement to come.

RESEARCH continued from page 1
gromming advice. A new theoreti-
cal study published in the European
Physical Journal E (doi: 10.1140/
epje/i2016-16116-4) concludes that
massaging perpendicularly to the
hair strands can help transport the
nanoparticles in shampoo-like drug
treatments toward the hair follicle.
The secret is in the structure of
cuticle and cuticle, which has a rigid
swath structure by using so far,
models of random motion, Matthias
Radke and Roland Netz were able
to simulate the motion of particles
moving along the jagged surface
of the hairs as a result of the oscil-
atory motion of massaging. They
found that the sawtooth-like sur-
face helped guide the nanoparticles
out of the nanoparticles in the
hair follicle when massaged perpendicu-
lar to the strand. When massaged
relative to the strand in a parallel
motion, the particles were found
move up the strand, away from the
inner and they may have figured
out why. In a paper in Physical
Review Letters (doi:10.1103/
PhysRevLett.118.051102),
Cunydhum et al. propose that
photons radiated from the
surface, extract angular momentum, Past observations have had limi-
ted resolution (about 200 km), but
the team’s new measurements promise more.

Cosmic test of quantum mechanics
correlated by quantum entangle-
ment. Nonlocality can be verified in
experiments whose outcomes cannot be
explained by any local theory. But
the experiments can have loopholes
that allow a way out of the logical
dilemma. In 2015, scientists closed two
major loopholes in the same experiment
to extrapolate: physics.aps.org/articles/v6/123),
but a third back door remained ajar: Bell
tests could be invalid if some of the experimental parameters were
 correlated through an unknown mechanism instead of being ran-
domly chosen. Handsteiner et al.
have now closed this “freedom of
choice” loophole by exploit-
ing the random nature of starlight.
Using two telescopes, the authors
collect photons from two stars and
used the photons’ fluctuations to
create randomized settings for
Bell tests. The results, described in
Physical Review Letters (doi:
10.1103/PhysRevLett.118.060401)
close the loophole over a time-
scale corresponding to the time
taken by light to travel to Earth,
600 years—a 16 order-of-mag-
itude improvement over previ-
os tests. (For more, see the
Synopsis “Cosmic Test of Quantum
Mechanics” in Physics
aps.org/synopsis-for/10.1103/
PhysRevLett.118.060401)

Particles ratchet along hair

Photons put a brake on the sun
as photons diffuse outward from
the core, their exchange of angular
momentum with turbulent plasma
produces a mild braking force. This
effect is most effective at the outer
layer of the Sun, where the plasma
density is low. The researchers
calculated the rotation speed implied by their photon
braking effect and found good agree-
ment with their solar observations.
This braking mechanism would not
be sufficiently strong to affect the
rotation speed of the Sun’s core,
but it could be relevant for brighter
stars, which radiate more photons.
(See the Focus story “Photons
Brake the Sun” in Physics
aps.org/articles/v10/13.)
Indeed a nuclear test. “Science is an add-on to the political discussion,” he said, “but it allows an honest broker to give advice.”

Though most talks centered on the original bombs’ development and legacy, one presentation zeroed in on the devices themselves. John Coster-Mullen, a retired photographer and truck driver from Waukesha, Wisconsin, pieced together over two decades a replica of the Little Boy uranium bomb that was dropped on Hiroshima, and self-published a book on the bomb’s design that has been lauded by experts for its accuracy.

Recently he discovered that an area where early bomb prototypes were tested has become publicly accessible, and he displayed at a press conference pieces of bomb casings that he and a colleague collected during a 2013 visit to the site. He did it all without official assistance from Department of Energy personnel, he noted, who to this day have kept Little Boy’s design classified. “There are some people who like what I’ve done and some people who don’t.” Coster-Mullen said. “I have a fan base at Los Alamos because I’ve preserved a lot of their history.”

Planning for the nuclear weapon-themed sessions got underway well before the 2016 U.S. presidential election. Nevertheless, Donald Trump’s nascent presidency added a note of urgency to the proceedings. Speakers noted the decision by the board of the Bulletin of the Atomic Scientists to advance the hands of its “doomsday clock” to 2.5 minutes before midnight. They also cited President Trump’s statements and tweets suggesting an ambition to rebuild the U.S. nuclear arsenal, and the lack of technical expertise held by Rick Perry, the nominee to head the Department of Energy, in contrast to his predecessor, physicist Ernest Moniz.

As the threat of nuclear weapons regains currency after a post-Cold War lull, and while many of the experts who have long advised the government approach retiree, a new generation of physicists must get involved, speakers urged. Technical expertise will continue to be needed to steward existing weapons stockpiles, establish and enforce monitoring regimes to prevent additional countries from acquiring weapons, and advise governments on the severity of threats from newly nuclear-armed countries such as North Korea.

That expertise should be provided no matter which party is in charge in Washington, Sessions added. “Nuclear weapons are not an ideological issue.”
The public can be divided into three groups: a small minority in constant contact with scientists and thus may understand somewhat what we do, a minority (probably less than 1 percent of the population) that has a positive appreciation of science, and a large majority that neither understands science, the connection to technology, nor the funding process for science. This large majority, in the best case, believes that we are dedicated to solving short-term practical problems such as curing cancer, developing green energy, reducing global warming, and stopping big bombs. Admittedly, they may believe that we work in purely philosophical, esoteric areas, unconnected to their daily lives.

Unfortunately, as a result of whom they vote for, this large majority ultimately makes important decisions regarding funding, the validity of certain theories such as evolution, and even the importance of science for decision making in the government. Simply put, a large uninformed public makes collective decisions about science, which not only impact the well-being of science but also the future of the world. I believe the current situation is bad and seems to be getting worse.

I have presented the issues outlined above to many different audiences of scientists and heard many criticisms, including:

1. The public already understands what we do.
2. Educate them and they will understand the importance of science.
3. Don’t dumb down the physics in order to make it understandable.
4. Trying to change things is a waste of time.
5. Sorry. None of the above statements are valid. Not only is our (scientists’) well-being at stake, but also the well-being of the world. Perhaps most importantly it is our obligation to inform the public!

In order to propose specific solutions to this problem it is important to understand that there are three areas which must be explained to the public in a steady, continuous and relentless fashion: the funding process, the effect of physics on technology, and the scientific method. These are also in the public’s mind and in which they are willing to spend time, and are passionate about it. It is especially important not to force young people who are starting a research career to spend time proselytizing to the public. Those that can do a good job will surface on their own. They can’t be forced!

At the personal level many of us can help out the situation if we recognize that there is a need and are willing to sacrifice some time. There are many activities that one can perform individually without much bureaucracy:

- Many of us teach large undergraduate courses. At the end of each course one can in one hour describe how research is done at universities and explain one’s own research. I have been doing this for many years and even managed to convert a few to become physicists.
- Participate in science-based artistic activities such as plays, movie productions, and exhibits, in different capacities as producer, writer, painter, or curator. This was done by a few and has been extremely successful.
- Interact with local museums and commercial enterprises to develop science-based activities such as science-based social gatherings and public lectures.

Science is not appreciated and understood by the public and produces a large barrier for their use. Perhaps an effective way to develop these and many other possible ideas is to hire a marketing company to develop a well-designed advertisement campaign. The most difficult part, not surprisingly, is to measure the effect of these types of activities. I am hoping that perhaps this article will stimulate not only a concerted effort in this direction but also will motivate somebody to invent a good method for measuring the effect of these activities. In any case, I am sure that independent of anything that is done by others, I will continue contributing to this effort as much as I can. Please, join me!

Acknowledgement: I thank Y. Bruynseraede and E. D. Dahlberg for critical reading of this article.

The author is a condensed matter physicist and director of the Center for Advanced Nanoscience at the University of California San Diego. He is a winner of major awards such as the Lawrence Award from the U.S. Department of Energy; several awards from the APS, the Material Research Society; and the International Union of Materials Research Societies. He has also won several regional Emmy awards and other television awards for his science-related movies. He has served the APS in many capacities as Chair of FIP, DMP and FOEP and various other committees in which he emphasized outreach activities to the general public and the legislature. Schiller received his Licenciado (from the University of Chile), Ph.D. from Northwestern University, and an Honoris Causa Doctorate from the Spanish Universidad Complutense. He is a member of the Chilean, Spanish, Belgian and Colombian academies of science.