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APS NEWS

APS physics

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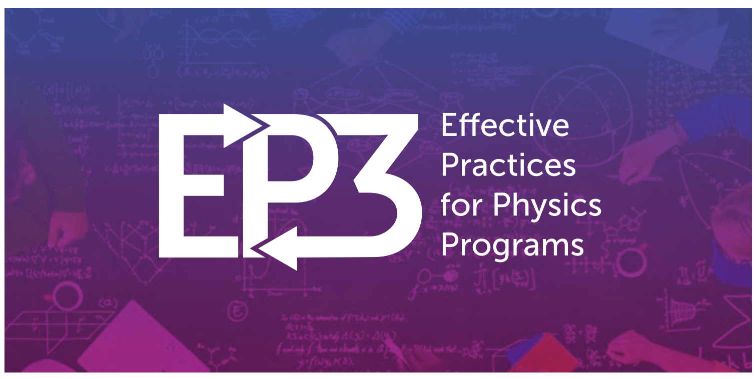
EDUCATION

Navigating the EP3 Guide to Enact Change

BY EDMUND BERTSCHINGER

The Effective Practices for Physics Programs (EP3) initiative aims to "[support] physics programs with collections of knowledge, experience, and proven good practice for responding to challenges and engaging in systematic improvement" via the EP3 Guide, available online at ep3guide.org. EP3 is led by the APS, in collaboration with the American Association of Physics Teachers (AAPT).



The Guide is a direct product of the work of the physics community itself. The content of each Guide section is contributed by disciplinary experts, synthesized by a team from the EP3 Task Force, and reviewed by more experts from the community. To date over 250 individuals have provided contributions and reviews for the EP3 Guide, including more than 2,400 individual strategies for departments to consider and implement.

One recently published section is particularly important to the mission of APS and the long-term well-being of departments: Equity, Diversity, and Inclusion (EDI). Many physicists are calling upon their organizations and leadership to address long standing problems in the recruitment, retention, and success of their members including students, postdocs, employees, and visitors. The EDI recommendations of the EP3 Guide provide a valuable resource for organizations and individuals seeking to improve program outcomes.

But don't approach this thinking that organizational change follows an algorithm. Unlike most physics research, it requires learning about oneself as well as others, both past and present. Like physics research, this is an iterative process of discovery. The EDI Guide has the depth of a graduate-level thesis informed by research in the social sciences.

EP3 CONTINUED ON PAGE 7

SCIENCE POLICY

APS Continues Progress to Make US More Welcoming for Science

BY TAWANDA W. JOHNSON

Matthew Olsen, Assistant Attorney General for National Security, recently announced that the China Initiative, which sowed fear among some APS members and curtailed legitimate collaborations, has ended in its current form. APS was a leading voice in calling for reforms to the initiative – holding community events to highlight the policy's negative impacts, launching a grassroots campaign to raise awareness with Congress, and having APS leadership meet with FBI staff and US Department of Justice (DOJ) officials to push for changes.

"While I remain focused on the evolving, significant threat that the government of China poses, I have concluded that this initiative is not the right approach," said Olsen during a February 23 speech. "Safeguarding the integrity and transparency of research insti-

tutions is a matter of national security. But so is ensuring that we continue to attract the best and the brightest researchers and scholars to our country from all around the world — and that we all continue to honor our tradition of academic openness and collaboration."

APS President Frances Hellman said while APS understands that there are real and viable threats facing the nation, the Society is relieved that the China Initiative will likely no longer be a hindrance to the best and brightest

CHINA CONTINUED ON PAGE 6

ANNUAL LEADERSHIP MEETING

Inclusive Expansion of the Physics Community

BY ABIGAIL EISENSTADT

To reach new physicists, the physics community must expand its understanding of who physicists are, what they do, and why they do it, according to a session called "Broadening Our Community" at the 2022 APS Annual Leadership Meeting on January 27.

Matthew Thompson, Chair of the APS Forum on Industrial & Applied Physics, began the session by acknowledging the need to honor all voices and all disciplines across physics. Moderator Ben Zwickl (Rochester Institute of Technology) then gave a brief presentation on how scientists can do so, introducing a two-part framework predicated on expanding the community and promoting diversity, equity, and inclusion in the field. Then, he asked the panelists to share how they defined themselves and whether they felt like they belonged in the physics community—and to contextualize those answers based on their diverse experiences in academia and industry.

When industrial physicist Larry Woolf (General Atomics), an active member of APS's EP3 Task Force, left academia over 30 years ago, he stopped publishing papers and attending scientific conferences. Since papers and conferences are some of the main ways scientists connect in the physics community, Woolf said this transition came with some sense of loss.

Lack of connection with the physics community also stems from the biased belief that academic physics is the only "true" type of physics, said Meghan Anzelc (Spencer Stuart), a data and analytics industry expert. Echoing Anzelc, Zahra Hussaini

INCLUSIVE CONTINUED ON PAGE 2

ANNUAL LEADERSHIP MEETING

Improving Global Science for the Benefit of Humanity

BY ABIGAIL EISENSTADT

International scientific collaboration has faced many obstacles in the past several years, hindering our ability to respond to climate change, inequality, and other pressing issues. At this year's APS Annual Leadership Meeting on January 27, a session called "Addressing Global Scientific Challenges" delved more into this nuanced topic, asking: How can scientists work together to identify and overcome challenges to global science?

"The challenges that science and scientists face today are indeed global. They are complex. They are existential and navigating towards solutions is no simple task," said Miles O'Brien, a science and technology correspondent at PBS NewsHour, who moderated the session.

He began the discussion by asking William Collins, Director of the Climate and Ecosystem Division of Lawrence Berkeley National Laboratory and a member of the Intergovernmental Panel on Climate Change (IPCC), whether the problems science faces today are truly more difficult than those in the past. "The challenges have gotten greater, precisely because we've delayed trying to solve the problem," Collins said.

Director of Biosphere 2 Institute, Cherry Murray (University of Arizona) noted that today's global problems of climate change, inequality, and so forth are inherently connected. "In order to do solutions, we need every nation in the world to work on these at the same time."

Referencing inequality among nations, O'Brien then asked Omololu Akin-Ojo, founding director of the ICTP-East African Institute for Fundamental Research, how disparities impact the way global solutions help countries. Funding, building capacity, and digital connectivity are additional limitations when tackling problems in Africa, Akin-Ojo said. Murray added that scientific solutions that can meet present-day needs still do not reach people equally due to inequities coming from the scientific process itself. Solving such inequality must begin locally through education, she said. Seconding this, Akin-Ojo highlighted the value of starting education early and teaching critical thinking to train the next generation of researchers. In his center for learning, students are solving local problems concerning energy availability, which overlaps with climate research and underscores the interconnectedness of global solutions.

GLOBAL CONTINUED ON PAGE 3

Interested in watching sessions from the 2022 APS Annual Leadership Meeting? See the playlist on the APS YouTube Channel: go.aps.org/aps-alm22

INCLUSIVE CONTINUED FROM PAGE 1

(Waymo), a software reliability engineer, described how she felt that her choice to pursue an industry career was judged as choosing a less prestigious path.

Biases in the physical sciences, like those against industry careers, can be used to make a clean separation between those who belong and those who do not, Zwickl said. He then asked panelists for ideas on how the community can fight those biases by deliberately broadening the definition of what physicists do.

Offering examples of the conversations she has had with students as they enter college, Director of the Fimbel Maker & Innovation Lab and founder of SciTech Cafe, Katherine Aidala, (Mt. Holyoke College) shared that most early students define physics as cosmology and quantum mechanics. Tabbetha Dobbins (Rowan University), a committee member of the APS Forum on International Physics and the AIP TEAM-UP project, suggested that one way to change that preconception is through a deliberate and intentional effort to reach such students—by emphasizing physics's adaptable skillset, for example.

But acquiring a skillset, while important, is not the reason most young scientists choose to enter physics in the first place, said Zwickl. He challenged panelists to think about how they might reach out to students who were curiosity-driven and how that outreach might look different for those who wanted to make a difference in the world.

Industry research tends to be geared towards making a difference because it centers around delivering applicable results, said Woolf, while academic research is often motivated by curiosity. Panelists across both industry and academia largely agreed.

Making a difference can mean many things and for academics, it involves "the matter of retention," said Dobbins. She explained that keeping a student engaged in the field is one way to have an impact as an academic. Underscoring Dobbins' point, Aidala gave a firsthand account of how the opportunity to major in applied physics encouraged her to pursue physics rather than engineering. Applied physics directly showed her that she could make a difference and that led her to find her place in the field, she said.

Research internships also facilitate retention because they help students see the connections between what they've learned and how it can be applied, said Anzelc, speaking from experience. Dobbins agreed, noting experiential learning is an important component of the physics curriculum.

Woolf noted that while academia relies on hierarchical status as a sign of worth, industry often values each player's role regardless of their career stage. Academia also places more focus on the individual, Hussaini said, because the individual must get their name on papers. The panelists agreed that creating a sense of feeling valued as a team member can be an instrumental tool for retention.

Zwickl discussed the overlap between these ideas and the promotion of diversity, equity, and inclusion in the context of AIP's TEAM-UP project. The initiative seeks to grow the number of African Americans in physics and astronomy. Task force member Dobbins stressed the importance of helping students from minority backgrounds embrace their titles as physicists at an early stage. Helping students identify as a physicist creates a sense of empowerment as those students then explore the many opportunities the community can offer, she said. Assisting students in owning their physics identities, Aidala agreed, is instrumental to helping minority students feel included.

As the session ended, the consensus seemed unanimous: broadening the physics community and promoting diversity, equity, and inclusion could be achieved with the same approaches. Inclusive expansion requires challenging what it means to be—and who gets to call themselves—a physicist.

The full recording of this session is available on YouTube.

The author is a science writer at the American Association for the Advancement of Science. She was previously an APS science communications intern.

THIS MONTH IN

Physics History

April 24, 1990: Launch of the Hubble Space Telescope

BY ABIGAIL DOVE

Launched on April 24, 1990, the Hubble Space Telescope (HST) represents one of the most ambitious undertakings in the history of unmanned space study. Over 30 years in orbit, HST has taken more than 1.5 million observations, and this data has formed the basis of nearly 20,000 scientific publications on objects as near as the moon and as far as the most remote galaxies—not to mention the unforgettably beautiful images of cosmic phenomena that spark wonder about the universe and our place in it. In a broader sense, the story of HST is also an incredible showcase of the highs and lows of "big science"—large-scale, high-budget collaborative projects funded by national governments. As a commentator during the height of the Hubble saga in the 1990s surmised, "For most science news to get printed these days, it has to involve big bang, big bucks, big screw-up, or big comeback—and with Hubble you've got them all."

Hubble being deployed from *Discovery* in 1990
CREDIT: NASA/IMAX

The concept of a space telescope dates back to a 1946 paper by astrophysicist Lyman Spitzer in which he questioned what unimagined parts of the universe we might be able to access with "a large reflecting telescope, many feet in diameter, revolving about the Earth above the terrestrial atmosphere." Spitzer outlined how a space-based as opposed to ground-based telescope could circumvent the turbulence of Earth's atmosphere and better capture wavelengths of light outside the visible spectrum. Put simply, the place with the best view of space is space itself.

Of the many scientists who helped transform the space telescope from idea to reality, one of the most impactful—and underrecognized—was Nancy Grace Roman, remembered as the "mother of Hubble." An internationally acclaimed astronomer in an era when few women were accepted in the field, Roman was tapped by a newly formed NASA in 1959 to serve as its very first Chief of Astronomy. By fostering connections between NASA and astronomy departments across the country, Roman is credited with establishing an ethos at NASA that major astronomy projects would be conducted for the benefit of the broader scientific community. In 1971, she convened a steering committee of NASA engineers and astronomers from around the country to design a space telescope that NASA could feasibly implement, along the way lobbying politicians and writing congressional testimony about the scientific value of such a project, even after funding was initially denied.

In 1977, three decades after the idea of a space telescope was first conceived, Congress at long last approved funding for what was then known as the "Large Telescope Project." Designs for the telescope began in 1978, featuring a 7.8-foot, 1,825-pound primary mirror to collect light from objects in space, as well as several advanced instruments, including a wide-field camera, a high-resolution spectrograph, and a high-speed photometer.

HST's launch date was pushed from 1983 to 1986 due to engineering challenges, and further delayed until 1990 in the wake of the *Challenger* disaster (see *APS News*, January 2021).

The setbacks did not end after HST was finally launched. After years of anticipation, the first images from HST—over 40 years and $1.5 billion in the making—appeared blurry and out of focus, a far cry from the crisp images expected from an instrument of this sophistication. The cause was later identified to be a spherical aberration: HST's primary mirror had been ground too flat by a mere 2 microns, 1/50th the width of a human hair. The primary mirror was designed to bring 70% of a star's light to the same focal point, but with this flaw it could only muster around 10%.

When news of this setback came to light, HST was heavily criticized in the media, lambasted in late night television sketches, and became the subject of a tense, high-profile congressional hearing over who was at fault for the flaw and how it should be fixed.

With HST's fate and the space program's reputation in jeopardy, disaster was averted thanks to two ingenious optical fixes. Work was already underway on a second-generation camera, WFPC2, to be later installed in a future servicing mission. Scientists realized that corrective optics could be implemented into this camera to compensate for the warped primary mirror. Separately, NASA scientists developed the COSTAR device—a set of corrective mirrors that could refocus the light paths of HST's other instruments to properly focus their images,

HISTORY CONTINUED ON PAGE 5

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MEETINGS

Beyond CRISPR: New DNA Tools Rewrite Genes to Fight Diseases Like COVID-19

BY JULIA OSTMANN

When Emmanuelle Charpentier and Jennifer Doudna won the Nobel Prize in Chemistry in 2020, their CRISPR gene editor had revolutionized medicine, agriculture, and genetics in just a few short years. But already, plans were in the works to move beyond CRISPR's simple scissors, which snip genes out of a DNA sequence.

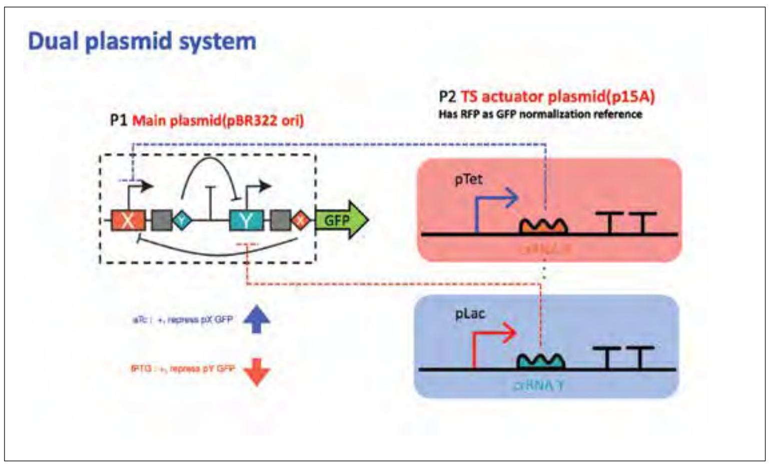
At the 2022 APS March Meeting, scientists revealed powerful new methods for untangling and rewriting DNA.

They announced their latest progress on the first artificial immune system and CRISPR-Cas12a toggle switch, and shared unexpected nanopore tools for gene mapping and parasitic disease diagnosis, at a press conference during the meeting.

Using proteins to *interfere* with CRISPR offers one of the most promising pathways toward building custom genetic circuits. Two groups are investigating how to program the right genes to activate at the right time—and potentially shut down disease.

The COVID-19 pandemic revealed that vaccinations, while effective, cannot be developed and deployed fast enough to prevent a global health crisis from wreaking havoc.

"There is a delay in building up herd immunity," said Yiming Wan, a doctoral biomedical engineering student at Stony Brook University.



Schematic of CRISPRi/dCas12a based dual plasmid genetic toggle switch.
CREDIT: YASU XU

"By properly adapting and combining genetic editing tools with synthetic regulatory circuits, we may be able to develop genetic medicines much faster—protecting not just the healthy, but also patients or elderly people whose immunodeficiency means traditional vaccines work less well."

"In other words, we may be able to develop a programmable, targeted artificial immune system," said Wan. The technique could improve treatment of diseases from COVID-19 to cancer to Zika.

Wan and his collaborators are testing a new method for turning gene expression on and off using a Cas13d RNA enzyme. Their goal is to create a new CRISPR-based platform that allows a scientist to program a viral defense mechanism against RNA viruses like SARS-CoV-2.

Biophysics PhD student Yasu Xu of Cornell University and his team study CRISPR programming using a slightly different protein, Cas12a.

"Recent progress in CRISPR-Cas systems shows their potential as a new generation of genetic editing tools—especially when using a catalytically 'dead' version of Cas proteins," said Xu.

But there are major problems when using Cas12a in particular. So the researchers developed a series of instructions for a tool that toggles between gene-on and gene-off, while maintaining cell stability in both states.

CRISPR CONTINUED ON PAGE 4

JOURNALS

Scientists Present a Recipe for Eternal Bubbles

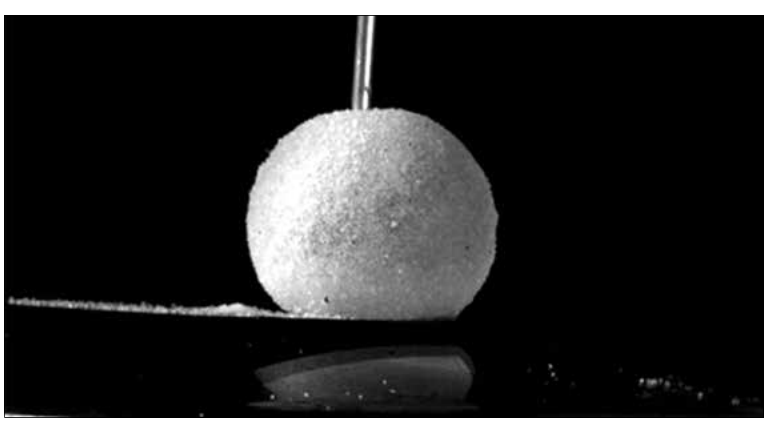
BY ABIGAIL EISENSTADT

Bubbles are many things, like shiny and short-lived. But new research suggests the latter isn't always true. Scientists have now invented "everlasting" bubbles that can survive for more than a year, according to a Letter recently published in *Physical Review Fluids*. Under the right conditions, these bubbles could theoretically last forever, because their composite liquid microparticle-populated films protect them from the usual processes that cause bubbles to pop.

The authors presented their new work earlier this year during an online *Physical Review* journal club session hosted by APS. A recording of the event is available on the APS YouTube Channel (go.aps.org/3IPAtTH).

Senior author Michael Baudoin (Université Lille) described the inspiration for his team's research by summarizing several classical fluidic objects and their properties. He shared that tiny "liquid marble" droplets can roll and bounce on surfaces, showing non-sticking properties. He also mentioned that "armored bubbles," or stabilized microparticle bubbles, can hold non-spherical shapes and resist dissolving.

Baudoin and his colleagues theorized that covering water bubbles with such fluidic objects might prolong the bubbles' lifespans by making their surfaces more resilient. But there was little progress in moving from theory to the design phase until the study's first author



Still frame from a movie showing the opening of a 5.1mm (in radius) stable water/glycerol gas marble punctured by a needle after 33 days. CREDIT: A. ROUX ET AL., *PHYS. REV. FLUIDS*.

Aymeric Roux (Université Lille) joined the team. Roux, a PhD student, designed a recipe to unite water and microparticle into one stable bubble.

The process was simple, Baudoin said: "We simply take some water and put the water in our container and then we take some microparticles—here it's just plastic beads that are about 80 microns—and we spread them at the surface of the liquid." Those microparticles float on the surface of the liquid, forming a "particle raft." Injecting gas into the water beneath the particle raft eventually leads to a freestanding water bubble encapsulated by microparticles.

As the research progressed, the team discovered another group had already published a similar recipe for fluidic object-supported bubbles called "gas marbles." However, compared to Baudoin's work, the recipe reported in the other paper used bigger microparticles, were hydrophobic instead of hydrophilic, and contained surfactant in addition to water. Also, the paper did not examine the lifespan of gas marbles.

Like all bubbles, gas marbles typically have a relatively short lifespan that culminates in a dramatic pop. They typically die in one of three ways: gravity-induced drainage, evaporation, and surface encounters. Gravity-induced drainage causes a bubble's liquid membrane to travel downwards. The film thins at the top and thickens at the bottom, until the bubble becomes unstable and ruptures. Similarly, evaporation causes a bubble's film to lose liquid until it bursts. Encountering a surface can also trigger a bubble

BUBBLES CONTINUED ON PAGE 6

GLOBAL CONTINUED FROM PAGE 1

O'Brien asked Collins whether it feels frustrating to be met with minimal action from policy leaders when sharing urgent information on climate change.

"My takeaway from this is that we need to broaden the channels of communication, so just communicating with world governments is not enough anymore. We need a hearts and minds proposition that reaches out to the activists in the world—the younger people," said Collins. The people who interact with the IPCC have not moved the needle significantly in 30 years, he added.

Such outreach must also highlight the economic benefits that good climate solutions can bring, said Murray. She emphasized that reduction of inequality and preservation of biodiversity were other outcomes with positive economic consequences that could come from international action on climate change.

The panel also discussed how to reconcile competition and collaboration in the scientific field and how to geopolitically enforce collaborative policies to stop climate change. O'Brien then asked panelists to explore how APS can have an impact facilitating such change.

"APS must look at these things holistically," said Murray. APS can contribute to the resolution of interconnected global challenges by educating physicists to be broader in their thinking, she offered. APS could encourage the physics community to engage in transforming energy infrastructures and support cross-hemispheric scientific collaboration, Collins added. APS has a valuable role in lobbying the US government to advance scientific enterprise, said Editor-in-Chief of *Science & Diplomacy* William Colglazier (AAAS), mentioning APS's various forums that inform its involvement on public and social issues. Accessibility of meetings through hybrid options like that at APS further scientists' ability to connect globally, said Akin-Ojio. He added that APS can also work with the government to limit the difficulties associated with citizenship for international researchers applying to receive funding in the United States.

Wrapping up the session, O'Brien asked panelists to prioritize these suggestions. Motivating new students for physics-based solutions to the climate challenge, fostering international collaboration, and communicating solutions to policymakers were among Collins' top picks. Murray included improving science education for all children. Colglazier also brought up continuing to internationalize with the global scientific hub and facilitating dialogues with other physics societies. Akin-Ojo said continuing to train young scientists in Africa and other countries as an investment in future generations.

APS CEO Jonathan Bagger concluded: "It is imperative that all physicists from all parts of the planet be engaged in developing solutions to challenges that are both local and global in nature. That means that physicists worldwide must not only have access to the latest scientific research but also to the larger scientific community to establish the collaborations and connections necessary to tackle these issues."

The full recording of this session is available on YouTube.

The author is a science writer at the American Association for the Advancement of Science. She was previously an APS science communications intern.

CRISPR CONTINUED FROM PAGE 3

"It would be the first CRISPR-Cas12a toggle switch ever," said Xu. "We can create programmable genetic toggle switches that mimic their electronic counterparts, and can help build more complex synthetic genetic circuits."

A group at California State University, Long Beach (CSULB) also wields protein to unwind and explore DNA.

"Nanopore sequencing involves measuring the electrical signal of DNA molecules as they pass through a tiny hole. This gives information about the shape of the molecule," said CSULB biophysicist Alexander Klotz, who leads the investigations.

When you attach a protein, the blocked ion flow through the hole produces a map of the DNA. The team heated up DNA until only the adenine-thymine (AT) bonds melted. Then they added a special protein that only links up with the melted bits—showing exactly where AT lives on the DNA strand.

"It will be the first time that this protein is used to uncover genomic information," said Klotz's student Nathan Howald, who ran the experiment. "The technique fills gaps in several technologies. It combines the portability of a nanopore, the speed of genomic mapping, and the potential to work on all types of DNA."

Nanopores can also help pierce the armor of Chagas' disease, Leishmaniasis, and other parasitic diseases. The parasites have unusual DNA looped thousands of times like chain mail.

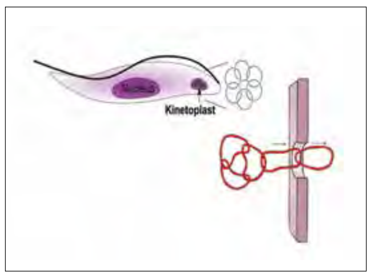


Illustration of a nanopore translocation of kinetoplast DNA extracted from a trypanosome parasite (above).
CREDIT: SIERRA BREYER, ALEX KLOTZ

"We used this chainmail DNA to learn about the physics of a new type of mechanical-chemical bond, and provide preliminary data that may be used to diagnose parasite infections in the future," said Sierra Breyer, the student who led the work.

Biophysicists have tried to simulate pulling the chain-mail DNA through a nanopore, but experiments seemed impractical or even impossible. Breyer broke the chain mail into smaller links to understand what holds them together physically.

"The new results settle a controversy about the role of friction within molecules," said Breyer.

From nanopores to CRISPR toggles, the cutting-edge tools we need to solve some of the most dangerous illnesses lie within the basic physics of our human code.

Julia Ostmann is a science writer at the Global Alliance for Genomics and Health. She was previously a science writer at APS.

PROFILES IN VERSATILITY

Unraveling the Universe Through Knitting

BY ALAINA G. LEVINE

Some people dream about monetizing their hobby. Others, like Elisabetta Matsumoto, make it a scholarly study. This talented physicist uses knitting as a way to discover and explain physical structures of the universe, while using principles of knot theory and soft matter physics to investigate and leverage characteristics of knitted materials.

While Matsumoto had been knitting for over a decade for fun, it was a chance encounter in grad school that started her on this career path at the intersection of knits, knots, and math. Her office mate at the University of Pennsylvania was working on a project involving a hyperbolic plane and when Matsumoto googled it, she found a community of people who crochet these planes and other objects in nature, including coral reefs. "I had always been interested in the geometry of surfaces...This was the first time I connected the dots that there is something mathematically interesting here," she says.

Happy to venture down the rabbit hole, she began knitting and "played in the space for a while to understand the rules for crocheting things mathematically and making mathematical surfaces." Given that she was also interested in knot theory and topics related to symmetry, "when I was applying for jobs, I spun some of those ideas together," she says. "I knew there wouldn't be a lot of competition starting out. And I got a lot of interviews from people who were curious about my work, even if it wasn't a fit in their department."

Now, as assistant professor in the School of Physics at Georgia Tech, Matsumoto leads a group that focuses on geometry and topology of soft materials, in particular the effects of nonlinear elasticity on emergent structural and mechanical properties in complex systems. Knitting serves her in two ways: it is the model and method to explore topological properties in nature. Additionally, she examines the physics and mathematics behind knotted objects, leaning on knot theory and a coalescence of materials science, applied mathematics, physics, engineering, and art. Her lab includes a loom machine.

Her road to science was a family affair; with a mother who is a geologist and a father who is a chemist, "my parents would say I didn't have a choice" about going into STEM, she says with a laugh. Defiant, Matsumoto steered herself towards a surgery career, but when she hit organic chemistry, like many, she took a hard pass. Besides, while surgery would have been fun, "all the advances are made by people in math and physics," she noted, and she wanted to contribute to knowledge discovery. As an undergrad at the University of Pennsylvania, she had many jobs in labs—in part because of her interest in science, but also because of a reason she says is hilarious. "I was shy and was mortified to work, for example, in the library where you would have to talk to random people."

After a bachelor's in physics, Matsumoto remained at Penn for a doctorate in physics with a specialty in chirality and elasticity in liquid crystals, something that set the stage for her shift into topology. "There is something nicely aesthetic about geometry, which I like too," she says. "The topology is really beautiful because you don't need calculus and all of the messy machinery of writing down lots of equations to deal with it. When people are probing things, you have mathematical diagrams. It almost seems tactile—you are moving these imaginary things around and using this to conduct proofs. I kind of like this reductionist side with building blocks, and on the other side it is really fascinating—the global properties you can get out of complex systems. I like that interplay."

Elisabetta Matsumoto

Her job continues to bring her joy, whether it is planning out projects, mentoring students, or engaging in science communications, something that has led to her being featured in the *New York Times*, *Popular Mechanics*, and other publications. Academia, and

KNITTING CONTINUED ON PAGE 6

FYI: SCIENCE POLICY NEWS FROM AIP

DOJ Raises Bar for Research Integrity Prosecutions, Discards 'China Initiative' Label

BY MITCH AMBROSE

This February, the Department of Justice retired the "China Initiative" label for its efforts to counter economic espionage and malign influence by the Chinese government and raised the bar for prosecuting cases involving academic research. DOJ indicated it will exert more oversight of investigations and criminal prosecutions for such cases and will consider seeking civil or administrative penalties for those that lack clear national or economic security implications.

The changes result from a review of the China Initiative conducted by DOJ National Security Division head Matt Olsen, who the Senate confirmed to the role late last year. Olsen explained in a Feb. 23 speech that he concluded DOJ's prosecutions of university scientists through the initiative had created a "chilling atmosphere" that is damaging the U.S. research system. While avowing he detected no racial bias in DOJ's work, he said the exclusive focus on China fueled a "harmful perception" that the department applies a lower standard to cases involving China or people of Chinese descent.

DOJ will now pursue a broader framework that addresses threats presented by a range of countries, though Olsen stressed that the department continues to regard the Chinese government as posing unique challenges beyond those presented by other rivals such as Russia or Iran.

Describing how DOJ will handle research security cases going forward, Olsen said it will assess "evidence of intent and materiality, as well as the nexus to our national or economic security." He also said the department will be less likely to pursue prosecutions in cases where individuals "voluntarily correct prior material omissions and resolve related administrative inquiries."

DOJ launched the China Initiative in 2018 to focus resources on cases involving either overt or "non-traditional" espionage by the Chinese government, and many cases pursued through the initiative have been uncontroversial. However, cases involving academics have sparked outcry because few involve allegations of theft or espionage, resting instead on charges that researchers' nondisclosure of ties with institutions in China were tantamount to criminal schemes to exploit federal funding agencies.

While DOJ secured a conviction against Harvard chemist Charles Lieber for lying to investigators and failing to report income he received from a Chinese university, pressure on the initiative has mounted as other nondisclosure cases have fallen apart. Some scientists charged by DOJ but later exonerated have called for the government to be held accountable for upending their lives, including MIT engineering professor Gang Chen and University of Tennessee nanotechnology researcher Anming Hu.

Chen has argued that DOJ failed to seek and turn over evidence that he did not violate disclosure policies on a 2017 grant application

FYI CONTINUED ON PAGE 6

UNIT PROFILE

APS Membership Unit Profile: The Topical Group on Energy Research and Applications

BY ABIGAIL DOVE

Given the urgency of the climate crisis, the development of technologies to support renewable and sustainable energy is one of society's most pressing scientific challenges. The Topical Group on Energy Research and Applications (GERA) is a home for researchers interested in using the principles of physics to develop new ways to generate, transmit, store, and efficiently use energy with as minimal an impact as possible on the Earth's environment.

Broadly, current energy science and technology research has four main areas of focus: (1) energy sources, including but not limited to solar energy, wind energy, geothermal energy, electro- and photo-catalysis, biofuels, hydrogen energy, and energy harvesting devices; (2) energy storage, which encompasses everything from batteries to fuel cells to supercapacitors to carbon capture and storage; (3) energy utilization, including energy conversion technologies, energy transport, energy transmission grids, and increasing the scalability of such technologies; and (4) sustainability, which covers topics ranging from atmospheric and climate science to increasing the energy efficiency of buildings, transportation, and industrial processes.

As the range of these topics might suggest, GERA's membership—now over 700 people—constitutes a highly interdisciplinary group. Energy research engages not only physicists but also chemists, engineers, and materials scientists, making GERA an important entry-point to APS for researchers with an academic home outside of physics. Furthermore, within physics, energy research draws upon several areas of the field, including condensed matter physics, materials physics, polymer physics, nuclear physics, and computational physics. Within APS, GERA cooperates most closely with the Divisions of Condensed Matter Physics (DCMP; see *APS News* April 2019) and Polymer Physics (DPOLY).

Beyond different academic specialties, GERA encompasses an impressive diversity of sectors where energy researchers work. "Energy research is very multidisciplinary as a portfolio, and GERA attracts researchers from academia, national labs, and industry. We have fundamental science up through applied research represented," explained GERA chair Marina Leite (University of California, Davis). To this end, GERA has also forged a close relationship with the Forum on Industrial and Applied Physics (FIAP; see *APS News* February 2020), both to build connections with energy researchers working in industry and to expose students and early career scientists to the wealth of career options available in the clean energy arena.

Mirroring the rapid development of the energy research field, GERA is a fast-growing unit, with membership rising almost 50% in the past two years. Notably, almost 60% of the group's members are

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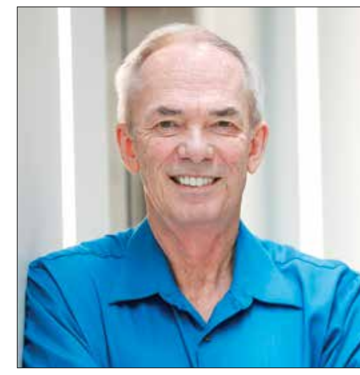
JOURNALS

Q&A with the New Lead Editor of *Physical Review C*, Joseph Kapusta

APS recently appointed Professor Joseph Kapusta, School of Physics and Astronomy, University of Minnesota as the Lead Editor of *Physical Review C*. Professor Kapusta takes the helm following the journal's previous Lead Editor Benjamin F. Gibson.

We sat down, virtually, with Professor Kapusta to learn more about his vision for this storied journal.



Joseph Kapusta

What does it mean to you to be the lead editor of *Physical Review C*?

I am honored and humbled to become only the fourth Lead Editor of PRC in 50 years. The journal has a history of being superbly managed. We have an amazing team comprised of a Managing Editor, 12 Associate Editors, and 1 Assistant Editor. They have the expertise to handle all areas of nuclear physics. They, along with a rotating Editorial Board of 15 members, are what makes PRC the most prestigious nuclear physics journal in the world. Having served as an Associate Editor for many years, I am very proud of this journal.

What is your vision for the journal?

PRC must maintain its high standards for quality so that it is the journal of choice for researchers. As such, it must respect its authors and honor its conscientious referees. I want to continuously build and replenish our referee base by bringing on board early career physicists who are publishing creative research in nuclear physics. We are planning to hold monthly Zoom meetings for authors and referees to provide brief tutorials or information sessions on the editorial process, to answer questions, and to seek comments and feedback so that we can continually improve the journal.

What research are you working on right now?

I am a theorist. My group and I are focusing on the high baryon density matter produced in heavy ion collisions in the Beam Energy Scan II at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL). A big

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essentially acting as a pair of eyeglasses for the telescope.

In December 1993, a team of astronauts was ferried to HST to install the COSTAR device and replace HST's original camera with WFPC2. Lasting 11 days and involving a record-breaking five spacewalks, it was one of the most technically complex missions NASA had undertaken to date. The risk paid off: The first images from the newly refurbished telescope to reach Earth later that month were crisp and clear, setting the tone for the jaw-dropping images that HST is now famed for.

Four subsequent servicing missions have kept HST operational for over 30 years, far exceeding the original expectation of 15 years.

While there is no set date for HST's retirement, no further refurbishments are scheduled. Given the telescope's aging hardware, the best estimates indicate that it will be brought back to Earth at some point during the 2030s.

It is perhaps fitting that the end of HST's tenure in orbit coincides with the launch of the James Webb Space Telescope (JWST), sent into space on December 25, 2021 and currently undergoing calibration tests in preparation to begin data collection later this year. While not technically a successor of HST—JWST is primarily an infrared telescope, whereas HST observes the universe in visible and ultraviolet wavelengths—it was designed to push the boundaries in understanding that HST helped to establish. Among these include previously unaddressable questions surrounding "cosmic dawn" and the formation of the first stars as well as gaining further insight on phenomena such as the expanding universe, a concept first demonstrated a century ago by HST's namesake, the legendary Edwin Hubble.

The author is a freelance writer in Stockholm, Sweden.

Further Reading:

"The Hubble Story." NASA.gov

Chiasson, E. The Hubble Wars, 1994.

OPINION

Nuclear Fusion: How Excited Should We Be?

BY PAUL NORMAN AND LEE PACKER

This article was originally published by The Conversation.

THE CONVERSATION

There's been tremendous excitement about recent results from the Joint European Torus (JET) facility in the UK, hinting that the dream of nuclear fusion power is inching closer to reality. We know that fusion works – it is the process that powers the Sun, providing heat and light to the Earth. But for decades it has proved difficult to make the transition from scientific laboratory experiments to sustained power production.

The fundamental aim of fusion is to bring atomic nuclei merging together to create a different, heavier nucleus – releasing energy in the process. This is different to nuclear fission, in which a heavy nucleus such as uranium is split into smaller ones while also releasing energy.

A significant difficulty has been the process of fusing light atoms, isotopes of hydrogen or helium, together. As they are electrically charged, repulsing each other, they resist fusing unless nuclei are moving fast enough to get physically very close to each other – requiring extreme conditions. The Sun achieves this at its core thanks to its immense gravitational fields and its huge volume.

One approach used in labs on Earth is "inertial confinement", whereby a tiny fusion fuel pellet around one-tenth of a centimetre in diameter is heated and compressed from the outside using laser energy. In recent years, some encouraging progress on this technique has been made, perhaps most notably by the National Ignition Facility in the USA where a 1.3 million Joules (a measure of energy) fusion yield was reported last year. While this produced an 10 quadrillion Watts of power, it only lasted for a fraction (90 trillionths) of a second.

Rendering of SPARC, a compact, high-field, DT burning tokamak, currently under design by a team from the Massachusetts Institute of Technology and Commonwealth Fusion Systems. Its mission is to create and confine a plasma that produces net fusion energy. CREDIT: CAD RENDERING BY T. HENDERSON, CFS/MIT-PSFC

Another technique, "magnetic confinement", has been deployed more broadly in laboratories worldwide, and is thought to be one of the most promising routes to realising fusion power stations in the future. It involves using fusion fuel contained in the form of a hot plasma – a cloud of charged particles – confined by strong magnetic fields. In creating the conditions for fusion reactions to take place, the confinement system needs to keep the fuel at the appropriate temperature and density, and for sufficient time.

Herein lies a significant part of the challenge. The small amount of fusion fuel (typically just a few grams) needs to be heated to huge temperatures, of the order of 10 times hotter than the centre of the Sun (150 million °C). And this needs to happen while maintaining

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BUBBLES CONTINUED FROM PAGE 3

to open, which leads to a loss of gas and subsequent disintegration. Since the other paper did not discuss how these three causes impact gas marbles, Baudoin and his colleagues saw a path forward for their research.

They refocused their experiment on creating an immortal gas marble able to withstand popping from any of the usual culprits. First, Baudoin, Roux, and co-author Alexis Duchesne (Université Lille) had to establish a baseline for bursting. They created particle rafts and injected gas into water to form freestanding microparticle-supported water bubbles. Roughly 38 minutes after the water gas marbles formed, they ruptured. Through analysis, the team determined that this rupture was caused by evaporation. Drainage was less of an issue for the water gas marbles, because the microparticles were creating small capillary bridges. Essentially, these particles were attracting the liquid, creating a surface tension effect larger than that felt from gravity on this micro-scale. Surface encounter did not play a role.

The intuitive next step, according to Baudoin, was to try to prolong the water-based gas marbles' lifespans by counteracting evaporation. They decided to add a hygroscopic liquid, glycerol, to attract water molecules in the surrounding air. Theoretically, the addition of that fluid would help recruit water back from the atmosphere into the liquid membrane to counteract rates of ongoing surface evaporation.

"With this recipe, we were indeed able to have some bubbles that lived for more than one year," said Baudoin, noting that the bubbles, which eventually all popped after 465 days, may have done so because light entered their spheres and altered their compositions. The team also developed a model to better understand how the bubbles, made of composite liquid film and microparticles, were interacting over the course of the year.

"What we discovered is a new material, a long-lasting film," he said, acknowledging that the film itself could be useful in fluidics research.

Following Baudoin's presentation, moderator Jacco Snoeijer (University Twente) opened the online chat for questions. Participants discussed how the composite film bubbles without microparticles might behave in the Space Station, what the maximum achievable size could be for the bubbles, and whether microparticles' size and dispersion were considered during the research. Other questions included where and how the bubbles were stored for the year and how small the bubbles could be made.

Snoeijer concluded the lively conversation by thanking participants for their attendance and commending Baudoin for his presentation on a "beautiful phenomenon."

The author is a science writer at the American Association for the Advancement of Science. She was previously an APS science communications intern.

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he submitted to the Department of Energy. He has also criticized DOE for not questioning the premise of DOJ's charges against him sooner, stating, "The DOE should have spoken up when it counted. That is a lesson for all federal agencies."

Reactions in Congress to DOJ discarding the China Initiative label have split along party lines.

Members of the Congressional Asian Pacific American Caucus, all Democrats, welcomed the move, as did House Science Committee Chair Eddie Bernice Johnson (D-TX). Johnson called the initiative the "wrong solution to a real problem" and a "harmful distraction that has stoked hostility against and suspicion of Asian American and Asian immigrant scientists."

Meanwhile, several Republicans in Congress blasted the decision. Senate Judiciary Committee Ranking Member Chuck Grassley (R-IA) has asked DOJ to reconsider, arguing the department had acted unnecessarily to "accommodate unfounded perceptions."

The author is Director of FYI.

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researchers coming to the US to study and work.

"APS looks forward to continuing to help ensure that the US provides an environment that welcomes international students and all physicists, and that encourages the open, free exchange of information in fundamental science," she said.

The Society has long advocated for the federal government to take a balanced approach to address its research security concerns, specifically fears that foreign governments such as China are attempting to illegally acquire the nation's most advanced technologies must be balanced with ensuring that the pursuit of fundamental science not be adversely affected. APS, while acknowledging that there are legitimate national security concerns, has maintained that the initiative was not the right approach to address those concerns.

For example, in a letter addressed to Biden Administration officials, Past APS President Sylvester James Gates, Jr. outlined a series of recommendations for adjusting the initiative. After the letter's release, Society leaders and APS Government Affairs staff met with DOJ officials regarding the initiative and its potential reformulation. During a meeting with the FBI, staff described the agency's plans for a research security "pivot,"-- a rebalancing of investigations where the FBI focuses on intentional, malign activity and federal agencies handle non-disclosure cases that are administrative or inadvertent in nature.

APS remains committed to ensuring that the best and brightest scientists have opportunities to make their careers in the US. And to that end, the Society is leading several scientific organizations in support of Temple University physics professor Xiaoxing Xi's case to hold the US government accountable for his wrongful arrest and prosecution in 2015 after he was accused of sending American technology to China. To support Xi, APS drafted a legal document—called an amicus brief—and filed it with the US Court of Appeals for the Third Circuit on February 14, 2022. The American Association for the Advancement of Science, the American Statistical Association, the American Geophysical Union, and the Gerontological Society of America joined the brief, and it states that: "The government's wrongful arrest and prosecution of scientists and engineers, particularly those of Chinese descent, is harming the US's reputation as the most desirable destination for the best and brightest scientists to make their careers. That loss of talented scientists reduces the quality and quantity of our nation's trained technical workforce and thereby harms both the economy and our national security."

In addition, the brief makes the point that, "To mitigate these negative impacts, the federal government must be held accountable when it engages in actions like the wrongful arrest of Mr. Xi. Government accountability is a necessary step to: restoring our nation as a destination of choice for international scientists; restoring confidence among US scientists that fundamental research collaborations posing no economic or security threat to the US can be pursued without threat of prosecution; and restoring the confidence of Asian-American scientists that there is equal justice under law."

Francis Slakey, APS Chief External Affairs Officer, said about the brief: "APS stands with physicists, and we are a voice for physicists, so we were very willing to take our message to court in support of Professor Xi."

Relatedly, APS was encouraged by the recent release of the Biden Administration's implementation guidance for National Security Presidential Memorandum 33 (NSPM-33). The guidance document provides federal science agencies direction on key areas of research security.Published as a report by the National Science and Technology Council Subcommittee on Research Security of the Joint Committee on the Research Environment, the guidance document contains the three primary provisions for agencies that APS had advocated for. They include: establishing a risk-based approach to assessing threats; providing a pathway to enable researchers to correct past disclosure mistakes; and involving the Department of Justice only "when warranted." Additionally, the guidance document explicitly requires that "Agencies must implement NSPM-33 provisions and related requirements in a non-discriminatory manner that does not stigmatize or treat unfairly members of the research community, including members of ethnic or racial minority groups."

"We are optimistic that this guidance document points the way to a more appropriate use of the judicial system to address criminal matters but leaves the scientific community and the federal science agencies to address non-criminal scientific transgressions," said Hellman.

Mark Elsesser, Director of APS Government Affairs, said he is encouraged by the progress the Society has made on its advocacy for a balanced approach to research security concerns, and he added that those efforts must continue.

"I'm proud of the role that APS and its members played to help us reach this better place. As we move forward, APS will continue to engage with the government on these issues. We need to work together to have our community once again feel comfortable with engaging in international collaborations and to restore the US as the destination of choice for international physicists," he said.

The author is APS Senior Public Relations Manager.

KNITTING CONTINUED FROM PAGE 4

in particular Georgia Tech, suits her perfectly. "I can't think of anything that gives you as much freedom of thought and ideas. I don't have to deal with the bureaucratic side. I don't have to worry about getting my paycheck," says Matsumoto. "I get a good idea and no one's going to say you can't do that, and you can work with people around the world or across the street and everyone's creative in their own way."

The opportunity and, indeed, the responsibility, to be innovative is something that is always on her mind. "An important part of research that people tend not talk about, is how creative you have to be to make things work. We are used to being told that the person who paints or dances is creative and analytic people aren't creative. But you have to be incredibly creative and resourceful and ingenious to get any research project working—it's always going to break, whether it is theory or experiment, and you're going to have dead ends and the more out of the box thinking you have, the easier it is to find you way out of the dead end into something interesting. It may not have been what you were planning but it will be interesting nonetheless."

Matsumoto is in the middle of the five-year NSF-funded project entitled "What a Tangled Web We Weave", that examines the mathematics of textiles and knitting. She's still polishing the mathematical proofs for one aspect that addresses what type of knots can actually be knitted. The other aspect of the project is equally fascinating and delves into understanding the elasticity of knotted fabrics. A piece of yarn may not have stretch to it, but once a sweater is knitted with the same yarn, the garment gains an elasticity. And with different patterns, you get totally different elastic responses. "We are trying to understand what is happening at the microscopic and mesoscopic level that gives these macroscopic properties to knits," she explains.

She is also seeking to move from investigations of two-dimensional materials to 3D. "So far, we have only thought about flat fabrics, but a sweater or gloves have an intrinsic three-dimensional quality, and you build the geometry into the elasticity," she says. "When you make things that have three-dimensional shape, you are distorting their in-plane characteristics. So can you use that to your advantage and create places that are distortions in one bit and really stiff in another bit?" The application of this research, especially with wearable electronics, where certain parts of the electronics need to be more rigid where others need to be malleable, is exciting.

Not surprisingly, Matsumoto has gained a fandom both in the knitting world and among STEM-enthusiasts, as she actively weaves together both communities. "I personally have a hard time separating my intuition as a knitter, someone who has done a huge amount of hand knitting, from what I understand mathematically," she says. This connectivity is invaluable in her work, as she presses forward with new ideas. "Once you start playing with these materials, you're just like 'why, why, why?' and there's a lot of richness and behavior and I like that I can play with the types of math I like. That's a big draw for me. I really like knot theory and differential geometry, which don't always go together well. I like having problems where I am forced to learn new math, and [knitting] is a really nice framework for that."

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students or early career scientists, signifying the vibrance of this field at a time when innovation in clean energy is more crucial than ever. Additionally, GERA is composed of over 20% women, placing it among the top APS units for gender diversity, but still with ample room for growth.

GERA is well-represented at the annual APS March Meeting. At this year's hybrid meeting in Chicago, GERA hosted three invited sessions and one focus session covering topics such as advances in thermal energy conversion, the interface between renewable energy and data science, computational modeling of materials for energy applications, and the future of energy—including discussions of fuel-agnostic engines for a decarbonized future, updates on fusion energy development, and nanotechnology-enabled energy storage paradigms.

A particular point of pride for GERA is its annual March Meeting Energy Research Workshop, which takes place the day before the main conference agenda begins. With around 100 participants from the United States and abroad, the workshop is an all-day event featuring presentations on hot topics in the field, round-table discussions, and plenty of networking opportunities. "We aim for a balance of senior researchers and upcoming new names in order to promote everyone in our field doing great work," noted Leite. The meeting is unique in that it brings together people from all areas of clean energy research, rather than just those working on one specific problem.

For APS members interested in learning more about energy research and applications outside of APS Meetings, the *Physical Review* journal *PRX Energy* promises to be an excellent resource. The new fully open access and highly selective APS journal will waive all publication fees until 2023 in order to encourage researchers to publish their work there. On a symbolic level, the introduction of a dedicated energy research journal provides important recognition of clean energy research as a major subfield of physics. It also provides a hub for cutting-edge clean energy research in all its diversity, which may otherwise have been dispersed across multiple journals focused on particular subfields of physics.

While GERA and *PRX Energy* are not formally affiliated, some members of *PRX Energy*'s editorial staff contributed to this year's March Meeting Energy Research Workshop. "The *Physical Review* journals have such a well-established reputation. Having a high-quality journal dedicated to clean energy research is excellent development," said Leite.

Looking forward, the GERA executive committee's principal goal for the group is to enliven participation beyond the March Meeting, particularly among younger researchers. The executive committee is currently exploring the possibility of a quarterly webinar series that keeps the broad, interdisciplinary conversations about clean energy research running year-round, particularly for those who cannot attend the March Meeting. "Young researchers can benefit a lot from having a survey of the larger field presented. It is a good way to give students and international researchers access to talks from prominent voices in the field," Leite noted.

Leite summarized the benefits of GERA membership as gaining access to a platform to seek recognition for one's work and network with experts in the field. "There is such a pressing need for clean energy technologies. Being able to showcase your results to an expert audience can help you advance in the field," she explained.

Overall, GERA stands out as a group with a bright future, promoting research and exchange of ideas at the forefront of one of the most buzzing and interdisciplinary areas of physics, at a time when our planet needs it most. More information can be found at the GERA website.

The author is a freelance writer in Stockholm, Sweden.

EP3 CONTINUED FROM PAGE 1

This realization presents a challenge: how to avoid becoming overwhelmed? My advice is to approach this guide the same way one learns a new physics topic: in stages. First read through the online document (using the excellent sectional formatting as an outline) to see what is familiar. Pick up a few ideas that you can use now. Second, create or join a study group to read and discuss the guide in more depth over a period of months or even a year. We don't expect students to learn quantum mechanics in a month; enough time and problem-solving practice are needed. The same is true here, and you'll find plenty of practice problems to work on with colleagues over two semesters.

Finally, use this as a guide for a multi-year cultural change initiative in your organization. Just as you should not try to learn everything alone, you should not try to change the culture of a department in isolation. Join a community of practice such as the SEA Change community, the EP3 DALI program, or APS-IDEA. This is especially important for responding effectively to the resistance facing all such change efforts.

The advice in this guide aligns with what I've learned as a physics department head, university equity officer, and activist. The guide wisely avoids the terminology of "underrepresented minorities" and "pipelines" and explains why putting equity first is important for success. It emphasizes creating a supportive environment for all as opposed to fixing people so they can better survive in a hostile environment. While valuing allies, it encourages them to go further to become accomplices and co-conspirators. And it gave me some great new ideas like renaming office hours and tutoring sessions as well as guidance on trauma-informed teaching.

The EP3 Guide is a living document that will evolve as the field progresses. Important new sections, such as "How to Create and Sustain Effective Change," remain to be added.

The author is a contributor to the "Equity, Diversity, and Inclusion" section of the EP3 Guide and Professor of Physics and affiliated faculty, Program in Women's and Gender Studies, at MIT. APS Head of Education Michael Wittmann contributed to this article.

Q&A CONTINUED FROM PAGE 5

question is whether the QCD phase diagram has a critical point at some value of temperature and chemical potential. We are constructing equations of state with parameters that can be adjusted to represent experimental data. To do this requires us to simulate these collisions from the initial contact through hydrodynamic modeling to the final state of particle emission. It is both challenging and exciting.

Where do you see growth in nuclear research?

Nuclear physics is a well-established but continuously evolving field. Examples of the evolution in accelerator-based research include the Facility for Rare Isotope Beams (FRIB) at Michigan State University, expected to begin operations soon; the Electron Ion Collider (EIC) at BNL, which has been approved for construction; the Facility for Antiproton and Ion Research (FAIR), under construction in Germany; and the Large Hadron Collider (LHC), which will likely run well into the 2030's.

Multi-messenger astronomy is beginning to allow for the observational study of neutron star mergers and to provide information on the properties of dense nuclear matter.

What was a memorable experience you had with publishing a paper?

Any time a well written manuscript containing outstanding physics receives a great review and is accepted quickly is very rewarding to me. A personally memorable time was when another journal asked me to referee my own paper!

What advice would you give to someone submitting to *PRC*?

Briefly, some important pieces of advice are: Consider using a structured abstract, clearly articulating the background, purpose, methods, results, and conclusion. These should be included even if the abstract is in the conventional format. Cite all relevant literature to recognize prior work performed by other authors and to show your knowledge of the field. Finally, check grammar and punctuation with whatever tools or resources are at your disposal. A paper should be a joy to read!

Correction: An earlier version of this article misstated the age of the journal and the year in which it first accepted submissions; in fact, Physical Review C *was established in 1970.*

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confinement in a magnetic cage to sustain an energy output.

Various machines can be used to try to retain this magnetic confinement of the plasma, but the most successful to date is the so-called "tokamak" design, which uses a torus (doughnut shape) and complex magnetic fields to confine the plasma, as employed at the JET facility.

Small step or big leap?

The recent results mark a real stepping stone in the quest for fusion power. The 59 million Joules of energy in total, produced over a five second period, gave an average fusion power of around 11 million Watts. While this is only enough to heat about 60 kettles, it is nevertheless impressive – creating an energy output 2.5 times the previous record, set back in 1997 (also at the JET facility, achieving 22 million Joules).

The success at JET is the culmination in years of planning and a highly experienced team of dedicated scientists and engineers. JET is currently the largest tokamak in the world, and the only device that is able to make use of both deuterium and tritium fuel (both isotopes of hydrogen).

The design of the machine, using copper magnets which heat up rapidly, means that it can only operate with plasma bursts of up to a few seconds. To make the step to longer sustained high-power operations, superconducting magnets will be needed. Luckily, this is the case at the ITER facility, currently being built in the south of France as part of an international effort involving 35 nations, which is now 80% complete. The recent results have therefore given great confidence in the engineering design and physics performance for the ITER machine design, also a magnetic confinement device, which is designed to produce 500 million Watts of fusion power.

Other important challenges remain, however. These include developing appropriately durable materials that are able to withstand the intense pressure within the machine, handling the huge power exhaust and, most importantly, generating energy that is economically competitive with other forms of energy production.

Achieving notable power outputs and sustaining them for more than very short periods of time has proved to be the major challenge in fusion for decades. Without this ultimately being solved, an eventual fusion powerplant simply cannot be made to function. This is why the JET results represent a significant landmark, albeit just marking a step along the way.

The giant leap will come with scaling up of the current fusion achievements in subsequent fusion systems, such as ITER and then in demonstration power plants beyond this. And this should be within reach in the not too distant future, aiming for operation by the 2050s or possibly slightly earlier.

Crucial benefits

There's a lot at stake. Fusion produces more energy per gram of fuel than any other process that could be achieved on Earth. Some of the main benefits of fusion are that the products of the process are helium and neutrons (particles which make up the atomic nucleus, alongside protons) – no carbon dioxide or other greenhouse gases are released. The raw fuels are deuterium, which can be found in seawater, and lithium - which is also abundant and found in vast salt flats. The potential fusion energy released from the lithium contained in one laptop battery and a bathtub of water is estimated to be equivalent to around 40 tonnes of coal.

Fusion does produce some radioactivity in the materials comprising the reactor. But this isn't expected to be anywhere near as long-lived or intense as the radioactive waste produced by nuclear fission – making it potentially a safer and more palatable choice than conventional nuclear power.

Ultimately, Rome wasn't built in a day. Various other aspects of human ingenuity, such as aviation, have historically taken significant amounts of time to progress to fruition. That means steps along the way which make progress are hugely important and should rightly be celebrated.

Fusion is creeping inexorably forward and we are getting closer and closer to achieving that once distant dream of commercial fusion power. One day, it will provide a near limitless supply of low-carbon power for many future generations to come. So while it is not quite there yet, it is coming.

Paul Norman is Senior Lecturer in Nuclear Physics at the University of Birmingham. Lee Packer is Applied Radiation Physics Section Leader at the Culham Centre for Fusion Energy.

THE BACK PAGE

APS Annual Leadership Meeting: Past President's Address

BY S. JAMES GATES, JR.

Good evening. I'd like to begin by thanking the cohort of individuals with whom I've worked during the past three years as a member of the APS Presidential Line. These are people from whom I've learned, leaned on, been advised by, and I am very proud to call these colleagues, but most of all, friends.

These include members of the APS Presidential Line, Past & Present: David Gross, Phil Bucksbaum, Frances Hellman, and Bob Rosner; Board & Council Colleagues, with special mention of Past & Present Council Speakers: Jim Hollenhorst, John Rumble, Andrea Liu, Baha Balantekin, and Robin Selinger; and APS Corporate Leadership: Kate Kirby who retired at the end of 2020, Jonathan Bagger (current APS CEO), members of the Senior Leadership Team, and others. This latter number of people is so large I must beg for forgiveness. Sincerely, this is not out of a lack of recognition, appreciation and truly enormous sense of gratitude, but I would forget to call out the name of some so richly deserving APS contributors to the success (I hope) of my presidential administration.

Perhaps, to be added, I am acutely aware that leaders rarely have the luxury of choosing the times of their service, but times always have the demand to choose the service of leaders. My election as Vice President set my service clock in this domain. I had no idea then what would be demanded during times of a national re-awakening about the reality of racial relations, a governmental trajectory threatening the foundations of our discipline, a once-a-century pandemic, and an unexpected acceleration of debilitating trends in the US cultural, societal, and political atmospheres. I have frequently heard the remark that, "APS has been passing through the most turbulent times since the 1960's!"

I started my APS Presidential year by stating: For an individual, it has been said that character is destiny. For an organization, perhaps it can be said that culture is destiny. Culture and values are tightly linked. Commitment to living the APS Values—the scientific method; truth and integrity; diversity, inclusion, and respect; partnering, cooperation, and open collaboration; speaking out; education and learning—has guided me, and the organization, through a particularly challenging year.

Long ago, I concluded APS is the vessel in which the culture of the discipline is forged. During these times, my administrative goals have been to use deliberation, dedication to an absolute commitment to hard-work, a high regard for excellence, past experience, probity, knowledge of history, and my decades-long observations of the culture of physicists as guide-stars to formulate policies and promulgate best practices that align with our 2019 Strategic Plan. As part of this, consideration of necessary transformations must be on the radar.

Change, however, is never easy.

A look at the letters sent by APS leadership in 2021 reveals the time of my service saw more communications with the Federal Government and the public, by 40% over comparable periods of time for such past activities. The diversity of these communications can be garnered from those directed to the US President's Science Advisor, Department of Defense, the Department of Justice, and the Federal Bureau of Investigation (these latter two most unexpectedly), the Department of Energy, the National Science Foundation, the US Congress, and most certainly our membership and the public. One of the most unusual experiences that occurred was appreciating that APS acquired the capacity and knowledge basis to file a lawsuit.

All of this was in addition to the conceptualization, inauguration, and implementation of the DELTA-PHY ("change physics") initiative. The initiative was launched as an effort for APS to permanently create a structure to deliberate upon and, if needed, move to transform its culture in a conscious manner. It does this by asking three key questions:

(1) What are the values of APS?

(2) Aside from producing world-class physics, what data exists on the inputs, outputs, practices, and traditions of APS?

(3) Do answers to these two questions align and are they in alignment with the APS 2019 Strategic Plan?

S. James Gates, Jr.

DELTA-PHY activities are envisioned to be timely and cutting across the Society's "stove pipes" of organizational structures (divisions, fora, units, etc.). They are a designated "APS Commons" and a lever for the Society-wide conscious initiation and management of its culture and curate its transformational culture change. Perhaps a bit surprisingly, DELTA-PHY has reinforced APS efforts beyond its internal structure. Anyone who attended the Partnering on Research Security session heard encouraging comments from the FBI that we are moving in the right direction.

On two critical issues—research security and the treatment of scientists of Asian descent—DELTA-PHY allowed APS to share with members what APS stands for; what APS is doing on their behalf; and gather feedback directly from the community. It enabled us to do all of this in a transparent way. It can be a tool/platform that APS Government Affairs will continue to use for years to come.

Another highlight from this year includes a number of APS's top science policy priorities in the science and innovation legislative packages from the House (e.g. NSF for the Future, DOE for the Future, NIST for the Future) and Senate (United States Innovation and Competition Act; note that APS doesn't have a position on USICA).

In addition to the increased authorization levels, these legislative packages include policy provisions aimed at: ending sexual harassment in STEM, broadening participation in STEM through research partnerships with Emerging Research Institutions, and addressing the liquid helium crisis.

In my inaugural presidential speech (see *APS News*, March 2021: My Goals for the American Physical Society), I called for 2021 to be a year dedicated to answering a series of questions brought to the foreground by the COVID-19 pandemic. The pandemic has provided us with an opportunity to change our culture consciously and intentionally along several axes.

We've increased APS's capacity to foster more effective communication to our community, through our meetings, for example. I am participating in our third Annual Leadership Meeting and I hope all who are doing so will spread the word of your experiences in this meeting. I also hope participants will advocate to fellow APS members to join future APS meetings. We are improving and executing virtual meetings with a global reach. APS is already a global entity. One of the statistics that is indicative and was recently revealed is that a very high percentage of articles published in our journals involve international collaborations. The advantages of an enhanced schedule of virtual meetings are obvious and during the last year as APS President, I have participated in such meetings in Brazil, Poland, among other countries. APS is also very much aware the in-person modality for meetings remains important, but with the examples of the past year the future points to a continued use of hybrid as these extend the accessibility and inclusivity of our activities.

Through our advocacy, I along with APS leaders in the Office of External Affairs and Government Affairs engaged in direct virtual meetings with high level officials about the "China Initiative." There is also internal advocacy on the need for the Society to be able to demonstrate possible sources of philanthropic support. As the APS 2021 President, I have reached out to the membership in this regard. I am happy to report that to my knowledge, the year of 2021 marked the first time there was 100% donation participation by the APS Board.

We've implemented strategies to foster Diversity, Equity, and Inclusion (what I call true "Cultural Climate Change") and to facilitate the open, global, and secure practice of physics through DELTA-PHY, actions of the APS leadership, and statements of public policy. Through ongoing discussions with the APS Ethics Committee, we are making progress on issues related to conflicts of interest and commitment as well as standards of ethical and professional behavior.

One of the most pleasant experiences of the year was to welcome the new APS CEO, Jonathan Bagger, into a leadership capacity and moreover to work closely with him as he got his sea-legs under him to guide the Society. Jon and I have known each other for over 40 years, and it was very rewarding to be his partner during this time.

I've always had confidence in the strength of our organization, but never more so than now. Having had the opportunity to lead APS as President of the Society in 2021, I enjoyed a unique vantage point—to see the breadth of services APS provides our community, to envision what APS could be in the future, and strategically map out with the help, wisdom, and consultation of my colleagues, foundational steps to secure APS's path forward for generations to come. It is my sincere wish that every APS member would be able to see this organization from a similar vantage point. APS has proven it can weather storms and emerge better for having done so.

We publish the most highly regarded physics publications in the world. By reviewing our governance structure and considering changes to how we manage and execute on our publishing strategy, we will maintain that stronghold.

We have continued to develop, establish, and maintain innovative and important programs for our membership, often in collaboration with our members.

We have convened! Through our computers, in our home offices, with the help of technology, and with large doses of patience and grace, we have shared our love of physics, new discoveries, and new research. We will continue to be adaptive and nimble as the organization faces the challenge of coherently engaging those both among the membership and outside the Society to safely gather in the presence of a variable and sometimes ominous figurative "COVID-19 weather."

These great disruptors—the pandemic, society's social, and political foment that we all are passing through—have not derailed us from our mission: to advance and diffuse the knowledge of physics for the benefit of humanity. As the premiere physics member organization, we constantly strive to maintain and increase excellence, and I know that we have been successful in doing so this year. I now pass the torch to my respected colleague and friend, Frances Hellman, to continue the way forward as your 2022 APS President.

The author is 2021 APS President. He is currently the Ford Foundation Physics Professor, Affiliate Mathematics Professor at Brown University, and Watson Institute for International and Public Affairs Faculty Fellow. This article is adapted from his presentation at the 2022 APS Annual Leadership Meeting.