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APS NEWS

A PUBLICATION OF THE AMERICAN PHYSICAL SOCIETY

ANNUAL LEADERSHIP MEETING

My Goals for the American Physical Society

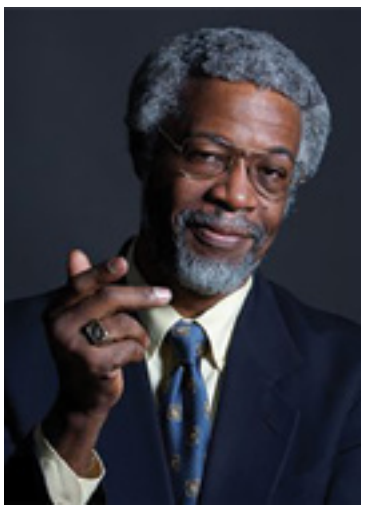
BY S. JAMES GATES, JR.

President Joe Biden has presented the goals of his administration as (a) ensuring our nation's recovery from the pandemic, (b) putting our economy back on a sound footing, (c) confronting issues around diversity and inclusion, and (d) mitigating climate change. Remarkably, those four points in President Biden's agenda map rather well into what I wish to do during my term serving as APS president.

COVID: In complex systems, there is the concept of the "strange attractor" and in astronomy there is the "Great Attractor" of the Laniakea Supercluster. We are hopefully coming to the end of a period that we might call the "Great Disruptor," namely the COVID-19 pandemic. As we look to the coming year, we as a community need to plan for the future and leverage what we have learned from this experience.

Some of my colleagues who do laboratory research have adroitly transitioned to remote work with increases in ease and efficiency. But limited access to observational and laboratory facilities has been a debilitating factor for

GATES CONTINUED ON PAGE 6



Sylvester James Gates, Jr.

The 2021 **Annual Leadership Meeting** was held virtually from February 4 to 6 (see the meeting website at aps.org/meetings/leadership). In addition to the address by APS President S. James Gates, Jr., other articles in this issue cover the APS Medal and Prize Ceremony (p. 3), Supporting Thriving Physics Departments and the EP3 Toolkit (p. 3), and Effecting Change: Individual Actions and Leadership (p. 5). Next month's issue will cover ALM sessions on Communicating Science to Nonscientists in Post-Election & Post-Pandemic America, the APS Physics Slam, and a panel on Federal Policies to Strengthen Science in Service to the Nation.

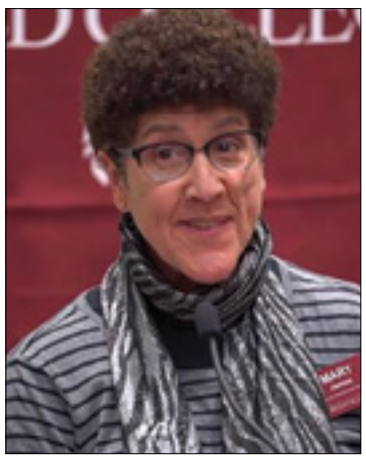
DIVERSITY

CUWiP Leverages Online Format to Build International Connections

BY LEAH POFFENBERGER

The Conferences for Undergraduate Women in Physics have been operating since 2006, with APS as their institutional home since 2012, to empower undergraduate women to continue their studies in physics. Typically, CUWiP conferences take place at 13 different sites across the United States and Canada on the same weekend, with students traveling to the CUWiP site closest to their home institution. This year, due to the ongoing COVID-19 pandemic, CUWiP was held online for the first time, allowing all attendees to interact through various virtual avenues. The online format also added another first: CUWiP became a truly international conference, with attendees signing on from 17 countries.

From January 22 to 24, 1100 students and 100 additional volunteer speakers and moderators gathered online for an uplifting weekend, packed with plenary sessions from inspiring physicists, workshops covering topics from applying to graduate school to managing mental health, and plenty of networking opportunities. This year's Millie Dresselhaus CUWiP Keynote Lectureship featured Mary James, Dean for Institutional Diversity at Reed College, who spoke on what it means to have access to physics education.



Mary James

CUWIP CONTINUED ON PAGE 7

SCIENCE POLICY

APS Releases New Report: Building America's STEM Workforce

BY TAWANDA W. JOHNSON

APS has released a new report that provides recommendations to strengthen the nation's STEM workforce, including building research capacity among emerging research institutions (ERIs), establishing a clear path for international talent to study and work in the United States, improving hostile work environments, and addressing the shortage of qualified STEM teachers.

Titled "Building America's STEM Workforce: Eliminating Barriers and Unlocking Advantages," the report examines both domestic and international challenges and opportunities. It synthesizes a range of public data and reports—complemented with surveys of physics department chairs and APS members—and recommends several federal actions related to building America's STEM workforce.

"This report comes at a critical juncture in our world—a time in which the United States is on the verge of losing its most crucial asset—talented human capital—as its sluggishness in addressing challenges amid increased global competition puts America in a precarious position," said APS President S. James Gates, Jr. "Our report lays the foundation for real, viable solutions to these issues."

Domestic Workforce Challenges and Opportunities

According to the report, the country needs to do a better job in attracting women, racial and ethnic minorities, and rural Americans to the US scientific and technical workforce, noting the importance of diversity in boosting innovation and productivity. One way to achieve that goal: expand opportunities to participate in research—a

STEM CONTINUED ON PAGE 4

MEMBERSHIP UNITS

The APS Topical Group on Statistical and Nonlinear Physics

BY ABIGAIL DOVE

The APS Topical Group on Statistical and Nonlinear Physics (GSNP) is a home for physicists interested in advancing and disseminating knowledge about the interdisciplinary area of nonequilibrium statistical physics.

Founded in the 1940s, GSNP is one of the Society's oldest units. The group has its roots in the Fermi–Pasta–Ulam–Tsingou Problem, the apparent paradox that complicated physical systems tend to exhibit periodic behavior over time.

"Fermi and his collaborators were obsessed by this problem in the closing days of World War II given the advances in computational ability at that time. They realized that there was a body of these puzzling phenomena in systems that were supposed to become random and did not, and this deserved study," explained GSNP chair-elect Thomas Witten (University of Chicago). "From that day to this, the preoccupation of our unit has been on phenomena with so much randomness and disorder that any description requires a statistical approach."

At present, GSNP's focus spans nonlinear science—including dynamical systems, chaos, and complex systems—as well as the application of concepts of statistical mechanics to nonequilibrium systems like granular media, biomolecules, and polymers.

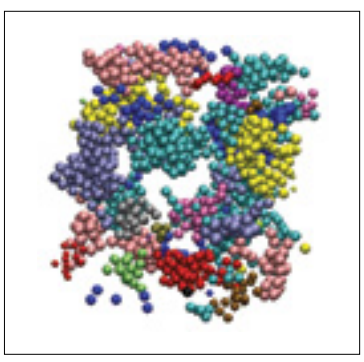


Image shows clusters and crystals of active particles forming in a colloidal suspension. Active matter is one of many topics explored by members of the APS Topical Group on Statistical and Nonlinear Physics. IMAGE: B. M. MOGNETTI ET AL., *PHYS. REV. LETT.* (2013); *PHYSICS* 6, 134 (2013).

The classic areas of interest within statistical and nonlinear physics include phase transitions, turbulence, and collective motion. More recently, interest has also grown around newer topics like dynamic networks and active matter—that is, complex particulate systems in which the constituent parts have their own rules of behavior (such as a flock of birds, a swarm of bacteria, or self-assembling biopolymers).

As these diverse topics suggest, GSNP is a highly interdisciplinary group that draws members from wide-ranging areas of physics. Within APS, GSNP cooperates most closely with the Divisions of Soft Matter (DSOFT; see *APS News* August/September 2019), Biological Physics (DBIO; see *APS News* December 2018), and Polymer Physics (DPOLY). GSNP also has a great deal of synergy with the Topical Group on the Physics of Climate (GPC; see *APS News* March 2020).

With approximately 1,400 members, GSNP is on the cusp of becoming a full-fledged APS division. According to APS policy, a topical group is eligible to rise to division status once its membership exceeds 3% of total APS membership (i.e., approximately 1,600 members) for two consecutive years. With division status, GSNP (or what could soon be "DSNP") will be entitled to additional leadership posts (namely, a dedicated Division Councilor to represent the division's views at national APS council meetings and two graduate student representatives), a greater allocation of sessions at APS meetings, and, on a symbolic level, recognition of statistical and nonlinear physics as a major subfield of physics.

A point of pride for GSNP is its large presence at the APS March Meeting. "We make our major footprint at the March Meeting," Witten explained. "Nearly everything happens there."

PHYSICS CONTINUED ON PAGE 3

EDUCATION

Get the Facts Out Launches New Research Study Sites

BY LEAH POFFENBERGER

In 2018, the American Association for Employment in Education found that the shortage of physics, chemistry, and math teachers was in the top five areas of concern. The Get the Facts Out (GFO) program (getthefactsout.org) is hoping to change that, by reframing the conversation around teaching as a profession and increasing teacher recruitment levels.

GFO hopes to dispel misinformation about teaching and encourage science majors who have an interest in teaching to enroll in teacher certification programs. To do this, GFO provides faculty with research-based and user-tested materials designed to offer accurate and positive information about teaching. Now, GFO is launching inaugural qualitative study sites to track the project's success by implementing, testing, and providing feedback on materials developed by the GFO team.

Six institutions have signed on to be research study sites: Brigham Young University; California State University, Long Beach; Chicago State University; Colorado School of Mines; University of Wisconsin, La Crosse; and West Virginia University.

The Research Study Sites will collect information on implementation of GFO content to help drive the development of more effective positive messaging about careers in teaching. Each site will test GFO materials and workshops, administer surveys to students and faculty, and provide enrollment numbers in their certification programs to GFO leadership. With their research, the Study Sites will contribute to honing GFO materials to help students visualize a career in teaching and combat the shortage of qualified science teachers in the United States.

The GFO project is jointly led by the Colorado School of Mines, APS, the American Chemical Society, the American Association of Physics Teachers, and the Association of Mathematics Teacher Educators, and is supported by a grant from the National Science Foundation.

THIS MONTH IN

Physics History

March 1882: Publication of Étienne Léopold Trouvelot's astronomical drawings

The rise of astrophotography in the late 19th century eventually revolutionized our ability to accurately map the night sky. Around the same time, a French artist and amateur naturalist with a passion for the heavens created a stunning series of hand-drawn astronomical illustrations of the Sun, Moon, Mars, Jupiter, and Saturn, among other objects. Étienne Léopold Trouvelot, who so loved solar eclipses, would see his work eclipsed by an emerging technology. But the beauty of those exquisite drawings is still entrancing people today.

Étienne Léopold Trouvelot
IMAGE: WIKIMEDIA COMMONS

Born on December 26, 1827 in Aisne, France, very little is known of Trouvelot's early life. But he was either forced to flee or was exiled from France in the wake of the *coup d'etat* in 1852 that brought Napoleon to power. By 1855, he had emigrated to Massachusetts, working as an artist to support his family. He also showed a strong interest in natural science, joining the Boston Society of Natural History.

That interest in natural science didn't mean he had a gift for experimental research. In fact, his earliest attempt at amateur entomology proved disastrous on an historic scale. After moving his family to Medford, Massachusetts, Trouvelot decided to raise about one million Polyphemus silkworms on the five acres behind his house. The native species' growth is largely kept in check by natural predators and Trouvelot didn't think the worms produced enough silk.

So sometime in early 1869, thinking he could increase silk production, he brought back a collection of gypsy moth eggs from a European trip. As bad luck would have it, a strong breeze one night blew the imported eggs into the wild. The consequences of this would not become apparent for 17 years, when gypsy moth caterpillars invaded the entire neighborhood in the summer of 1886. The infestation eventually spread to the entire state and the gypsy moth remains a despised invasive species to this day—all thanks to Trouvelot.

Fortunately, Trouvelot's interests turned to the night sky, apparently inspired when he witnessed several spectacular auroras. He started sketching what he saw, and those sketches caught the attention of the director of the Harvard College Observatory, Joseph Winlock, who brought Trouvelot onto his staff in 1872, igniting the artist's passion for astronomy. Trouvelot created hundreds of sketches based on his observations through the observatory's 15-inch refractor telescope, and these in turn became a collection of 35 plates, some rendered in color.

His engravings of the Sun were particularly noteworthy, capturing sunspots and solar flares in exquisite detail. In 1875, Trouvelot discovered so-called "veiled spots," which he thought were

Trouvelot's drawing of Jupiter
IMAGE: WIKIMEDIA COMMONS

a variant on sunspots. And he embarked on an ambitious project to create a series incorporating his observations of Mars, Jupiter, and Saturn. The idea, he wrote, was to "represent the celestial phenomena as they appear to the trained eye and an experienced draughtsman through the great modern telescopes."

He started fixing a ground glass plate, or reticle, to his telescopes, engraved with a grid of squares. Images would be projected onto the grid, and he could make more accurate drawings on paper ruled with a similar grid. Although astrophotography was developing rapidly around this time, Trouvelot was convinced that "a well-trained eye alone is capable

HISTORY CONTINUED ON PAGE 6

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Editor.....**David Voss**
Staff Science Writer.....**Leah Poffenberger**
Contributing Correspondents.....**Sophia Chen and Alaina G. Levine**
Design and Production.....**Meghan White**

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HONORS

The 2021 APS Medal and Society Prize Ceremony

BY DAVID VOSS

With the APS Annual Leadership Meeting entirely online this year, the usual gala festivities that accompany the awarding of the Society's top honors also moved into a virtual format. Hosted by APS President S. James Gates, Jr. and APS CEO Jonathan Bagger, this year's ceremony honored three distinguished scientists for their major research accomplishments; impactful lecturing, mentorship, and communication of physics; and cutting-edge research. A highlight of the event was a documentary video on the lives and research of the honorees (youtube.com/watch?v=VTZ9lqvL59s).

Vedika Khemani of Stanford University received the 2021 George E. Valley, Jr. Prize for "seminal theoretical work on novel phases of many-body localized and Floquet systems, including demonstrating the absolute stability of a time crystal in such systems." The Valley Prize recognizes an early-career individual for an outstanding scientific contribution to physics that is deemed to have significant potential for a dramatic impact on the field. The prize consists of $10,000, a certificate citing the contribution made by the recipient, and an invited talk at an APS March or April Meeting.

William Jackson of the University of California at Davis received the 2021 Julius Edgar Lilienfeld Prize for "outstanding contributions to fundamental chemical physics and spectroscopy associated with asteroids and comets, and for exemplary teaching at both the undergraduate and graduate levels, as well as lifelong service and inspiration to a diverse community." The Lilienfeld Prize recognizes outstanding contributions to physics and exceptional skills in lecturing to diverse audiences. The prize consists of $10,000, a certificate citing the contributions made by the recipient, an invited talk at an APS March or April Meeting, plus expenses for three lectures by the recipient given at an APS meeting, a research university, and a predominantly undergraduate institution.

Gordon Baym of the University of Illinois at Urbana-Champaign was awarded the 2021 APS Medal for Exceptional Achievement in Research for "major discoveries in theoretical condensed matter and many-body physics, neutron star structure and composition, quark matter and quark-gluon plasma physics, and in atomic physics and ultracold quantum gases." The Medal was established to recognize contributions of the highest level that advance our knowledge and understanding of the physical universe in all its facets. It is intended to celebrate scientific inquiry and the pursuit of knowledge. The Medal carries with it a prize of $50,000, a certificate citing the contributions made by the recipient, and an invited talk at an APS March or April Meeting. The APS Medal for Exceptional Achievement in Research is funded by a generous donation from Jay Jones, entrepreneur.

In addition to the documentary film, the entire ceremony can be viewed on the Annual Leadership Meeting website (aps.org/meetings/leadership/) and more information about the awardees is available at the APS Honors website (aps.org/programs/honors/).

Gordon Baym

William M. Jackson

Vedika Khemani

PHYSICS FROM PAGE 1

GSNP's lineup for the upcoming 2021 APS March Meeting includes five invited sessions and 12 focus sessions. Particular excitement surrounds an invited session on cell mechanobiology, which will bring together several illustrations of how motion from molecular behavior within cells can give rise to dynamics at the level of whole cells, tissues, and organs. Examples include the nonlinear dynamics of cardiomyocytes beating in sync with one another and the molecular action underlying the autonomous organization of the winding and unwinding of DNA to coordinate the expression of certain genes at a particular time.

Another hot topic within GSNP's sessions is textiles, topology, and the physics of knitting—a fascinating example of emergent properties given that a one-dimensional strand of yarn can give rise to extremely intricate, three-dimensional objects, and that combinations of just two simple knit stitches can produce fabrics with vastly different elastic properties.

Another major March Meeting event for GSNP is the awarding of its flagship Leo P. Kadanoff Prize for theoretical, experimental, or computational achievements in statistical and nonlinear physics. This year's award went to Sidney Redner (Santa Fe Institute), who will speak about the concept of "first-passage probability" and its applicability to phenomena as diverse as the firing of neurons to the execution of stock options. Given the unexpected cancellation of last year's March Meeting in the early days of the COVID-19 pandemic, the 2020 awardee, Nigel Goldenfeld (University of Illinois, Urbana-Champaign) will also give a presentation summarizing his work exploring how patterns evolve over time—an area that touches everything from the flow of turbulent fluids to the dynamics of geological formations to the structure of ecosystems.

GSNP additionally co-awards the Lars Onsager Prize with the APS Division of Condensed Matter Physics (DCMP; see *APS News* April 2019) to recognize outstanding research in theoretical statistical physics, with an emphasis on quantum fluids.

Looking forward, the GSNP executive committee's principal goal for the group is to increase participation beyond the March Meeting. To this end, GSNP leadership recently initiated a remote seminar group—named the "k log W" group as a nod to Boltzmann's entropy formula—to recognize leading work in statistical physics throughout the year.

Witten summarized the benefits of GSNP membership as a place to seek recognition for one's work and access to expertise in the field. "We provide a forum of people who can best appreciate your ideas and discuss how these ideas can grow and be validated. That's what science is about—that's the value we bring to this branch of science," he explained.

Witten emphasized that people need not specialize in statistics or nonlinear physics in order to gain from the GSNP community: "A lot of our members are mostly interested in a particular phenomenon rather than the fact that it's a statistical problem," noted Witten. "However, anyone who uses statistics stands to gain by becoming a member of GSNP so that they can consult with people, develop ideas, and discuss and where these ideas fit into the overall knowledge of statistical phenomena."

Overall, GSNP stands out as an ambitious and collaborative group within APS, promoting research and exchange of ideas at the forefront of one of the most active and interdisciplinary areas of physics. More information can be found on the GSNP website (engage.aps.org/gsnp/home).

ANNUAL LEADERSHIP MEETING

Strategies and Tools to Promote Thriving Physics Departments

BY LEAH POFFENBERGER

Due to the COVID-19 pandemic placing economic stressors on institutions of higher education, physics departments across the country have become worried about significant budget cuts or even permanent closure. Financial pressure on physics departments isn't a new phenomenon, in part due to a post-2008 trend of state governments disinvesting from public institutions, but as the pandemic exacerbates existing conditions, many institutions are looking for a way forward.

The 2021 APS Annual Leadership Meeting (ALM) featured a special session entitled "Thriving Physics Departments: Proactive steps to take in difficult economic times" to address strategies and tools available to physics departments facing threats. APS President-Elect Frances Hellman and Theodore Hodapp, APS Director of Project Development, moderated a panel discussion with speakers from a variety of institutions: Bob Birgeneau, University of California, Berkeley; Courtney Lannert, Smith College and University of Massachusetts Amherst; Willie Rockward, Morgan State University; Mike Dubson, University of Colorado Boulder; and Kevin Pitts, University of Illinois Urbana-Champaign.

The ALM session also marked a formal introduction of the APS Toolkit for Departments Under Threat, an online resource for physics departments facing immediate risks of closure or significant defunding. The Toolkit, co-authored by Lannert and Jim Borgardt (Juniata College), is a fast-tracked project to address critical challenges facing physics departments.

Launched in conjunction with the new Effective Practices for Physics Programs (EP3) guide (See *APS News*, February 2021), the Toolkit describes actions leadership in crucially at-risk departments can take on three timescales—immediately, in the next six to twelve months,

and in the next three years—to increase enrollments and support their institution's mission. The Toolkit also encourages positive communications among participants and emphasizes the need for quantifiable metrics.

During the ALM session, each panelist made introductory comments, presenting information on various challenges physics departments are currently facing and strategies they have employed at their own institutions. Following opening remarks, the panelists accepted audience questions, before breaking out into seven different virtual discussion rooms, organized around topics such as institutional review and improving departmental culture.

To start the session, Birgeneau discussed the economic factors that have resulted in destabilized physics departments, beginning with state governments divesting from public institutions, some cutting funding by 25 to 30 percent. According to Birgeneau, many institutions expected to have their budgets restored but were never raised to the same level of funding, and a resulting freeze in university tuition, without dedicating resources to low-income students, has created issues. He also stressed the importance of physics education and research playing a core role in the quality of STEM teaching overall.

Lannert then presented data collected by the EP3 project that

TOOLS CONTINUED ON PAGE 6

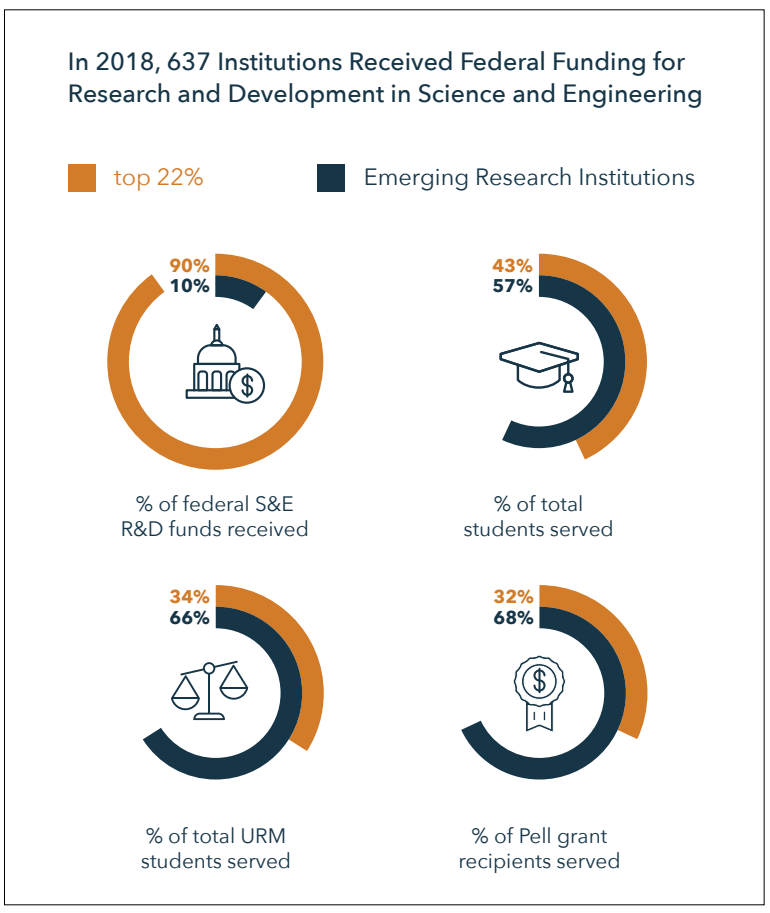
STEM CONTINUED FROM PAGE 1

known high-impact practice for workforce strengthening and diversification—to students from underrepresented groups.

To do so, the report recommends increasing research capacity among ERIs—including minority-serving institutions, tribal colleges and universities, historically Black colleges and universities, and regional colleges and universities with smaller research activities—institutions that historically lag in federal R&D funding behind major research-intensive institutions. In 2018, for example, of the 637 universities that received federal R&D funding in science and engineering, the top 22% of universities received 90% of the funding. ERIs received only 10% of the funding, despite serving 57% of all students attending those institutions. Further, ERIs served 68% of Pell Grant recipients and 66% of underrepresented minority students.

To provide research opportunities more broadly, federal agencies can expand research capacity by encouraging and enabling meaningful partnerships between the nation's top research universities and ERIs. Additionally, federal agencies should encourage more research proposals directly from ERIs, track statistics on awards to ERIs, and conduct a comprehensive portfolio analysis of the awards for ERIs to help identify best practices and methodologies for increasing funding to these institutions. The report notes that the solution is not to reduce the funding of top universities, but to increase overall R&D investments while adjusting distributions to make them more equitable.

The report also concludes that hostile work environments must be addressed to keep the nation on a path to success. In addition to unequal access to research opportunities and training, studies show that there are systemic and cultural aspects of the current R&D ecosystem, especially for women and people from underrepresented minority groups, that detract from an inclusive and productive career environment. The United States must also significantly increase the number of qualified high school STEM teachers, who are critical to creating the 21st century workforce needed to maintain America's global leadership.



International Workforce Challenges and Opportunities

The report also considers the international component of the US STEM workforce. In particular, outdated visa and immigration policies that dissuade, rather than attract, international talent must also change to bolster the US STEM workforce and strengthen the nation's S&T enterprise. For instance, recent federal policies have limited the opportunities for foreign-born scientists and engineers to come to the United States.

To address the issue, APS conducted surveys and gathered testimonials from both domestic and international members to better understand the detrimental effects those policies are having on the country's ability to attract and retain talented international students and scholars. The solutions, according to the report, are to allow international students applying for an F-1 visa to indicate they would like to stay in the United States after graduation, and provide international students who earn advanced STEM degrees from US institutions a clear path to a green card should they choose to stay and work in the country after graduation. The report points out that addressing issues related to both domestic and international students is essential to getting the nation back on a solid footing as an S&T global leader.

Recommendations

"These aren't small challenges, but they're also not insurmountable," said Mark Elsesser, Interim Director of the APS Office of Government Affairs. "In fact, our report highlights a series of actionable recommendations—many of which do not require additional resources—that, if implemented, would help foster a more robust and diverse STEM workforce, which is essential to the United States maintaining its global leadership in S&T."

The report specifically outlines the following recommendations:

Broadening Opportunities by Building Research Capacity

- The solution is not to reduce funding to research-intensive institutions. Instead, we must increase our R&D investments overall, while also adjusting their distribution.
- Agencies should enable and incentivize our top research universities to create meaningful lasting partnerships that strengthen the research capacity at emerging research institutions, including minority-serving institutions (MSIs), tribal colleges and universities (TCUs), historically black colleges and universities (HBCUs), and the colleges and universities with smaller research activities, which are often in underserved states. To facilitate a large participant pool, these partnerships should not be limited geographically.
- Agencies should strongly encourage research proposals directly from emerging research institutions.
- Agencies should track statistics on awards to emerging research institutions.
- Agencies should conduct a comprehensive portfolio analysis of the awards for emerging research institutions and identify best practices and methodologies for increasing funding to these institutions. The report recommends that federal agencies provide funding to expand and sustain high-quality STEM teacher preparation programs at colleges and universities, similar to the NSF Robert Noyce Teacher Program Capacity Building grants

International Workforce

- Allow international students applying for an F-1 visa to indicate they would like to stay in the United States after graduation.
- Provide international students who earn advanced STEM degrees from US institutions a clear path to a green card should they choose to stay and work in the United States after graduation.

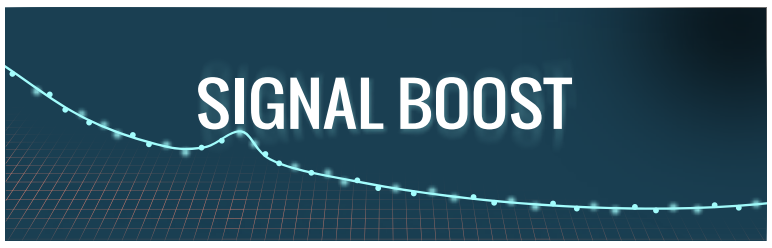
Improving Inclusivity in Laboratories and Work Environments

- Congress should reintroduce and pass the Combating Sexual Harassment in Science Act of 2019.
- Agencies should adopt and implement policies consistent with the NSF's update of terms and conditions: Sexual Harassment, Other Forms of Harassment, or Sexual Assault.

Increasing Qualified STEM Teachers

- Provide federal agencies the funding necessary to expand and sustain high-quality STEM teacher preparation programs at colleges and universities, similar to the NSF Robert Noyce Teacher Program Capacity Building grants.
- Provide federal agencies the funding necessary to increase teacher preparation scholarships and fellowships, such as the NSF Robert Noyce Teacher scholarships and fellowships grants, and expand teacher student loan forgiveness to appropriate levels that address the magnitude of the US STEM teacher shortage.

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



Signal Boost is a monthly email video newsletter alerting APS members to policy issues and identifying opportunities to get involved. Past issues are available at go.aps.org/2nr298D. **Join Our Mailing List: visit the sign-up page at go.aps.org/2nqGtJP.**

FYI: SCIENCE POLICY NEWS FROM AIP

Biden Builds Out Science Team

BY MITCH AMBROSE

Days before his inauguration, President Biden announced selections for several senior science policy leadership positions within his administration, including geneticist Eric Lander as his science advisor and director of the White House Office of Science and Technology Policy (OSTP). Biden also elevated the science advisor position to Cabinet rank, a move that is unprecedented in the history of White House science policy.

Alongside Lander, Biden named sociologist Alondra Nelson as OSTP's deputy director for "science and society," an entirely new role. He also appointed Caltech bioengineer Frances Arnold and MIT geophysicist and vice president for research Maria Zuber as the new co-chairs of the President's Council of Advisors on Science and Technology, marking the first time the council will be led by women.

Lander is widely known in the biomedical research community for playing a major role in the Human Genome Project and later founding the Broad Institute, a major genomics research center co-located at MIT and Harvard University that he directed up until joining the Biden administration. He has long been active in science policy, serving as co-chair of PCAST for the duration of the Obama administration. He also is a leading critic of forensic science methods and how they are used in courtroom settings.

In a letter appointing Lander to the job, Biden invoked the recent 75th anniversary of "Science—The Endless Frontier," a landmark report that World War II science administrator Vannevar Bush wrote at the direction of President Franklin Roosevelt. Suggesting another such pivot point has arrived, Biden wrote, "I believe it is essential that we refresh and reinvigorate our national science and technology strategy to set us on a strong course for the next 75 years, so that our children and grandchildren may inhabit a healthier, safer, more just, peaceful, and prosperous world."

FYI CONTINUED ON PAGE 5

ANNUAL LEADERSHIP MEETING

Advancing Diversity, Equity, and Inclusion

BY LEAH POFFENBERGER

A core tenet of the mission, vision, and values of APS is creating a physics community that fosters diversity, equity, and inclusion (DEI). In line with those goals, the 2021 APS Annual Leadership Meeting featured a powerful session titled Effecting Change: Individual Actions and Leadership. The two-hour session focused on motivations, experiences, and actions that can be taken to improve diversity, equity, and inclusion in the physics community.

Nadya Mason (University of Illinois at Urbana-Champaign), former chair of the APS Committee on Minorities in Physics, and Ed Bertschinger (MIT), co-chair of the AIP National Task Force to Elevate African American representation in Undergraduate Physics and Astronomy (TEAM-UP) moderated the session, which featured eight speakers in three sections. The first section focused on motivations, or reflections on why diversity is valuable, with remarks from Michelle Lollie (Louisiana State University), Brian Shuve (Harvey Mudd College), and Arlene Modeste Knowles (American Institute of Physics). Next, Brian Nord (Fermilab), Jessica Esquivel (Fermilab), and Risa Wechsler (Stanford University) discussed what actions individual physicists can—and should—take to effect change and confront barriers to a diverse, equitable, and inclusive physics community. Lance Cooper (University of Illinois, Urbana-Champaign) and Gina Quan (San Jose State University) then described actions leadership in can take at an institutional level to improve DEI.

Lollie opened the section on DEI motivations with a statement: "I am Michelle Lollie, a Black woman who studies physics—and I am a human being." All too often, she says, society wants to place people in boxes—like being a Black woman or a physicist—rather taking the responsibility of humanizing others. A dedication to DEI centers on taking responsibility for how we treat others and recognizing their inherent value as human beings. Lollie emphasized the importance of humanizing individuals, especially when hearing statistics that attempt to describe the experiences of marginalized groups in physics.

According to Shuve, that innate humanity is a part of the draw of physics: it's something real and universal— "we're all made of atoms." To maximize objectivity while studying such a universal field, he says, the physics community should reflect the demographics of our society. But it doesn't—thanks to biased structures, metrics, and expectations that have compounding, destructive effects on marginalized groups. By focusing on such metrics, physics misses out on empathy, community organization, and new ways of thinking through a continued exclusion of people of color, LGBTQ+ people, and others. "If we truly believe we're doing physics because it makes the world better, we have to make it more human and less discriminatory," said Shuve.

Modeste Knowles presented data on the persistent exclusion and underrepresentation in physics of women, people of color, people with disabilities, LGBTQ+ people, and others. For example, even as the number of physics degrees awarded in the US has grown 75 percent since 2004, there has been no change in the number awarded to Black physicists. Failure to foster diversity comes at a cost: a less robust STEM workforce for the future, the reduced ability to solve complex problems for the field of physics, and an even bigger cost for those who are marginalized, who are forced to endure environments hostile to their identity groups on a daily basis. "Engaging in DEI work is just the right thing to do, if you believe we're all capable of succeeding in physics and you believe that everyone has the right to pursue physics, without being encumbered by sexism, ableism, and other forms of oppression," said Modeste Knowles.

As the focus of the session shifted into how to take action, Nord called out institutions that talk about diversity, but instead of taking action, prioritize institutional power and the comfort of predominantly white, male physicists over justice and change. He described a need for individuals—especially those with power—to reflect on what actual changes are happening at institutions and to make space for those with real knowledge of how to make such changes happen. Nord also spoke of the need for change now, instead of asking physicists from marginalized groups to wait around for incremental improvements or compromise—a practice he says is common, and incredibly damaging. "We are in a state of urgency... watching how white supremacy has a stranglehold on the world—and physics is not separate," said Nord. "For the majority of its existence, physics has not embraced this urgency—if it did we would not be where we are."

Next, Esquivel discussed the task of individual activism, which she undertakes at the expense of her time, her career, and at times her health. "The aim is to change the physics spaces we work in so that we aren't uncomfortable, but that requires uncomfortable conversations and dismantling an oppressive system," she says. Esquivel is deeply involved with work to create these spaces, through Black In Physics, a community built to highlight Black scholars and create a counter-space that focuses on the whole self, and ChangeNow, a collective of Black physicist at Fermilab, calling for the physics community to take action to value Black Lives. This is work Esquivel undertakes because she has to, not because she wants to, she says, and she called on others to join in the work: "it's easy to laud the efforts [of] marginalized people, but it's important to note that we didn't choose physics to clean up the mess we didn't create... use this as fuel to not be allies, but accomplices."

Wechsler echoed previous themes of centering humanity in physics and the importance of bringing as many people to the table as possible. She emphasized the importance of listening to the experience of Black, Brown, and transgender colleagues—anyone who experiences the physics community in a different way, and who do not have the option to wait on incremental change. Wechsler discussed work she has participated in at Stanford to build a community dedicated to

addressing diversity at her institution, stressing the need for many different voices being part of this community. She also described the experience of not feeling like she had the power to make change, and how to navigate it: "I had learned a lot about reaching outside of my own comfort zone to talk to senior white men about how they can do things I can't...you have to do what works for you at the stage of the career you're at."

The final section of the session focused on how leadership can effect change at their institutions, with Cooper describing practical ways for administrators to identify and address the barriers to a more vibrant and diverse physics department. He recognized the importance of making structural changes and challenging the current systems in place for recruitment and admissions. As an example, he discussed the effect that de-emphasizing the GRE had on admission, doubling the number of women admitted to the physics PhD program at University of Illinois, Urbana-Champaign and increasing the number of Hispanic and Black applicants by 80 and 50 percent respectively. "What we're trying now is taking a holistic view of students—trying to find the things we value, but that might otherwise be ignored in the traditional admissions process," says Cooper.

Quan concluded the final section by sharing two projects that represent collective efforts to cultivate institutional change. She discussed the Departmental Action Team (DAT) project that brings faculty, students, and staff together to create change around educational issues by shifting departmental culture and helping DAT participants become change agents by developing new skills. Another project, The Access Network, supports student leadership in advancing equity in STEM at sites across the country. Both of these projects focus on students, and Quan emphasizes that these students should be recognized as full members of such organizations and be rewarded and compensated for their work. She also discussed the need to view work for institutional change as a continued process that should be evaluated and adjusted as necessary. "If you recognize that change is an ongoing process, you can look at change as an iterative process that can be evaluated; can introduce new ideas," says Quan "This perspective is valuable, since our environment is always changing."

A question and answer session followed, along with an invitation for participants to list their own ideas for improving DEI at their institutions in a provided chat-box. Mason ended the session which a challenge to the audience: "become an activist in whatever way works for you."

Recordings of this and other sessions at the Annual Leadership Meeting are available at aps.org/meetings/leadership.

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How Lander's role will mesh with other science-related positions in the White House remains an outstanding question. For instance, Biden has also designated Anthony Fauci, director of the National Institute of Allergy and Infectious Diseases, as his "chief medical adviser," and former FDA Commissioner David Kessler as the "chief science officer" for his pandemic response. In addition, his two top climate advisors, Gina McCarthy and John Kerry, have their own dedicated staffs.

Biden's letter to Lander suggests his position will have a strong focus on strategic matters, instructing him to recommend "general strategies, specific actions, and new structures" for the federal government's science and technology portfolio.

Echoing four questions that Roosevelt posed to Bush, Biden asked Lander to consider five: what lessons the pandemic holds for public health, how science and technology can address climate change, how the US can ensure it is a world leader in technology, how the benefits of science and technology can be broadly shared among Americans, and how to ensure the "long-term health" of science and technology in the US.

The first task that Biden has assigned Lander is to lead a wide-ranging review of scientific integrity policies across the federal government, which will recommend improvements and examine past instances where researchers have been subject to "improper political influence."

Outside the White House, Biden has chosen to retain Francis Collins as director of the National Institutes of Health, a position Collins has held since President Obama appointed him in 2009. As expected, Sethuraman Panchanathan is continuing his six-year term as director of the National Science Foundation, having been confirmed by the Senate for the job last year. Biden will continue to make selections for key science leadership jobs within his administration over the course of the coming months, many of which will require Senate approval.

The author is Director of FYI.

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GATES CONTINUED FROM PAGE 1

many physicists. As a university instructor in my 50th consecutive year in the classroom, I don't expect education to return completely to what was conventional beforehand. In teaching students online, I have learned things that I cannot do in a real world classroom and a number of us have had this experience.

Last year, beginning with the March Meeting, APS was forced to operate in a completely new virtual manner. The extraordinary process that enabled the APS leadership to cancel the March Meeting in real time was an amazing thing to witness. The Presidential Line, the Speaker of the Council, the Treasurer, and the Senior Management Team of our Society all performed at the highest level.

On the evening of February 29, 2020 at 9pm, all of the leaders met on a Zoom call to discuss whether we would hold our planned meeting in Denver. All of the relevant factors were discussed: the late breaking news on international developments, reports on the trajectory of the international spread, and the highest regard for the health of APS members and the host community. In the end, it was the data and the science that drove this difficult decision, which avoided a "superspreader" (a word then unknown) event and saved lives.

This year, we had our Annual Leadership Meeting online and it was a very active and exciting conference (aps.org/meetings/leadership/). Going forward, how do we find the right balance between pre-pandemic and post-pandemic procedures?

The economy: As a community, we have to confront changes to the economic resources that traditionally have supported physics. What will be the priorities of the National Science Foundation and the Department of Energy? What will be the state of philanthropy? The Society will continue to strongly advocate for the funding that supports the physics enterprise in all of its dimensions.

Our colleges and universities are struggling during this dire pandemic. We had an entire session at the Annual Leadership Meeting dedicated to the kinds of challenges that our academic members face because a large percentage are within the university environment. More broadly, much will have to be done for members outside academia as well.

And for APS and the economic challenges we face, how do we find the sweet spot to ensure a financially sustainable model amid changes in journal publishing and virtual meetings? I will work with the Treasurer and the experts on the APS Senior Management Team to ensure that we go forward as a viable organization.

Diversity, equity, and inclusion: In 2019 the new APS Strategic Plan was presented. This document put front and center our commitment to diversity, equity, and inclusion. In a sense, we were ahead of the curve, whereas later the country as a whole only started really debating this issue with, first, the tragic and horrible deaths of George Floyd and Breonna Taylor and so many others. Then, the massive protests that took place afterward around the country were manifestations of an apparent awakening.

In response, APS has been having a series of webinars that we have called DELTA PHY ("change physics") to bring these issues to our membership. These are archived on the APS website (aps.org/programs/minorities/webinars/); you can view the recordings and see the sorts of topics we are tackling in the webinars.

I will work for our Society to remain ahead of the curve. On diversity, equity, and inclusion, I want our Society to be an example to all STEM societies.

Climate change: Here, I don't mean Father Time and Mother Nature and global warming per se, but instead the cultural climate of the physics community. I will challenge us to improve the climate of our community, specifically with regard to several concerns I have.

Diversity is one of them. But what about the issue of ethics? There persist disturbing stories about scientists who have not been transparent about funding sources. Conflicts of interest and commitment seem to abound. Our government is increasingly concerned about undue influence and deleterious impact on our national security and our economy. Although I believe we are seeing overenthusiastic steps being taken, our government does have a point about foreign influence, and we can't dismiss it.

Lack of transparency runs counter to the norms and practices of scientific culture. What can we as a Society do to support our own values? APS has begun formulating a path toward establishing higher ethical standards as well as initiated discussions on how to hold transgressors of these norms accountable.

And there is simply the issue of how we treat each other—are we respectful of one another? Those of us who are physicists need to respect our colleagues who are not faculty members and who are not researchers. Do we hold our colleagues in respect?

Do our cultural norms enable or inhibit the effective communication of our science to nonscientists? The public investment in physics from pure theory to experiment and observation all the way to practical applications is dependent on our ability to share our stories.

These are all issues rooted in our culture, and I am hopeful that the DELTA PHY model, which so far has been applied to diversity, equity, and inclusion, can be broadened to become a community common where we can collaboratively and intentionally engage these questions: What is our culture? How is this culture compatible with our values?

Climate change, in this sense, is something I want to address during my term as APS president. I have no illusions that I will complete this work, but I do have the hope of establishing these four points as sustainable, dedicated actions that we will take to improve our community.

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. Gates received the 2011 National Medal of Science, with a citation reading, "For his contribution to the mathematics of supersymmetry in particle, field, and string theories and his extraordinary efforts to engage the public on the beauty and wonder of fundamental physics." In 2013, he was elected to the National Academy of Sciences and later elected to the council of the NAS. Currently, he remains an active researcher at the boundary of mathematics and physics. This article is adapted from his presentation at the 2021 APS Annual Leadership Meeting.

HISTORY FROM PAGE 2

of seizing the delicate details of structure and configuration of the heavenly bodies, which are liable to be affected, and even rendered invisible, by the slightest changes in our atmosphere."

He was, of course, wrong about that. Astronomy libraries and observatories were initially eager to purchase his chromolithographs, but interest waned as astrophotography continued to improve, since actual photographs provided even more detailed and accurate depictions of celestial objects.

All in all, Trouvelot completed around 7000 drawings, using the facilities of several observatories. The best of the completed pastels was exhibited at the first World's Fair in Philadelphia in 1876, along with Alexander Graham Bell's telephone, the first commercial typewriter, and the right (torch bearing) arm of the Statue of Liberty. But Trouvelot craved an even larger audience for his work. In March 1882, Charles Scribner's Sons published Trouvelot's scientific writings under the title, *The Trouvelot Astronomical Drawings Manual*.

"While my aim in this work has been to combine scrupulous fidelity and accuracy in the details, I have also endeavored to preserve the natural elegance of the delicate outlines peculiar to the objects depicted," a humbler Trouvelot wrote in his introduction. "But in this, only a little more than a suggestion is possible, since no human skill can reproduce upon paper the majestic beauty and radiance of celestial objects."

Trouvelot remained fascinated by the Sun for the rest of his life, and he was especially keen on solar eclipse, even traveling to what was then the Wyoming Territory with his son George in July 1879 to witness the eclipse, setting up their telescopes at a nearby Naval Observatory research camp. In 1882, after the publication of his manual, he returned to France to work with famed astronomer Jules Janssen, then director of the Meudon Observatory.

Back in Meudon, Trouvelot's relationship with Janssen soured. He wrote to American friends about how much he missed "the purity of the American sky" and longed to return, particularly given his failing health. But it was not to be. Trouvelot died in Meudon on April 22, 1895. Craters on both the Moon and Mars are named in his honor.

Further Reading:

Herman, Jan K. and Corbin, Brenda G. (1986) "Moths to Mars," *Sky and Telescope* 72(6): 566-568.

Onion, Rebecca. "Beguiling 19th Century Space Art Made by a Self-Taught Astronomical Observer," *Slate*, January 21, 2015.

TOOLS FROM PAGE 3

had helped to spur the creation of the Toolkit. Even before COVID-19, almost half of US physics departments have at some point faced some kind of threat—be it significant funding cuts or closure. In response to this report, APS has launched both EP3—a project to improve physics departments by building on research and community knowledge—and the Toolkit for Departments under threat. The Toolkit is a targeted, strategic tool, created with the help of 50 department chairs and administrators at range of institutional types.

For inspiration on what a thriving physics department looks like, Rockward described what he calls the C.A.R.E approach, with each letter corresponding to several goals: C for community, climate, and collaborations; A for awareness, administration, alumni, and appreciation; R for recruitment, retention, research, and rewards; E for EP3, entrepreneurship, and enthusiasm. Enthusiasm, he says, is critical in thriving departments, with excitement for physics driving interest from students and support from the surrounding academic community.

Dubson, who comes from one of the largest physics departments in the country with close to 600 physics majors, described the systems in place within the department to place a value on teaching. Tenure track faculty and instructors rotate through teaching as many courses as possible, with instructors usually taking on freshman lectures and course development projects. He also described how his department has remained a thriving one, despite freshman enrollment being down this year due to COVID.

Pitts then offered what he called a campus perspective on the budgetary constraints that Birgeneau introduced. Since every department on campus faces the same squeeze from reduced budgets, Pitts advises ensuring that a department's goals align with an institution's goals and priorities. He also says that campus leadership responds well to a department doing their own prioritization of needs and demonstrating efficiency—creative ways to cut costs without cutting jobs.

After their opening remarks, the panelists took questions on a variety of topics, from how to implement lessons learned during the current period of online instruction to ways of making physics more attractive to incoming students. Session attendees were then able to interact more closely with the speakers and other experts in small-group breakout rooms, choosing whichever topics were most useful. The breakout rooms also enabled brainstorming and sharing of ideas and resources among participants, using their broader community to strengthen their home departments.

EP3 Effective Practices for Physics Programs

Recordings of this and other sessions at the Annual Leadership Meeting are available at aps.org/meetings/Leadership. Resources for creating a thriving physics department are also available at EP3guide.org and EP3guide.org/toolkit.

CUWIP CONTINUED FROM PAGE 1

Despite the online format, attendees were able to build connections with other women in physics with whom they can share experiences, advice, and ideas, a primary goal of CUWiP. Through the Zoom chat function, attendees discussed and reacted to talks in real time, commiserating about shared experiences—experiences they were used to coping with alone, often in a class where they don't see people like themselves. "Speed Geeking" sessions sprinkled throughout the conference also gave attendees a chance to broaden their networks, with 10-minute sessions in randomly assigned Zoom rooms with 10 other people. Speaker breakout rooms provided a space after each session to keep discussions and questions going. Some of the attendees even started their own Discord messaging channel for the conference, hoping to preserve and continue the connections they were making with other women in the physics community.

The conference kicked off on Friday evening, with the first of four plenary sessions: a panel featuring Kelly Nash (University of Texas at San Antonio), Érica Silva (Federal University of Mato Grosso), and Jessica Esquivel (Fermilab). In a discussion moderated by Barbara Szczerbinska, Chair of the CUWiP National Organizing Committee, the panelists shared their personal journeys into physics and answered audience questions. A recurring theme of the panel was overcoming obstacles faced by people in marginalized groups in physics, from imposter syndrome to harassment. The panelists shared their own strategies of successfully navigating careers in physics, emphasizing the importance of building a strong support system, caring for mental health, and remembering that failure is a part of physics—not a sign someone doesn't belong.

After the panel discussion, CUWiP attendees had their first chance to chat face-to-face in their first Speed-Geeking session, before heading to a virtual networking fair. The networking fair utilized an online meeting program called Gather Town that allows users to pilot a tiny avatar through a virtual space. Attendees were able to make connections with representatives of different labs, schools, and companies by simply walking up to a booth with their avatar and starting a video call—almost like a real-life interaction.

On Saturday morning, attendees had their choice of workshops and talks to attend during three different time slots. The parallel sessions ranged in topics, from applying to and navigating grad school, to a leadership workshop, to discussions of various physics careers. Breakout sessions after each session allowed speakers and attendees to interact further.

A highlight of the conference for many students was the Millie Dresselhaus CUWiP Keynote Lectureship, which took place Saturday afternoon. In her talk, James reflected on her own path into physics and the ways her professors at Hampshire College, MIT, and Stanford ensured she had access to everything she needed to succeed. Throughout her career, James has worked to help physics become more welcoming and supportive of those who may not have those tools to access the field: James has served as chair for the APS Committee on Minorities and recently was the co-chair of the American Institute of Physics Task Force to Elevate African American Representation in Undergraduate Physics and Astronomy (TEAM-UP).

James described a number of barriers that are in the way for many students walking into physics classrooms, especially those coming from underrepresented demographics: imposter syndrome, stereotype threat, belongingness uncertainty, and fixed-mindset thinking. To help overcome these obstacles, James reminded attendees to tap into their savvy, tenacity, and resilience, to take advantage of resources they are entitled to, and to not let anyone steal their joy.

Following a speaker chat and a short break, the third plenary of the conference featured Anita Sengupta (University of Southern California), who discussed the exciting engineering involved in exploring Mars. While she is currently Chief Product Officer at an engineering start up as well as an associate professor at USC, Sengupta spent 16 years with NASA's Jet Propulsion Laboratory (JPL), most recently working on Mars rover landing technology. Through her talk, Sengupta stressed the importance of trying new and different things in her career as she turned her love of sci-fi into real science. When she was tapped at JPL to work on landing technologies for Mars rovers, Sengupta says she wasn't then an expert, but jumped at the opportunity to "follow [her] curiosity."

More parallel sessions followed, going into Saturday evening, and resuming on Sunday morning. Attendees were able to learn about important topics, such as dealing with imposter syndrome and sexual harassment in physics, as well as practical skills like negotiation and communication. Student lightning talks on Sunday featured 10-minute presentations showcasing undergraduate research.

On Sunday afternoon, the fourth plenary and official closing session of the conference featured Sharona Gordon, professor of Physiology and Biophysics at the University of Washington and founder of Below the Waterline, an organization working to combat sexual harassment in academic science, engineering, and medicine by changing the climate in these fields. Gordon described a profound sense of not feeling safe growing up, due to a family culture that seemed to penalize her for being female: a search for safety pushed her quickly through school. Her strategy was to amass so many credentials that no one would discriminate against her—a strategy that ultimately failed, as she continued to face harassment and discrimination, even as an associate dean. She came to the conclusion that "only in a world that we're all safe can anyone feel safe," and became devoted to helping others—especially women and others from underrepresented groups—succeed in physics.

She spoke on Below the Waterline, which was launched in response to a National Academy of Sciences report that identified three types of sexual harassment that was depicted as an iceberg: the first two types, sexual coercion and unwanted sexual attention, exist above the waterline. The third type, gender harassment, floats below the waterline, making it less apparent even though this type of harassment is the most pervasive—and contributes substantially to an unwelcoming community. According to Gordon, melting the iceberg starts with changing the temperature of the water through everyday behaviors to improve the environment of science. While navigating physics, Gordon reminded attendees to have self-compassion, and trust they already have everything they need to be successful.

Student feedback, shared by attendees during and after the conference, indicated that many attendees found that the plenary talks and discussions with other students made them feel less alone in the world of physics. Some students also specifically enjoyed the online conference, having never had a change to attend an in-person CUWiP in the past.

The 2021 CUWiP Conference was made possible with sponsorship from the National Science Foundation, the Department of Energy, and the Heising-Simons Foundation, with additional support from the Alfred P. Sloan Foundation, General Atomics, and Google Quantum AI. Recordings of CUWiP sessions are available at the Women and Gender Minorities community on APS Engage (engage.aps.org).

THE BACK PAGE

Lewis Latimer: The Shadow Behind the Light Bulb

BY GARRETT R. WILLIAMS

The post-civil war period in the US saw many scientific discoveries foundational to technology today. Notable among these breakthroughs was the invention of the incandescent light bulb, attributed to the famous Thomas Alva Edison [1], along with his less-known African American collaborator, Lewis Howard Latimer.

When illustrious scientific minds such as Edison and Hiram Maxim raced towards new heights of innovation, Latimer's knowledge of physics and electrical engineering proved invaluable. During a season of explosive change in American culture, Latimer's rise from the son of a slave to remarkable inventor is a historical gem, although the details of the story have fallen through the cracks of history. The existing records about Latimer are scarce and in somewhat poor agreement on important specifics concerning his relations to the early electric lighting industry, greatly inhibiting the accessibility of his story.

Lewis H. Latimer
IMAGE: WIKIMEDIA COMMONS

Garrett R. Williams

Latimer, from Desk Clerk to Draftsman

Born in Chelsea, Massachusetts, on September 4, 1848, Latimer was the youngest of four born to George and Rebecca, who had escaped from slavery in Virginia in 1842. In 1864, seven years following the famous Dred Scott case, George Latimer went into hiding, fearing the return of slavery, leaving sixteen-year-old Lewis to falsify his age and enlist in the United States Navy to support his mother and siblings during the Civil War [2].

After an honorable discharge, he took up a desk position at the Crosby and Gould patent law office, where he taught himself mechanical drawing and drafting by observing the work of the firm's draftsmen. While records do not unanimously agree on Latimer's level of formal education—some suggest he received training at Phillips Grammar School in Chelsea, others insist he was largely self-educated [2]—there is no doubt of Latimer's profound skill in physics, mechanics, and design.

As a desk clerk, Latimer was able to hone a profound attention to detail and a thoughtfulness that made the office boy stand out even among experienced professionals. Recognized for his talents and quick wit, Latimer was soon promoted to draftsman. As a draftsman, Latimer was integral to a number of revolutionary projects, including Alexander Graham Bell's design of the telephone [3]. Before long, Latimer became directly involved with the booming field of incandescent lighting physics.

Latimer as an Expert in his Field

In 1880, Latimer was sought as an assistant manager and draftsman by Maxim, Edison's primary competitor, at the US Electric Lighting Company. Years later, Latimer was recruited by Edison at the Edison Electric light Company.

The available details surrounding Latimer's work with Edison and Maxim are highly controversial: Some sources make no mention of his scientific prowess, remarking only on his activity as a patent clerk. Other sources insist that Latimer was a scientific equal and forerunner on these research teams and that the records are far too deferential to Edison individually. These scholars speculate the deference was likely a reflection of the times when big ideas couldn't possibly be ascribed to non-white people [2]. However, substantial evidence exists for one of Latimer's contributions: the integration of the carbon filament into the 1879 design credited to Edison. The filament was able to better regulate electrical discharge because of the natural durability of carbon, significantly lengthening the lifetime of the bulb for practical use [4]. While working with Edison, Latimer wrote the time's most thorough book on electric lighting, the 1890 *Incandescent Electric Lighting: A Practical Description of the Edison System*.

For this work, Latimer was formally acknowledged as one of the charter members of the Edison Pioneers, a distinguished group of people deemed responsible for creating the electrical industry. Latimer was the only person of African ancestry in the organization when it was officially formed on January 24, 1918. In 1929, on the 50th anniversary of Edison's pre-carbon filament design of the light bulb and widely heralded invention of electric light, Latimer's two daughters were guests of honor of the Edison Pioneers' annual meeting. However, when the 75th anniversary was celebrated in 1954, no mention of Latimer was made [4].

Latimer on Electrical Energy and the Carbon Filament

In *Incandescent Electric Lighting*, Latimer recounts the physics that lay the foundation for electric lighting [5]. Latimer had a mastery of his craft and a gift for teaching and is said to have even shared his passion with his siblings and mother before her death in 1910. This book was extremely popular as it presents how an incandescent lamp produces sustainable light in an easy-to-comprehend, conversational style. In this text, Latimer describes that although complex, the electric generator is possible to understand.

In his book, Latimer explains that the same force responsible for shifting a needle around on a smooth table as a magnet waves over it can also induce electrical current in a copper wire [5]. Latimer intuitively applied the basic concepts of electromagnetism, a term coined by Danish Scientist Hans Christian Oersted in the 1820s and rigorously formalized by Scottish scientist James Clark Maxwell in the 1860s. The central idea communicated in Latimer's work is the function of the electric generator: to convert the mechanical energy imparted to it into electrical energy.

The level of detail with which Latimer writes on the physics and mechanics of the incandescent bulb suggest he played an integral role in his partnership with Edison and Maxim. In Latimer's publication, he describes a relationship between a force, an electric current, and a magnetic field, a concept we now know as *magnetic torque*, using a loop of wire mounted on a rotating shaft between the two poles of a horseshoe magnet. By turning the shaft rapidly between the two poles, an electric current can be generated in the loop of wire, effectively converting mechanical energy into electrical energy to be used for the light bulb—the same principle is at play in modern generators. Desire for control over this energy conversion in powering lighting systems inspired Latimer to modify Edison's original designs with one of his own: the carbon filament bulb.

While Edison is widely considered the "Father of Electricity" for his developments in electrical engineering, including a preliminary light bulb, his model was far from the finalized product for which he receives recognition. The original light bulb only burned for a few short hours, even though its platinum filament delayed melting [1]. It was clear that for practical use, changes to the burning filament were necessary. Some claim Edison tested thousands of materials for filament manufacturing before happening upon the best one while others call it a sheer stroke of genius. In fact, an overwhelming amount of evidence suggests that the famed giant stood on the shoulders of Latimer's physical intuition and sound methodology [3].

In *Incandescent Electric Lighting*, Latimer describes the causes of the problem from two practical stand points: (1) a combustible material requires oxygen to burn, and (2) the light bulb burns out because the filament gets too hot and conducts more current than it can sustain. In addition to pumping air out of the bulb, Latimer also suggested that, "while the copper and platinum wires readily conduct the current, the carbon filament offers a great deal of resistance to its passage" [5]. Now well known in modern science, carbon can conduct heat well, and it is one of the best materials at dissipating energy in the form of heat and light, thus this new bulb is described *incandescent*.

Lewis Latimer, a Man Worth Remembering

Although some details of his history may be lost to time, Latimer's journey as a Black scientist during a tumultuous period in a highly transformative field can still be recognized and appreciated. From the son of slaves to accomplished intellectual, Latimer's story has the power to inspire not only people of color, but all members of the scientific community and society at large. This letter is a call to the academic world to remember and lift up the shadows behind other intellectual lights.

Acknowledgements

I emphatically recognize Gary and Sonya Williams, two people without whom I would not be here, and my young brother Gaoshua Williams. My parents imparted to me the value of hard work, the importance of perspective, the will to resist mediocrity, and an appreciation for my African ancestry that inspired this letter.

I dedicate this letter to all those who came before me and those who will come after.

The author is a PhD candidate in the Department of Physics, University of Illinois at Urbana- Champaign. This article is adapted from his winning essay for the APS Forum on the History of Physics Essay Contest. The full essay can be found at engage.aps.org/fhp/resources/essay-contest.

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