APS NEWS
A PUBLICATION OF THE AMERICAN PHYSICAL SOCIETY
APS.ORG/APSNEWS

January 2019 • Vol. 28, No. 1

APS physics

Plasma physics and plants
Page 3

Physics Highlights from 2018

The editors of *Physics* (physics.aps.org) look back at their favorite stories of 2018, from groundbreaking research to a poem inspired by quantum physics.

Graphene: A New Superconductor

2018's splashiest condensed-matter-physics result came from two sheets of graphene. Researchers in the USA and Japan reported finding superconductivity in stacked graphene bilayers in which one layer is twisted with respect to the other. The superconductivity they saw resembles that of high-temperature superconductors, potentially allowing use of twisted graphene as a model system for studying this behavior. The group took the APS March Meeting by storm when they announced the result in a standing-room-only talk, which was also live-streamed to hundreds more gathered around a screen in a foyer at the Los Angeles Convention Center (see physics.aps.org/articles/v11/27). The experiments sparked a series of theoretical studies, each attempting to explain this unconventional behavior (see physics.aps.org/articles/v11/84). One prediction indicates that twisted graphene's superconductivity might also be topological, a desirable property for quantum computation.

The Higgs Shows up with the Heaviest Quarks

After detecting the Higgs boson in 2012, the next order of business was testing whether it behaves as expected. Two such experiments at CERN, which measured the interactions of the heaviest quarks with the Higgs, attained the gold standard of "5 sigma" statistical significance. Analyzing proton-proton collisions, CMS and ATLAS determined the interaction strength between the top quark and the Higgs boson by measuring how often the Higgs boson is produced with a top quark and a top antiquark (see physics.aps.org/articles/v11/56). The same collaborations

later reported the first observation of the Higgs boson decaying into bottom quarks (see physics.aps.org/articles/v11/91). This decay is the most likely fate of the Higgs boson, but it was extremely difficult to see above the heavy background of bottom quarks generated in a typical experiment. So far, all measurements agree with the standard model of particle physics, but the uncertainties have enough wiggle room to allow for new physics.

Dark Matter Theories Take Their Lumps

Plenty of shakeups this year in the realm of dark matter. With a disappointing showing from the main dark matter contenders called WIMPs, other "less WIMPy"

HIGHLIGHTS continued on page 6

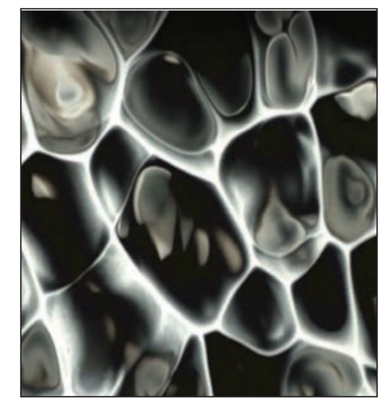
Blending Paint with Physics

By Leah Poffenberger

2018 APS Division of Fluid Dynamics Meeting, Atlanta—Five years ago, Roberto Zenit, a physics professor at the National Autonomous University of Mexico, was studying biological flows when art historian Sandra Zetina enlisted him for a project: using fluid dynamics to uncover the secret behind modern art techniques.

At this year's Division of Fluid Dynamics meeting—his 20th—Zenit, an APS Fellow and member of the editorial board of *Physical Review Fluids*, presented the work of a cross-disciplinary collaboration that tapped into the minds of influential modern artists.

"I'm not qualified to tell you about art, but I do know that every painting starts in the same place," said Zenit during his invited talk. "There's a blank canvas, and then materials to create the art with certain properties, certain viscosities, and densities, and then you need somebody who knows about fluids, a person who has developed certain knowledge about the way the fluids behave. Painting is fluid mechanical."



In the 19th century, modern art emerged as an artistic movement through rejection of traditional artistic methods and the adoption of new ideas in painting. The techniques created as part of a 1936 artists' workshop held by Mexican painter David Alfaro Siqueiros were influential in the development of modern artistic methods

PAINT continued on page 6

APS Membership Unit Profile: The Forum for Early Career Scientists

By Abigail Dove

The APS Forum for Early Career Scientists (FECS) provides support and mentorship to postdocs as they navigate through the early stages of their career, whether in academia or industry, in the US or abroad, or even a scientific field other than physics. This support spans from the professional—including networking opportunities with senior scientists in various physics careers, resources to help with successful grant writing, and funding for conference travel—to the practical—including support and advice around changes in geographical location, particularly for moving abroad.

Established in 2016, FECS is a relative newcomer to APS, but the forum's fast-growing membership of nearly four thousand underscores the appetite for this kind of mentorship and support among early career scientists embarking on the next phase of their professional lives.

FECS was founded by Maria Longobardi (who has served as chair since 2016) with the help

Maria Longobardi

of Jason Gardner (chair-elect whose term will begin in 2019). Longobardi and Gardner met while serving in the APS Forum for International Physics (FIP), and the idea for FECS was born from the perceived shortcomings Longobardi observed in the mentorship and support she and her colleagues received while navigating twists and turns in their career trajectories and locations as young scientists. Longobardi is a gravitational wave theorist turned condensed matter experimentalist, now working at the intersection of

FECS continued on page 5

International News

The APS Task Force on Expanding International Engagement

By Jonathan Bagger

***Editor's note:** The following is an introduction and accompaniment to this month's Back Page (p. 8).*

Physics is a worldwide effort. Today, close to one quarter of APS members live outside the United States. Three-quarters of the papers published in APS journals have corresponding authors with international affiliations. And so much of science is done by collaborations that cross national borders.

What is the role of APS in this global endeavor? The Society's Office of International Affairs has long been part of the APS, advancing physics, furthering cross-cultural communication, and speaking out for oppressed scientists. Today, the APS Committee on International Scientific Affairs and the APS Office of International Affairs have built a portfolio of programs that serve APS members and physicists worldwide.

But there is clearly more to do. The APS strategic plan that covered the years 2013 to 2017 identified expanding international engagement as a key goal of the Society, and in March 2017, APS Chief Executive Officer Kate Kirby launched the APS Task Force on Expanding International Engagement.

The Task Force was composed of 12 APS members living or working across the globe with a broad range of research interests and leadership experiences. The Task Force worked for nearly 18 months to understand the priorities of all APS stakeholders and to identify goals and recommendations for the Society's leadership. As Chair of the Task Force, I am deeply grateful for the time and talent they devoted to the task, as well as for input and guidance we received from the APS Board and Council, APS journal editors and staff, and APS members worldwide.

Our committee's report identified guiding principles, shared values, overarching goals, a set of supporting recommendations, as well as an implementation plan. In November 2018, I was proud to present the Task Force's *Report, Recommendations & Implementation Plan* to the APS Council of Representatives at its meeting in Dallas, Texas. Our recommendations were well received and fully adopted by the Council. I am pleased that APS members will learn more about this effort on the Back Page of this issue of *APS News*. Likewise, the full report is available on the APS website at aps.org/programs/international/.

In reading the Back Page, you will see that our wide-ranging recommendations affect all aspects of APS. Our implementation plan provides concrete actions the Society can take to ensure our recommendations will have the most impact. This will be done with the guidance of the APS Committee on International Scientific Affairs (CISA) and the APS Office of International Affairs, in coordination with other APS committees and departments.

Jonathan Bagger

Our primary recommendation is that APS deepen its international engagement across the full range of Society activities. This is a transformational recommendation, one that affects the entire APS, not just the programs under the direct purview of the APS Office of International Affairs. We believe that our report can serve as a useful guide towards expanding the Society's service, not just to APS members, but to the entire international physics community.

TASK FORCE continued on page 5

Shoucheng Zhang 1963-2018

By Daniel Garisto

Shoucheng Zhang

Shoucheng Zhang, a theoretical physicist whose research pushed the frontiers of understanding exotic states of matter, has died at 55. His family released a statement saying that he had passed away "after fighting a battle with depression." News outlets have reported that the family confirmed Zhang died from suicide.

Zhang, a pioneer in topological insulators, also worked on high temperature superconductivity and predicted the quantum spin Hall effect. In addition to being a Fellow of the APS, Zhang had also won the APS Oliver Buckley Prize, a Guggenheim fellowship, the Alexander von Humboldt prize, and the Dirac Medal.

"He was one of the brightest theorists of his generation and it's an enormous loss for the whole community that this happened," said Laurens Molenkamp, the Editor of *Physical Review B*. "I lost a friend."

In addition to his career in physics, Zhang was an entrepreneur who founded the venture capital firm Danhua Capital, which invested in developing technologies.

"He was a spectacular person. One of the most catholic intellectuals I've known. He was interested in everything. We discussed Lucretius and we discussed the history of empires and he tried to explain to me what blockchain was, I'm afraid, unsuccessfully," said Steven Kivelson, a colleague at Stanford.

Shoucheng Zhang was born in Shanghai in 1963 and began attending Fudan University while he was only 15. He then moved on to the Free University of Berlin, and later Stony Brook University, where he earned his PhD.

At Stony Brook, he initially studied supergravity with his advisor Peter van Nieuwenhuizen, before turning to condensed matter on the advice of his personal hero, Nobel laureate Chen-Ning Yang.

"He had a superior way of analyzing problems," said van Nieuwenhuizen.

As a condensed matter theorist, Zhang used his knowledge of particle physics, which gave him a unique ability and insight at the time, said Kivelson. "He had a deep faith in elegant mathematics to reveal important physics, but at the same time, he was also very interested in phenomena that can be measured in the real world."

With Kivelson and Hans Hansson, Zhang developed a topological quantum field theory that explained phenomenological features of the fractional quantum Hall effect. Zhang later used this approach to more broadly make predictions about properties of quantum Hall systems. Experiments quickly confirmed his theories.

In 1993, Zhang became one of the youngest professors at Stanford, where he remained until his death. Students spoke fondly about Zhang.

"Shoucheng was a wonderful person who always pushed his students (myself included) to think originally and creatively," said Bogdan Bernevig, a former student who is now a professor at Princeton. "I owe a lot of what I am, intellectually, to him."

Zhang turned his attention to high-temperature superconductivity, where he established a symmetry principle that unified the antiferromagnetic and superconducting states of matter.

Werner Hanke, a professor at the University of Würzburg who collaborated with Zhang on this research said that "one of his central gifts was certainly his infectious enthusiasm," which led to a love for "exploring radically new ideas."

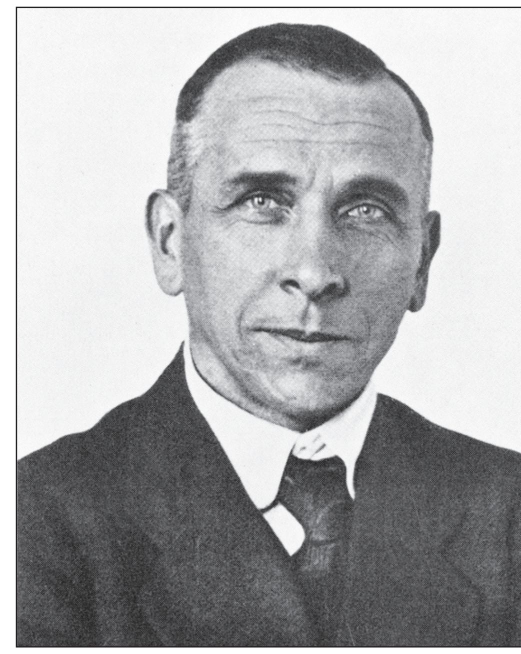
Zhang's seminal work, though, would be in topological insulators. Along with Molenkamp and Charles Kane, he helped introduce the new state of matter—an insulator on its interior, but a symmetry-protected conductor on its surface. Topological insulators have been observed in materials such as mercury telluride (HgTe). The field that has grown around them is in no small part due to Zhang's work.

"Shoucheng was an outstanding teacher and mentor…who could explain the most complex concepts

ZHANG continued on page 6

This Month in Physics History

January 6, 1912: Alfred Wegener Presents His Theory of Continental Drift



Alfred Wegener

The notion that the continents were once joined together dates back to at least the 16th century, with the Flemish cartographer and geographer Abraham Ortelius. Ortelius created the first modern atlas: the *Theatrum Orbis Terrarum* (*Theater of the World*). He noted how the geometry of the coasts of America and Europe/Africa seemed to match like pieces in a jigsaw puzzle, and proposed they had gradually drifted apart over time due to earthquakes and floods. But it was a German scientist named Alfred Wegener who developed a robust hypothesis of continental drift over 300 years later.

Born in 1880, Wegener earned his PhD in astronomy from the University of Berlin in 1904, but his scientific interests were much broader, encompassing geophysics, meteorology, and climatology. His work in meteorology was especially significant, since he pioneered the use of balloons to track air circulation and published a widely used standard textbook. He became a tutor at the University of Marburg, taking time out to join expeditions to Greenland in 1906 and 1912 to study polar air circulation.

While browsing in the university library one day, Wegener happened upon a scientific paper listing fossils of plants and animals on opposite sides of the Atlantic Ocean. He noted the striking similarities between types of rock and fossils, especially fossilized plants. Wegener noticed, as Ortelius did, the same jigsaw puzzle-like shapes of the continents, and how well they seemed to fit together. "A conviction of the fundamental soundness of the idea took root in my mind," he later wrote.

On January 6, 1912, he made the first presentation of his hypothesis of continental drift at a meeting of the German Geological Society in Frankfurt, right before embarking on another scientific expedition to Denmark and Greenland. This contradicted the prevailing hypothesis among geologists at the time, which postulated that land bridges had once connected the continents and were now buried under the ocean.

He suggested that the continents were once a single landmass and gradually drifted apart, either because of the centrifugal force of the Earth's rotation, or some kind of astronomical precession. Wegener also originally thought mid-ocean ridges might play some role, since the Atlantic seafloor "is continuously tearing open and making space for fresh, relatively fluid and hot [material rising] from depth." But he eventually abandoned those notions.

Wegener managed to uncover even more examples of similar organisms on widely separated continents over the next few years. By 1915, he had compiled evidence gleaned from multiple scientific disciplines in support of his theory (dubbed *Urkontinent* for "All-Lands") in *The Origin of Continents and Oceans*. He continued to go on expeditions to gather additional evidence, updating his treatise accordingly. The last edition was published just before his death in 1930, with the new observation that geologically younger oceans were shallower than their older counterparts.

Wegener's hypothesis invited plenty of skepticism, especially from geologists, who resented this outsider's revolutionary ideas. The American Association of Petroleum Geologists hated the American translation so much it organized a special symposium to oppose the theory of continental drift. Among his detractors was geologist Franz Kossmat, who argued that the oceanic crust was just too tough for continents to "simply plough through." The University of Chicago's Rollin T. Chamberlin was especially harsh. "Wegener's hypothesis… is of the footloose type," he observed, "in that it takes considerable liberty with our globe, and is less bound by restrictions or tied down by ugly, awkward facts than most of its rival theories.".

The fact that Wegener didn't really have a convincing mechanism for how continental drift might occur didn't help his theory gain broad acceptance. But the theory did find the occasional champion, notably British geologist Arthur Holmes and South African geologist Alexander Du Toit. In the 1950s, greater exploration of Earth's crust along the ocean floor provided supporting evidence that continents indeed moved on crustal plates that spread or subducted at mid-ocean ridges. By the late 1960s, plate tectonics was the scientific consensus among geologists.

In 1924, Wegener became a professor of meteorology and geophysics at the University of Graz in Austria. Ever the adventurer, he met with a dramatic end during his final expedition to Greenland. His team set off in 1930 with the goal of establishing three permanent stations on the ice sheet to monitor its thickness and observe Arctic weather year-round. For the expedition to succeed, Wegener

WEGENER continued on page 3

APSNEWS

Series II, Vol. 28, No. 1
January 2019
© 2019 American Physical Society

Editor....David Voss
Staff Science Writer....Leah Poffenberger
Contributing Correspondent....Alaina G. Levine
Design and Production....Nancy Bennett-Karasik

APS News (ISSN: 1058-8132) is published monthly, except for a combined August-September issue, 11 times per year, by the American Physical Society, One Physics Ellipse, College Park, MD 20740-3844, (301) 209-3200. It contains news of the Society and of its Divisions, Topical Groups, Sections, and Forums; advance information on meetings of the Society; and reports to the Society by its committees and task forces, as well as opinions.

Letters to the editor are welcomed from the membership. Letters must be signed and should include an address and daytime telephone number. APS reserves the right to select and to edit for length and clarity. All correspondence regarding *APS News* should be directed to: Editor, APS News, One Physics Ellipse, College Park, MD 20740-3844, Email: letters@aps.org.

Subscriptions: *APS News* is an on-membership publication delivered by Periodical Mail Postage Paid at College Park, MD and at additional mailing offices.

For address changes, please send both the old and new addresses, and, if possible, include a mailing label from a recent issue. Changes can be emailed to membership@aps.org. **Postmaster:** Send address changes to APS News, Membership Department, American Physical Society, One Physics Ellipse, College Park, MD 20740-3844.

Coden: ANWSEN ISSN: 1058-8132

APS COUNCIL OF REPRESENTATIVES 2019

President
David J. Gross*, *Kavli Institute for Theoretical Physics, University of California, Santa Barbara*

President-Elect
Philip H. Bucksbaum*, *Stanford University and SLAC National Accelerator Laboratory*

Vice President
Sylvester J. Gates*, *Brown Theoretical Physics Center, Brown University*

Past President
Roger W. Falcone*, *University of California, Berkeley*

Chief Executive Officer
Kate P. Kirby, *Harvard Smithsonian (retired)*

Speaker of the Council
John Rumble, Jr.*, *R&R Data Services*

Treasurer
James Hollenhorst*, *Agilent Technologies*

Corporate Secretary
Jeanette Russo, *American Physical Society*

General Councilors
Bonnie Fleming, Andrea J. Liu*, Vivian F. Incera*, Robin L. B. Selinger

International Councilors
Johanna Stachel, Marta Losada*, Ahmadou Wagué*, Enge Wang

Chair, Nominating Committee
Larry D. Gladney, *University of Pennsylvania*

Chair, Panel on Public Affairs
James D. Wells, *University of Michigan*

Editor in Chief
Michael Thoennessen, *Michigan State University (on leave)*

Division, Forum, and Section Councilors
Michael Coleman Miller (*Division of Astrophysics)*, David Schultz *(Division of Atomic, Molecular, and Optical Physics)*, William Bialek *(Division of Biological Physics)*, Robert Continetti *(Division of Chemical Physics)*, John Bradley Marston* *(Division of Condensed Matter Physics)*, Giulia Galli *(Division of Computational Physics)*, Howard Stone (*Division of Fluid Dynamics)*, Beverly Berger* *(Division of Gravitational Physics)*, John Fourkas *(Division of Laser Science)*, Samuel Bader (*Division of Materials Physics)*, Baha Balantekin* (*Division of Nuclear Physics)*, Elizabeth Simmons *(Division of Particles and Fields)*, Stuart Henderson *(Division of Physics of Beams)*, Amitava Bhattacharjee *(Division of Plasma Physics)*, Murugappan Muthukumar *(Division of Polymer Physics)*, Charles H. Bennett *(Division of Quantum Information)*, Noah Finkelstein (Forum on Education), Julia Gonski *(Forum on Graduate Student Affairs)*, Virginia Trimble *(Forum on the History of Physics)*, John Rumble, Jr.*(*Forum on Industrial and Applied Physics)*, Emanuela Barzi (*Forum on International Physics)*, Pushpa Bhat* (*Forum on Physics and Society)*, Philip R. Johnson (*Mid-Atlantic Section)*, Nora Berrah *(New England Section)*

Senior Management Team
Margaret Bandera, *Chief Financial Officer;* Mark Doyle, *Chief Information Officer;* Kate P. Kirby, *Chief Executive Officer;* Matthew M. Salter, *Publisher;* Francis Slakey, *Chief Government Affairs Officer;* James W. Taylor, *Deputy Executive Officer and Chief Operating Officer;* Michael Thoennessen, *Editor in Chief*

* *Voting Members of the APS Board of Directors*

New Supported Sites Chosen for PhysTEC

By Thomas Hone

PhysTEC (the Physics Teacher Education Coalition) is pleased to announce awards to four new sites: Appalachian State University, Texas A&M University-Commerce, the University of Kansas, and Worcester Polytechnic Institute. These new PhysTEC Supported Sites are well poised to dramatically improve their physics teacher education programs and have impacts beyond their campuses, serving as national models for program improvement.

Central to improving each institution's physics teacher education program is hiring a Teacher-in-Residence (TIR). The TIR will recruit students to become high school physics teachers, mentor learning assistants, and organize a mentoring program for pre-service teachers. Furthermore, the TIR program will expand and sustain a community of high school physics teachers, both pre-service and in-service.

Building on the rapid growth in the number of physics majors at **Texas A&M University-Commerce**, project leaders plan to attract many more to physics teaching and implement new support for them on their pathway through the program. The project leaders will develop new recruiting materials and advertise in lower division STEM classes, at university events, at local high schools and community colleges, and through connections with local industry.

Appalachian State will focus on developing an understanding of best practices in collaborating with rural school districts and with first-generation college goers as well look for ways to strengthen retention of physics secondary education students and teachers.

At the **University of Kansas**, project leaders will integrate PhysTEC with the existing UKanTeach program for preparing STEM teachers. The result will be new pathways for physics majors to become teachers, and opportunities for those majoring in mathematics and other STEM fields to pursue physics minors and to obtain certification to teach physics. In addition, they will impanel an external advisory board, consisting of area high school physics teachers and administrators, to mentor newly graduated teachers and provide an outside assessment of their teacher preparation program.

Similarly, **Worcester Polytechnic Institute** will not only seek new ways to improve recruitment efforts but also coordinate advising and mentoring among students in the physics teacher education program, faculty, in-service teachers, academic advising, and the STEM Education Center as well as create an assessment model to determine factors that influence the recruitment and retention of students who pursue careers as physics teachers.

These new comprehensive sites are expected to graduate relatively large numbers of teachers, with an aim of becoming thriving programs that graduate five or more physics teachers per year. The project will offer up to $100,000 per year for 3 years for the institution to achieve their project goals. In addition, they will be able to network with the best programs throughout the country.

Each site will also be addressing the six Physics Teacher Education Program Analysis (PTEPA) rubric standards. These standards are: an institutional commitment; leadership and collaboration; recruitment; knowledge and skills for teaching physics; mentoring and professional support; and program assessment.

In the United States, there are over 27,000 teachers of high school physics who serve students in over 20,000 public and private high schools. While many of these physics teachers are excellent educators, fewer than half have a major or minor in physics or physics education. Physics consistently rates as a K-12 education field with a "severe shortage" of teachers, as demand far exceeds supply for open positions. PhysTEC is guided by a vision of educating sufficient numbers of qualified teachers to provide an excellent physics education for all students.

To date, the PhysTEC project has funded over 40 institutions to build model physics teacher education programs. These PhysTEC Supported Sites have demonstrated significant successes in increasing the number of highly qualified

SITES continued on page 6

2018 APS Division of Plasma Physics Meeting

By Katherine Kornei

Portland, Oregon—This past November, the 60th Annual Meeting of the APS Division of Plasma Physics (DPP) was joined by the 71st Annual Gaseous Electronics Conference. The presentations—more than 2,000 in total—ran the gamut from astrophysical plasmas to applications in biomedicine, along with fundamental plasma physics. Here are a couple of highlights.

Venus flytrap plant after being treated with plasma.

No Flies, Just Plasma

Gabe Xu, an aerospace engineer at the University of Alabama in Huntsville, presented a study of the response of Venus flytraps—those carnivorous plants known for catching unsuspecting insects—to plasma. Xu and his collaborators, Alexander Volkov and Vladimir Kolobov, were interested in the effect of plasma-produced reactive oxygen and nitrogen species ("RONS") on the plants' ability to shut their traps. Molecules such as O_2, O_3, H_2O_2, and NO occur in a variety of plants and animals as part of their biological signaling systems.

Using an atmospheric-pressure plasma jet, the researchers directed helium plasma at the Venus flytraps. The team left a roughly 1-centimeter gap between the tip of the jet and the plants' leaves. Xu and his colleagues found that the Venus flytraps exposed to RONS closed after roughly 1 second and reopened a few days later, consistent with the timing recorded for plants dining on insects. (Short "sensor hairs" on the insides of the leaves, when bent, normally induce electrical signals that cause the traps to snap shut.) Presumably the plant is absorbing the RONS, which are triggering some biological chemical behavior, said Xu. What the mechanism is that induces closure still remains elusive, however. "We're still quite in the dark about the actual biological and chemical pathways which are responsible for the observed effects," said Xu. The scientists plan on testing how plasma-produced RONS affect other plants, like *mimosa pudica,* which also exhibit a mechanical response. "If we can determine what kind of signals the plasma is passing to the 'brains' of the plant, then we can better understand the bioelectrochemical mechanisms," said Xu.

Link to abstract: aps.org/Meeting/GEC18/Session/ET4.6

Plasma in the Vineyard

Wine is a multi-billion-dollar industry, and the best reds and whites are produced from healthy grapes. But wine grapes, like some other fruits, are marked by a biological peculiarity: they must be exposed to a certain number of "chilling hours"—a cumulative duration of cold temperatures—to coax them out of dormancy in the spring. However, as the climate warms, some wine-growing regions may not receive a sufficient number of cold nights to satisfy this chilling requirement. That's where plasma comes in.

Zaka-ul-Islam Mujahid, a plasma physicist at Jazan University in Saudi Arabia, and his colleagues applied 2, 5, and 10 minutes of plasma to dormant Muscat of Alexandria grape vines in the laboratory. They found that the short treatment released from dormancy plants that had never been chilled. The plasma-treated plants also exhibited healthier-looking leaves and vines and more synchronous growth than untreated plants. "In just a few minutes you can have the same effect…. that you have with two months of chilling, said Mujahid. These findings reveal that plasma is a good alternative to applying hydrogen cyanamide, a toxic chemical banned in several countries that is sometimes used to break grape bud dormancy. The next step will be replicating these results in vineyards, said Mujahid. If that's successful, "plasma may allow crops to be grown in areas where they haven't been traditionally grown."

A grape vine swells with buds in early spring.

Link to abstract: aps.org/Meeting/GEC18/Session/PR2.12

DPP continued on page 7

WEGENER continued from page 2

needed to transfer sufficient provisions from West Camp to a spot called Eismitte ("mid-ice"), where two of his men were planning to camp out through the brutal winter.

There was a late thaw, and the six-week delay in provisions meant the men at Eismitte would have to return to West Camp earlier than expected, since they didn't have enough fuel for the winter. Determined that his mission should succeed, Wegener set out with his meteorologist Fritz Loewe and thirteen native Greenlanders on dog sleds loaded with the necessary supplies. It got so cold (-76 degrees F) that Loewe had to amputate his frostbitten toes with a penknife. Most of the natives returned to West Camp, but the remaining three men eventually reached Eismitte.

Wegener and 23-year-old team member Rasmus Villumsen set out with two dog sleds for the return trip to West Camp, killing the dogs one by one for food. When they were down to one sled, Villumsen rode it while Wegener skied alongside him. Neither man ever reached the base camp. Wegener's body was finally recovered on May 12, 1931, halfway between the two sites, where it had been buried with care by Villumsen and marked with his skis. Villumsen's body was never found.

Further Reading:

Wegener, Alfred. *The Origin of Continents and Oceans* (English edition). New York: Dover, 1966.

Wegener, Elsie and Loewe, Fritz, eds. *Greenland Journey: The Story of Wegener's German Expedition to Greenland in 1930-1931.* London: Blackie & Son, Ltd., 1939.

Letters

Members may submit letters to letters@aps.org. APS reserves the right to select letters and edit for length and clarity.

Teaching Physics

The November 2018 issue of *APS News* reported that physics graduates are wondering what to do with their degrees ("I Graduated – What Now?"). As a former high school physics, chemistry, and mathematics teacher in mostly inner-city Chicago Public Schools, I would highly recommend that every physics major program in higher education offer training in high school physics teaching to its students.

All students in higher education must take electives and a state teaching certificate in high school physics would offer almost immediate employment, especially in the big cities of America. The starting salary of a certified teacher in physics, chemistry, or mathematics almost everywhere in the US is about $50,000 per year. There is a critical need for high school physics, chemistry, and especially mathematics teachers.

And since most physics majors take many mathematics courses in order to master the subject matter in a higher education physics major program, obtaining another high school teaching certificate in mathematics could be easily accomplished.

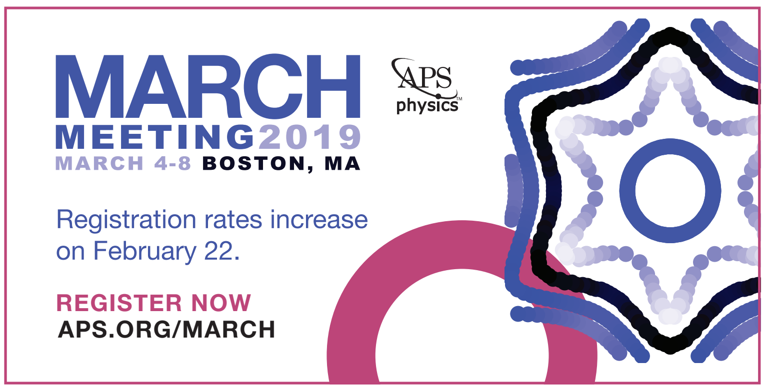
Twice, my high school physics teaching position was closed, but I always immediately found a mathematics position because I also obtained a state high school mathematics teaching certificate. This extra teaching certificate in high school mathematics was easily accomplished because my physics courses required a great deal of mathematics courses I had to take as prerequisites.

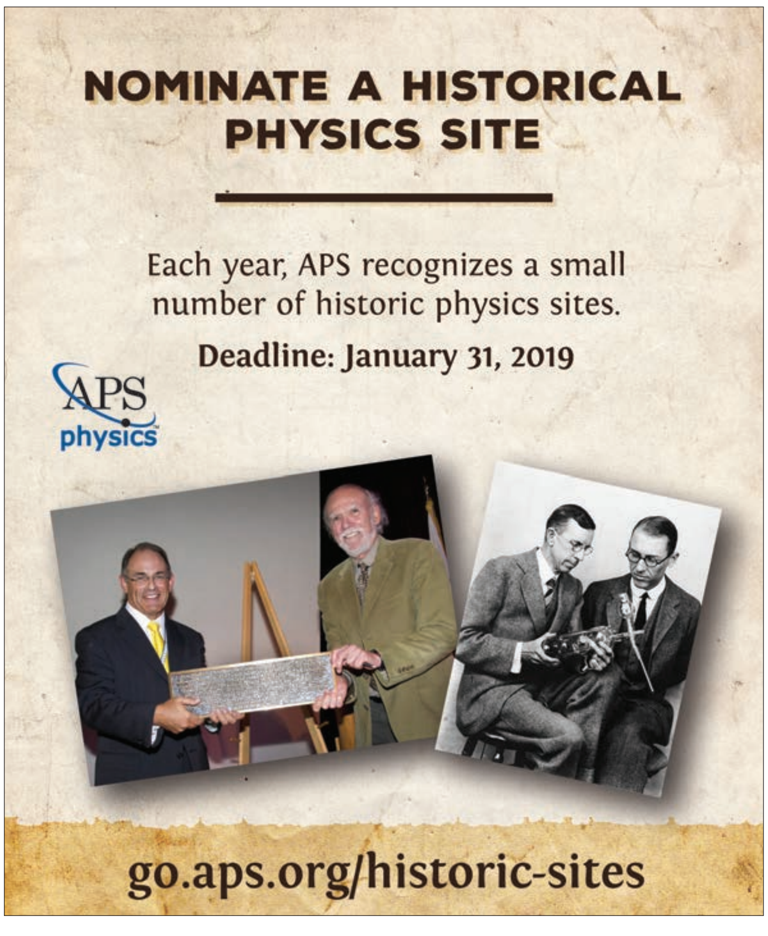
The excellent salary of my high school physics teaching position (and sometimes mathematics teaching position) not only paid my daily living expenses but also helped pay for my other master's degree and my after-retirement PhD with both savings and my pension.

Sadly, after retirement I found that recent BA graduates in fields such as business, psychology, art, history, criminal justice, and film could only find employment for about $10.00 per hour in coffee shops and fast-food restaurants. There are virtually no teaching positions anywhere in history, art, music, or biology.

Physics departments should make potential bachelor's candidates aware that a physics degree combined with a high school physics teaching certificate will mean almost immediate well-paying lifetime employment almost everywhere in America.

Stewart Brekke
Downers Grove, Illinois





The APS Office of Government Affairs

APS Launches Campaign to Help Members Mitigate Their Carbon Footprint

By Mariah Heinzerling

APS recently took steps to help curb greenhouse gas (GHG) emissions by offering members an opportunity to mitigate their carbon footprint by making a donation to an environmental organization of their choice.

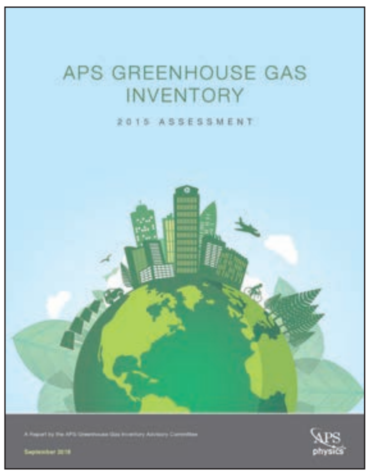
In November 2018, APS unveiled the pilot campaign by providing Division of Fluid Dynamics (DFD) members the ability to mitigate the effect of their travel to and from the DFD annual meeting in Atlanta, Georgia. Rather than promoting the purchase of carbon offsets, which have often been criticized as being insubstantial, the Society provided members with an estimate of their carbon footprint from traveling to and from the meeting and provided options for donation.

APS calculated a suggested donation amount using an estimate of the average travel-related GHG emissions per person and the social cost of carbon as published by the Interagency Working Group, an organization of federal regulatory agencies charged with determining the social cost of GHGs.

"DFD is proud to be the first APS division to offer this step toward mitigating the carbon footprint from Society activities. As members of a scientific society, it is our responsibility to support APS in continually implementing forward-thinking strategies in the critical fight against climate change," said Eckart Meiburg, a professor of mechanical engineering at UC Santa Barbara and 2018 chair of DFD.

For those without a preferred organization, APS suggested directing donations to the Clean Energy Trust (CET). The Trust (cleanenergytrust.org) is a nonprofit clean technology accelerator focused on bringing scientific and technological advances to market that change how the world generates, consumes, and reuses energy and natural resources. CET is a 501c3 public charity, and donations are tax deductible. By donating to CET, DFD meeting attendees supported an investment in entrepreneurs who are working to commercialize clean technology startups, reduce GHG emissions, and mitigate the risks of climate change.

The DFD effort follows APS's recent release of its Greenhouse Gas Inventory Report, an analysis of the Society's day-to-day operations and select activities that contribute to its carbon footprint. Member travel to and from annual meetings was the second-largest GHG contributor detailed in the inventory.

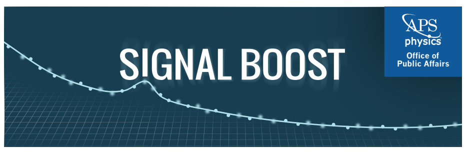


DFD members who registered for the 2018 meeting received information about the pilot ahead of their travel and were notified throughout the meeting about participating in the campaign. APS also launched a social media campaign to inform members.

CET has received several donations from APS members, and another organization reached out to APS expressing interest in being involved with future iterations of the campaign. During upcoming meetings, APS will improve upon the model tested at the DFD meeting and aims to make the donation option available earlier in the registration cycle.

"APS will continue running this donation campaign at our largest national meetings. By working with CET and potentially other organizations going forward, we hope to make APS meetings beneficial not only to the physics community but also the environment as a whole," said Mark Elsesser, manager of science policy at the APS Office of Government Affairs.

The author is a Science Policy Intern in the APS Office of Government Affairs.



Signal Boost is a monthly email video newsletter alerting APS members to policy issues and identifying opportunities to get involved. Past issues are available at go.aps.org/2nr298D. To receive Signal Boost and learn more about grassroots activities, contact the Office of Government Affairs at oga@aps.org.

Join Our Mailing List: visit the sign-up page at go.aps.org/2nqGtJP.

FYI: Science Policy News From AIP

Trump Administration Takes Aim at National Climate Assessment

By Adria Schwarber and William Thomas

On November 23, 2018, the Trump administration released volume two of the Fourth National Climate Assessment (NCA4). Mandated by law, the assessment documents and projects the impacts of climate change on the environment, economy, and public health of the US. The first volume, which examines the physical science of climate change, appeared in November 2017.

Although there have been no indications the administration interfered with NCA4's production, top officials have criticized its methods and conclusions. It is also widely suspected that the administration's decision to release it ahead of schedule on the day after Thanksgiving was a deliberate attempt to minimize attention to it.

NCA4 concludes climate impacts are "intensifying" across the US and that the evidence of anthropogenic climate change is "overwhelming and continues to strengthen." It also offers detailed accounts of localized impacts, along with accompanying resilience and mitigation planning tools, and includes a more systematic analysis of the economic impacts of climate change than its predecessors.

Asked by reporters about NCA4, President Trump replied, "I've seen it. I've read some of it, and it's fine." But when pressed on his views of its assessment of the economic damage climate change could cause to the US, he said, "I don't believe it."

Trump has famously said he believes climate change is a "hoax." In more recent interviews, he has acknowledged the climate is changing but, rejecting the scientific consensus, he has also suggested it is the result of natural variability.

Acting Environmental Protection Agency (EPA) Administrator Andrew Wheeler offered the administration's most detailed criticisms of NCA4 in a live interview with the Washington Post on November 28. While he thanked the federal employees who worked on the report, he argued it is based on overly pessimistic assumptions that do not take sufficient account of future technological improvements that would reduce greenhouse gas emissions.

Wheeler also suggested the Obama administration had specifically instructed the report's authors to use a "worst-case scenario." He said the next national assessment, due in four years, might assume more technological advances in reducing emissions.

Later that day, the EPA released a "fact check" pointing to a 2015 memorandum from the US Global Change Research Program (USGCRP) as evidence the assessment team had been "pushed" into employing a high-emissions scenario called RCP8.5. A "representative concentration pathway" (RCP) is a particular emissions trajectory that can be consistent with a variety of scenarios for future energy demand, energy sources employed, and other factors.

The memo in question actually

NCA4 continued on page 7

Profiles in Versatility

Is weather the culprit?

By Katherine Kornei

Elizabeth Austin has seen a lot of weather. Trained in atmospheric physics, she investigates the role of weather in crimes and accidents as a forensic meteorologist. "It's a niche," she admits of her profession, which combines the skillsets of a physicist, a chemist, and a meteorologist and requires careful navigating of complex court cases.

Born in New York and raised in Southern California, Austin grew up backpacking in the mountains of the western United States. Those camping trips solidified her interest in nature. In high school, Austin realized that she could combine her passions for nature and science when her physics teacher showed a movie of the Tacoma Narrows Bridge ripping itself apart in high winds. The combination of physics and atmospheric science that contributed to the bridge's demise fascinated Austin. She had found her field.

After earning a bachelor's degree in Atmospheric Science at the University of California, Los Angeles, Austin enrolled in a graduate program at the University of Nevada, Reno. It was during graduate school that a colleague told Austin about forensic meteorology. The idea that science could be used to solve mysteries and determine the causes of accidents was "so up my alley," says Austin. "It was a combination of everything I was interested in."

Soon after finishing her MS and PhD in Atmospheric Physics, Austin founded a research and consulting firm that, in its present incarnation, is called WeatherExtreme Ltd. Originally a one-woman show, WeatherExtreme Ltd. now has employees across the United States and in Nepal. The firm provides weather forecasting services and weather-related problem solving, like helping companies determine the best location for their headquarters. The scientists at WeatherExtreme Ltd. also investigate court cases in which people have been hurt in part due to weather. The public has a certain fascination with the idea that a natural phenomenon like weather can cause—or at least strongly contribute to—an accident, Austin says.

Austin is often asked to provide an expert opinion on crimes and accidents that involve the weather. She's been involved in over 1,500 cases spanning the fields of aviation, tornadoes, boating, and avalanches. After years of appearing in courtrooms, Austin has practice presenting the meteorological facts in simple terms that juries can understand. But her work sometimes still takes a mental toll, Austin says, particularly when the accidents involve children. One case sticks with her: a fifteen-year-old girl went parasailing in Florida in 2007 and was killed after her parasailing rope snapped in high winds and she was blown into a building. The winds weren't unexpected, Austin showed: A National Weather Service area forecast issued earlier that morning had called for strong thunderstorms and wind gusts to 40 miles per hour. Austin's work on that case contributed to the passing of the Florida Parasailing Act in 2014, which prohibits commercial parasailing in certain wind, rain, fog, and thunderstorm conditions.

A frequent public lecturer about forensic meteorology, Austin also

Elizabeth Austin

holds a faculty position in the Atmospheric Science Department at the University of Nevada at Reno. In 2018, she was featured on The Weather Channel series "Storm of Suspicion," which focuses on criminal cases in which the weather played a role.

Austin's favorite atmospheric phenomenon is a rare event called a waterspout. These features, which are funnels of swirling air that appear over water, resemble small tornadoes. In September 1998, Austin saw several waterspouts on Lake Tahoe, the largest of which was about 100 meters in diameter. Austin recalls scientists from the National Oceanic and Atmospheric Administration flocking to Lake Tahoe to study that event, something she remembers as "unbelievable."

The many different fields in which Austin is fluent—such as the fluid dynamics of the atmosphere and atmospheric chemistry—are linked by physics. "Physics is a huge part of what I do," she says. "You kind of have to be a jack of all trades."

The author is a freelance writer in Portland, Oregon.

TASK FORCE continued from page 1

I cannot think of a better time for this report to appear. Physics relies on the free circulation of people and ideas. I need only look at my laboratory, TRIUMF, to see this demonstrated every day. Our users and visitors travel to Canada from some 39 countries, spanning every continent except Antarctica. Our students and staff hold passports from 30 nations.

Today, with isolationism on the rise globally, these fundamental principles are under threat. By increasing its international engagement, following the goals and recommendations presented by the Task Force on Expanding International Engagement, APS can stand in support of the global physics community and of the values we share worldwide.

Jonathan Bagger is the Director of TRIUMF and served as Chair of the APS Task Force on Expanding International Engagement. He also has served on the APS Board of Directors, Council of Representatives, and has Chaired the APS Division of Particles and Fields (DPF) and Committee on International Scientific Affairs (CISA).

Physics Teacher Education Coalition

Join the nation's largest meeting dedicated to the education of future physics teachers

2019 PhysTEC Conference

March 2-3
Boston, MA

phystec.org

REGISTER NOW

- Special Workshop: 'Get the Facts Out' toolkit for recruiting teachers
- Study Results: Building Thriving Physics Teacher Education Programs
- Networking with leaders in physics teacher education

And more!

APS physics · AAPT Physics Education · NSF

FECS continued from page 1

material science and microbiology, and Gardner is an instrumental scientist whose career has taken him from his native England to the US and now to Australia.

Jason Gardner

The Forum on Graduate Student Affairs (FGSA) has existed since 2001 to provide support for physics graduate students, and Longobardi and Gardner emphasize that a counterpart to meet the unique needs of post-docs and early career scientists was long overdue. "Post-docs have different needs than the graduate student community," underscored Longobardi. Principally, many FECS members have families, which adds another dimension of complexity to the already challenging tasks of relocating and, if necessary, applying for visas. Added Gardner, many aspects of the professional landscape are unfamiliar to early-career scientists as they finish their postdoctoral fellowships. "Many early career scientists don't realize the different opportunities in front of them, what the competition in the job market looks like, what is involved in leaving the USA for work, or even what to ask when interviewing for a job," he said.

Importantly, the forum's support extends not only to early career scientists pursuing traditional paths in academia, but also the increasing number interested in joining industry and the private sector. This takes place in large part through events and receptions co-hosted with the Forum for Industrial & Applied Physics (FIAP) to promote dialogue and exchange between early career scientists and more senior members of industry. Beyond networking, this support also takes the form of actively educating early career scientists about the opportunities that exist beyond the sphere of academia, a domain that is likely quite unfamiliar, particularly for the majority of early career scientists whose mentors have been exclusively professors and academic researchers. For example, one of FECS' most well-attended APS Meeting sessions to-date was a symposium on data science featuring panelists from academia as well as companies like Netflix and Uber to discuss various applications of data mining and work with large data sets.

In this way, FECS could play an important role in keeping industrial and applied physicists involved in the APS community. Citing a drop-off in APS membership among physicists who transition out of academia, Gardner noted that FECS aspires to be a kind of bridge between the worlds of academia and industry: "People in industry may not think that APS has anything to offer them, but that's certainly not the case."

Beyond the emphasis on career development and network building, FECS is sharply focused on helping members hone their science communication skills. "Science is for all, and we have to learn how to communicate to a broad audience," noted Longobardi, herself a skilled science writer and a former editor at *Nature*, "I'm convinced this is one of the duties of a scientist." Currently this spirit of science communication is most evident in the forum's twice-yearly newsletter – a forum where, in Longobardi's words, "people from gravitational physics can explain their research to condensed matter physicists" and vice versa. To make science communication more accessible for FECS members who may not yet feel confident contributing to the newsletter, the forum is also in the process of organizing workshops and webinars to help early career scientists develop and practice this crucial skill.

Although FECS is geared toward meeting the needs of early career scientists, activities aren't restricted to this population. "We always get asked 'Am I too old to join FECS?'" noted Gardner, "and we want elders in the community to join and help guide these busy young minds." Longobardi echoed that her vision for the future of FECS involves a greater emphasis on guidance and mentorship from more senior scientists. As one example of how this intergenerational mentorship might come to fruition, FECS hopes to establish workshops at future APS meetings where early career scientists can get feedback on their CVs or resumes from experienced senior researchers and members of industry—especially those who have been involved in the hiring process.

Overall, FECS stands out as a forum with an incredibly bright future, and one that occupies an important niche for post-docs and early-career members in all their diversity. More information on this forum can be found here: aps.org/units/fecs/

The author is a freelance writer in Helsinki, Finland.

APS physics BRIDGE PROGRAM

The APS Bridge Program is an effort to increase the number of physics Ph.D.s awarded to underrepresented minority students.

DEADLINE: MARCH 15, 2019

APSBRIDGEPROGRAM.ORG

HIGHLIGHTS continued from page 1

candidates have been vying for the top spot (see physics.aps.org/articles/v11/48). One of these dark matter options, primordial black holes, garnered a lot of attention following the detections of black hole mergers by the LIGO-Virgo collaboration, but the excitement went down after a supernova lensing study found that black holes cannot account for all of the dark matter (see physics.aps.org/articles/v11/97). However, the biggest splash of the year was an unexpected absorption signal from hydrogen gas at the time of the first stars. To explain these observations, theorists have proposed that the gas was cooled through interactions with dark matter (see physics.aps.org/articles/v11/69). One possibility is that dark matter particles carry a very small (one could say WIMPy) electric charge.

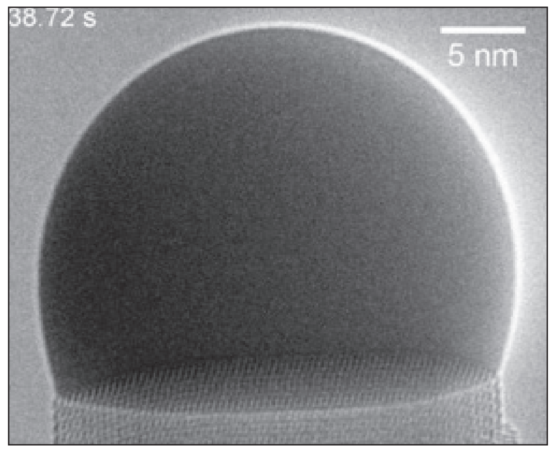
Quantum Cryptography via Satellite

Researchers in China and Austria used a satellite link to hold the first intercontinental videoconference protected by quantum cryptography (see physics.aps.org/articles/v11/7). The data security was provided by quantum key distribution (QKD), which exchanges cryptographic keys that are encoded in quantum-entangled photons. Long-distance QKD has been previously demonstrated on terrestrial networks of optical fibers, but optical losses in the fibers had limited the communication distance to a few hundred kilometers. Exploiting the undisturbed propagation of photons in space, the satellite experiment involved two stations that were 7600 km apart. Exchanging secret keys at kilohertz rates, the teams were able to send quantum encrypted images and to hold a secure videoconference that lasted 75 minutes and required 2 gigabytes of data. The demonstration is good news for those who envision a "quantum internet" built around a global network of ground stations and satellites.

Encryption in space

Neutrino Puzzle Gets Complicated Again

Researchers with the MiniBooNE experiment at Fermilab in Illinois detected a signal that is incompatible with neutrino oscillations involving just the three known flavors of neutrinos (see physics.aps.org/articles/v11/122). Confirming earlier results from the Liquid Scintillator Neutrino Detector (LSND) at Los Alamos—now with higher statistical significance—the finding suggests that muon neutrinos can transform into electron neutrinos over much shorter distances than expected. Both the MiniBooNE and the LSND results could be explained by a theory that includes a fourth, "sterile," neutrino, which interacts only through gravity. The hypothesis of sterile neutrinos had seemed to have serious dents, as it's inconsistent with other recent results with neutrinos produced at accelerators and nuclear reactors. The new MiniBooNE result, however, rekindles the debate about these particles, whose existence could potentially explain dark matter and the matter-antimatter asymmetry in the Universe.



Growing nanocrystals

Tops Spin at 60 Billion RPM

Imagine a game of dreidel with a 60-billion-RPM top. Two independent teams set world records by spinning objects at such rates. The researchers, from the Swiss Federal Institute of Technology (ETH) in Zurich and Purdue University in Indiana used circularly polarized light, which has a rotating electric field, to twirl nanoscale objects (see physics.aps.org/articles/v11/73). The centrifugal force at these rotation rates was nearly enough for the silica spinners to break apart, so the technique could be used to stress-test nanomachine parts, say the teams. It could also be applied to study a hard-to-detect quantum form of rotational friction called the Casimir torque, a frictional effect caused by interactions of the object with the virtual particles of the quantum vacuum.

SI Drops the Kilogram Standard

The units of measurement have historically been based on tangible things, like a human hand, a volume of water, or a chunk of metal. But these objects can change with time or place, which is why the world metrological community voted in November to adopt more universal definitions for the international system of units (SI) (see physics.aps.org/articles/v11/117). The four affected units—the kilogram, the ampere, the kelvin, and the mole—will now be defined in terms of fundamental physical constants, like Planck's constant and the elementary electric charge. But bathroom scales, body thermometers, and other everyday measurement devices need not fear, as their jobs are secure. The only big loser is the international prototype kilogram—a platinum-iridium cylinder housed in Paris—which will no longer hold the title of mass standard for the world.

Cinematic Crystal Growth

Electron microscopes have provided stunning images of atoms and molecules for decades. Still, this video of a nanowire growing one atomic layer at a time was the most popular of the ones we shared on social media—perhaps because it's like watching the world's tiniest 3D printer in action (see physics.aps.org/articles/v11/106). To understand how atoms position themselves when a crystal grows out of a liquid, researchers in France monitored the process with a transmission electron microscope. The liquid was a nanodroplet of gold that was supersaturated with gallium and arsenide atoms. The video shows atoms falling out from beneath the droplet to create a "step" at one corner of the liquid-solid interface. The step then sweeps across the surface as more atoms add up to build a new crystal layer.

Equations for Knitted Fabric

Yarn is resistant to stretching, but knitted sweaters are very stretchable. Intrigued by this seeming contradiction, physicists at the École Normale Supérieure in Paris and Lyon investigated the stretching process for knitted fabrics (see physics.aps.org/articles/v11/66). The team applied controlled stretches to a fabric knitted with nylon thread and then came up with a few simple equations that account for the material properties they observed. Others had previously suggested that the stretchiness results from the yarn sliding from stitch to stitch and from the stitches becoming distorted. But the new equations, which can be adapted to any stitch pattern, explain the process quantitatively. The team hopes their results could be useful for engineers developing so-called smart fabrics, which, for example, could adopt specific shapes in response to heat.

Quantum Physics Gets a Poetic Makeover

Many find it hard to conjure the words needed to accurately describe the quirky world of quantum objects and its logic-defying rules. But researchers and artists alike keep trying to do exactly that. One such artist, poet Amy Catanzano, thinks that poetry could provide a tool for developing a more effective language for communicating the complex ideas of quantum physics. This year she put her idea into practice through a poem about a topological quantum computer consisting of four quantum bits (see physics.aps.org/articles/v11/103). The poem attempts to translate the quantum theory behind this computer through its word choices and its structure. Whether physicists will adopt poetry as a language for quantum physics remains debatable. Either way, this poem provides a pathway for those outside of physics to acquaint themselves with some tricky quantum concepts.

ZHANG continued from page 2

in ways that made them clear and understandable even to simple experimentalists and chemists," wrote Stuart Parkin and Claudia Felser, both researchers at institutes of the Max Planck Society in Germany. Both said they would not have worked on topological materials without having met Zhang.

For his discoveries in this area, Zhang was frequently mentioned in shortlists for the Nobel Prize.

In a statement, his family noted that his favorite poem, "Auguries of Innocence," by William Blake, "expressed his life's mission for boundless exploration and discovering beauty."

To see a World in a Grain of Sand
And a Heaven in a Wild Flower
Hold Infinity in the palm of your hand
And Eternity in an hour.

The author is a freelance science writer based in New York.

Additional Information

If you are in crisis, please call the National Suicide Prevention Lifeline at 1-800-273-TALK (8255), or contact the Crisis Text Line by texting TALK to 741741.

SITES continued from page 3

physics teachers. Those with comprehensive funding support have collectively tripled the number of PhysTEC graduates.

The PhysTEC project has support from the National Science Foundation and from individual and corporate gifts to the APS Campaign for the 21st Century. The project is led by the APS and the American Association of Physics Teachers. More information about PhysTEC is available at www.PhysTEC.org.

The author is Senior Coordinator for Education and Diversity programs at APS.

PAINT continued from page 1

that didn't involve spreading paint with a brush. Famous American painter Jackson Pollock, a student of Siqueiros, was in attendance at the workshop, developing his signature style of dripping.

"When [Zetina] was studying the paintings from Siqueiros during this period, she had the vision to involve fluid mechanics. She came to me with these paintings and asked me this question 'how do you paint like that? What do you need to know to produce these patterns?'" said Zenit.

Zetina and Zenit combined historical detective work—searching through letters Siqueiros wrote during the 1936 conference and watching videos of Pollock painting—with fluid mechanics experiments to characterize how the artists achieved their signature styles.

Siqueiros described his accidental painting technique in a letter, which Zenit loosely translated: "if there are two pools of paint that are superimposed on top of each, together they can infiltrate [or combine]." Using Siqueiros' vague instructions, Zenit's lab began experimenting with layering liquids with different viscosities and densities.

"First, we poured a layer of viscous fluid—black paint in this case—and on top of that, we poured a second layer of paint of a different color. You end up with two-layer pancake. What you see after some time is, progressively as time advances the white paint will infiltrate into the black paint to generate these patterns that are characteristic of this accidental painting technique" said Zenit. "The lines only appear in this manner if the top fluid is denser than the bottom fluid."

Accidental painting makes use of Rayleigh-Taylor instability, which occurs at the interface between two fluids with different densities as an upper layer of dense white paint pushes on the lower layer of black paint. A slow mixing process occurs as the paint dries, creating the unique texture. Rayleigh-Taylor instabilities are often found in nature, accounting for the appearance of the Crab Nebula for example, and studying their formation is difficult. Using paints, according to Zenit, could provide a medium to help elucidate this phenomenon.

Pollock's unconventional painting method of dripping paint from a stick over a horizontal canvas also held fluid-mechanical interest for Zenit and Zetina: How did he create the straight, steady filaments of paint that build up to create his art?

"The filaments were laid in a certain rhythmical manner—Pollock allowed himself to be filmed while he was working," said Zenit. "What we wanted to know is what Pollock knows—we want to explore the physical space in which he works to generate these steady filaments."

Using historical movies of Pollock painting, Zenit measured how quickly Pollock moved his hands and from what height he dripped paint and built an experimental set-up to test what affected the paint on the canvas. What Zenit found was that, at a reasonable paint viscosity, hand speed was the necessary factor for creating Pollock's signature straight lines of paint rather than curling coils.

"What we see is that when the speed of the hand is small is when the filament coils because of a buckling instability. Fluid doesn't have the room to flow freely and it buckles and curls," said Zenit. "If you move the substrate at a high enough rate, you are able to prevent coiling."

Understanding how techniques were achieved—thanks to fluid dynamics research—has allowed artists to recreate and reclaim these innovative modern art techniques, integrating them into new works of art. Zenit's research has also expanded beyond techniques from famous artists of the past: His lab now has an artist in residence, Octavio Moctezuma, a professional watercolor painter, who wanted to understand how physics made his art possible.

"These are techniques that artists do, but they don't have the tools or terminology to explain it," said Zenit. "We have learned a lot about artists—they are masters of fluid mechanics, but they don't know it."

BACK PAGE continued from page 8

- Develop new and/or strengthen existing electronic communications vehicles for physics communities outside the U.S., especially for those without established physics societies.

Goal 2: Integrate international affairs across all APS activities.

Recommendations:

- ✷ *Leadership*: Hold regular summits of physical society presidents and leaders of international physics organizations; partner with national physics societies toward joint advocacy on issues of common concern. Include more international members in APS leadership at all levels (Units, Advisory Committees, Prize and Award Committees, Nominating Committees, etc.).
- ✷ *Units*: Empower Units to expand joint activities; establish an International Officer on every Unit Executive Committee with a clear mandate to strengthen linkages and activities with international partners.
- *Senior Staff & Programs*: Expand international reach of APS programs; ensure senior staff include international communities in program plans.
- *Editors:* Increase and facilitate the APS profile and editorial presence at international meetings; increase, as appropriate, the number of associate editors, editorial board members, and reviewers from international locations.

Goal 3: Expand international opportunities for young physicists; better prepare young physicists for international careers.

Recommendations:

- ✷ Increase connections to the international private sector/industry to improve career development opportunities outside academia.
- Establish additional summer research opportunities for U.S. and non-U.S. undergraduate students at premiere research facilities outside the country of their home institution.
- Significantly increase international student and early-career participation in APS annual and Unit meetings. Expand existing APS programs and meetings that focus on young international physicists.

Goal 4: Advance government policies that promote international scientific collaboration.

Recommendations:

- ✷ Advocate for international research activities and for stable funding for large-scale international projects.
- ✷ Promote and advocate for scientific mobility (e.g. visas and immigration policies, removing barriers to engagement), including a proper balance between open scientific exchange and intellectual property and security concerns.
- Establish an APS State Department Fellowship Program and/or expand APS sponsorship of existing AIP State Department Fellowships to further engage APS members in policy formation.

Implementation

Along with its recommendations, the Task Force also developed an ***Implementation Plan*** with specific actions designed to accomplish each goal. This Plan gives the pragmatic next steps for each recommendation and is provided in Appendix A of the full report (aps.org/programs/international).The Task Force also recognized the need for APS to consider: 1) evaluation and assessment of current international programs; 2) measures of success (metrics) for existing and future international activities; and, 3) impact upon resources and sustainability of key initiatives.

The Task Force's ultimate observation, however, was that ***APS must deepen its international engagement across the full range of Society activities.*** This is a transformational proposition, one that affects far more than programs under the direct purview of the APS Office of International Affairs. Therefore, international goals must be embraced by the APS leadership and consistently incorporated into the Society's ongoing strategic planning. More specifically, the Task Force asserted that APS must allocate sufficient resources (staff, financial, and leadership attention) to develop and implement a five-year roadmap with near-, mid- and long-term goals.

The Task Force emphasized that if the Society is indeed committed to expanding its international engagement, APS must make transformative change a priority and commit resources accordingly. In particular, some international activities may be especially attractive to potential donors or foundations, and APS may launch fundraising campaigns for certain new initiatives.

Conclusion

The Task Force recommendations covered a wide range. Most importantly, the Task Force hopes that APS members, leaders, and staff will embrace its overarching proposal: ***that APS fully incorporate international engagement into all of the Society's activities.*** To realize this vision, the Society must proactively welcome international members and integrate them into all APS activities and leadership levels.

Even the most carefully developed recommendations, however, have little impact without follow-on commitment to progress. Consequently, the Task Force stressed that its report represents merely the first step towards expanding the American Physical Society's service to the international physics community. Doing so will not only benefit the APS members, but will also strengthen the Society's leadership in serving all physicists worldwide.

Task Force members: **Jonathan Bagger, Chair, TRIUMF; **William Colglazier,** Vice-Chair, Center for Science Diplomacy, AAAS; **Dirk Jan Bukman.,** APS Editorial Office; **Luisa Cifarelli,** University of Bologna; **Carlos Henrique de Brito Cruz,** São Paulo Research Foundation and Universidade Estadual de Campinas; **Laura H. Greene,** National High Magnetic Field Laboratory, Florida State University; **Alan J. Hurd,** Los Alamos National Laboratory; **Young-Kee Kim,** University of Chicago; **Patricia McBride,** Fermi National Accelerator Laboratory; **Eliezer Rabinovici,** Hebrew University, Jerusalem; **Johanna Stachel,** University of Heidelberg; **Nai-Chang Yeh,** California Institute of Technology. APS staff: **Amy K. Flatten,** Director of International Affairs; **Michele E. Irwin,** International Programs Manager.*

NCA4 continued from page 4

documents USGCRP's decision to use both RCP8.5 and a moderate-emissions scenario called RCP4.5 as the "core scenarios" in its analysis. It states these scenarios are in line with the ranges of scenarios considered in the third NCA and the Intergovernmental Panel on Climate Change's Fifth Assessment Report, which were both released in 2014.

NCA4 itself states that RCP8.5, which generally assumes high population growth and the use of carbon-intensive energy sources, is consistent with current global emissions trends. RCP4.5, it notes, is associated with lower population growth, more technological innovation, and the use of energy sources with a lower carbon intensity.

Justifying its use of the scenarios, the report states they "capture a range of potential greenhouse gas pathways and associated atmospheric concentration levels through 2100," while noting it does not assess the "feasibility of the socioeconomic assumptions" underlying them. The report further states, "The resulting range of projections reflects, in part, the uncertainty that comes with quantifying future human activities and their influence on climate."

Adria Schwarber is a Science Policy Analyst and William Thomas is Senior Science Policy Analyst with FYI *at the American Institute of Physics.*

***FYI* has been a trusted source of science policy and funding news since 1989, and is read by members of Congress and their staff, federal agency heads, journalists, and US scientific leaders. Sign up for free *FYI* emails at aip.org/fyi**

DPP continued from page 3

Mysterious Ball Lightning

Lightning comes in more than just jagged bolts—it's also been reported as a luminous ball a few tens of centimeters in diameter. "Ball lightning" is extremely rare, and its properties are downright baffling: observers have clamed it can travel through windowpanes and it has been spotted within aircraft. Scientists don't know how ball lightning forms, however, and why it's often accompanied by a strong odor and buzzing noises. It's surprising that we don't understand a phenomenon that's been recorded for centuries, said Hui-Chun Wu, a physicist at Zhejiang University in China.

Wu has proposed a theoretical model to explain ball lightning. The first step to forming ball lightning, his theory postulates, is that the tip of what will become a lightning bolt generates more than 10^{15} electrons moving at nearly the speed of light. When this relativistic burst of electrons strikes the ground, it creates microwaves that ionize gases in the air to produce a plasma, Wu's theory proposes. This plasma expands into a bubble with a diameter dictated by the wavelength of the electromagnetic radiation (roughly 20-50 centimeters). When molecules such as N_2 and O_2 in the plasma are excited by nearby electrons, they emit visible light. As a result, the spherical structure—the ball lightning—appears to glow. Wu's model also explains the smells and sounds often associated with ball lightning: humans can hear microwaves because they create acoustic pressure in the inner ear, and the plasma creates ozone (O_3) that gives off a distinctive odor. And because microwaves can travel through insulators like glass, Wu's model is consistent with ball lightning being created on the other side of windowpanes. Wu is currently planning experiments to test his model—he aims to detect electrons and microwaves produced in high-voltage settings that mimic the conditions of lightning.

Link to abstract: aps.org/Meeting/DPP18/Session/UI2.6

The author is a freelance writer in Portland, Oregon.

APS physics

GORDON AND BETTY MOORE FOUNDATION

Fundamental Physics
Innovation
AWARDS

LECTURESHIP AWARDS
Supports visits to enable seminars and exchanges of ideas

VISITOR AWARDS
Supports extended visits between researchers to learn, develop, and share techniques or scientific approaches

CONVENING AWARDS
Supports scientific meetings to generate or build on ideas within the community

Learn more:
aps.org/programs/innovation/moore

The Back Page

An International Strategy for Serving the APS Mission

*By the APS Task Force on Expanding International Engagement**

The APS Council has strongly endorsed the Report of the Task Force on Expanding International Engagement. Effective international partnerships are crucial both to APS and the entire physics enterprise in the United States. This report gives APS a strategic roadmap for making connections and strengthening relationships with the international physics community.
—Timothy J. Gay, 2018 Speaker of the Council

Physics is a global endeavor, with some of the greatest breakthroughs and achievements realized through international collaboration. The APS membership reflects the international nature of physics, with nearly one quarter living outside of the United States (Fig. 1). Physicists cross continents to attend the Society's annual meetings, with nearly one third of all March Meeting participants coming from outside the United States, making it one of the largest and most internationally diverse gatherings of physicists worldwide. Moreover, international issues cut across essentially all interests of APS, and their importance is increasing:

- ***Research:*** International research collaborations are on the rise; more countries are partnering to build large-scale collaborations and facilities.
- ***Industry:*** Companies are increasingly multinational; more U.S. corporations are expanding offshore research and development facilities.
- ***Journals:*** Three-quarters of corresponding authors publishing in APS journals are now from outside the United States.
- ***Education:*** The United States competes to attract and retain first-rate students and scientists, yet international applications to U.S. physics Ph.D. programs are declining.
- ***Outreach:*** APS engages physicists at all levels worldwide, offering K-12 students hands-on physics activities and bringing the excitement of physics to U.S. and, increasingly, to international audiences.
- ***Policy:*** Open exchange is the lifeblood of scientific progress; recent government policies restricting scientific mobility are affecting U.S. participation in international collaborations, as well as international participation in U.S.-based collaborations.
- ***Membership:*** Nearly one-quarter of APS membership lives outside the United States; APS surveys indicate that many members would welcome a more international outlook from the Society.

The *APS Strategic Plan: 2013-2017* recognized that expanded international engagement was key to the Society's service to the physics community. Consequently, APS created new international programs to serve its members, increased its offerings to physicists in the developing world, established ongoing physicist exchanges with new international partners, and united with other national physical societies to carry out a suite of joint activities.

Then, with the development and upcoming launch of the *APS Strategic Plan: 2019*, APS leadership decided it was time to take the Society's international efforts to the next level, and in March 2017, APS Chief Executive Officer Kate Kirby launched the APS Task Force on Expanding International Engagement. The Task Force worked for nearly 18 months to understand the interests, concerns and priorities of all APS stakeholders and to create an international strategy to serve the larger APS mission.

Guiding Principles

- ***International partnerships strengthen APS.*** Expanded and strengthened partnerships with other national, regional, or international physics organizations will enable APS to better serve the global physics community. While increased international partnerships and activities may attract new APS members, the Society is not aiming to grow its membership through expanded international engagement. The APS does not aim to be the world's physical society.
- ***International collaboration strengthens physics in the United States.*** The U.S. physics enterprise benefits from international engagement with physicists worldwide. APS meetings and publications strengthen that engagement. As physicists often belong to their own national or regional physics society—and also to APS—the Society can offer a global community for physicists, with new opportunities for international partnerships.

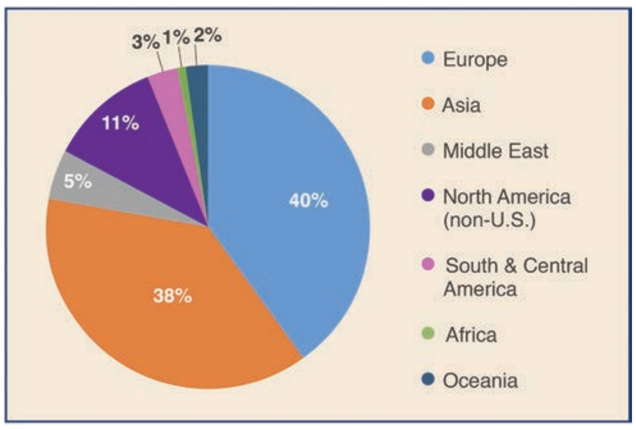


Figure 1: Geographic distribution of APS Members. As of January, 2018, 13,772 of 55,385 APS members were living outside the United States.

Figure 2: Stakeholder responses to Question 1 (below)

These Principles served as the foundations upon which the Task Force built its recommendations for the Society.

Understanding Stakeholder Interests

Task Force members conducted extensive outreach to better understand the perspectives and priorities of essentially all APS stakeholders. Most notably, the Task Force partnered with the Statistical Resource Center of the American Institute of Physics to conduct a survey of APS members on international priorities. A sample of nearly 9,400 members (~6400 U.S.; ~3000 non-U.S.) yielded a 33% response rate, with an especially strong response from non-U.S. members. This suggested that APS members, especially those outside of the U.S., were invested in the Society's efforts to expand its international engagement. In addition to the survey, the Task Force sought advice from essentially all APS components, as well as other national and international physics organizations:

APS Units and Other Physics Organizations

- Executive Committees of all APS Units
- Industrial Physics Advisory Board
- National physical society leaders
- International and regional physics organizations
- International Union of Pure & Applied Physics (IUPAP) Presidential Line
- U.S. Liaison Committee to IUPAP

APS Leaders & Staff

- APS Presidential Line
- Board of Directors
- Council of Representatives
- Senior Management Team
- APS Senior Staff
- Lead & Remote Editors

Outreach Findings: Shared Values

While the stakeholders' feedback proved critical to developing the Task Force goals and recommendations, the feedback also revealed a few shared values among essentially all groups:

- ***Connectivity and Community:*** All APS members, regardless of nationality, rated "being part of a larger physics community" as the primary reason for APS membership. Consequently, APS should serve as a global hub, welcoming the world's physicists and working with international partners to advance shared interests.

Figure 3: Stakeholder responses to Question 2, (below)

- ***Inclusiveness:*** APS must strive to serve all its members – worldwide. It must provide more ways for non-U.S. members to participate in all aspects of the Society. It should move from mere "passive allowance" towards "proactive inclusion" of international members across all of its activities.
- ***Representative Leadership:*** Non-U.S. members comprise 24% of total membership, but international members are not proportionally represented across the Society's leadership (i.e., Unit Leaders, Program Committees, Advisory Committees, etc.). APS must work to ensure that international voices are included in all aspects of the Society's leadership and advisory roles.

Outreach Findings: Survey Results

The "Member Survey," and subsequent internal surveys to APS components, provided crucial insights into the stakeholders' priorities. To compare and contrast responses, every survey included two common questions:

1. *The list below describes some broad, **over-arching goals** for APS international programs. Which of these do you believe APS should make top priority? [Select up to 2.]*
   - Increase international member participation in APS leadership
   - Expand international reach of existing APS programs
   - Serve developing country physicists, without encouraging "brain-drain"
   - Prepare young physicists (PhD students, postdocs, early career) for international partnerships and collaboration in industry, academia, or other careers
   - Promote "Science Diplomacy"
   - Create incentives for physicists outside of the U.S. to belong to both APS and the national physical society in their current country of residence
2. *The list below describes some broad, **cross-cutting issues** that involve actions that APS might take. Which of these do you believe APS should consider making a top priority? [Select up to 2.]*
   - Scientific Mobility
   - Long-term Funding for International Projects
   - National Benefits of International Scientific Collaboration
   - International Mechanisms for Planning of International Scientific Collaborations
   - Joint National Physics Society Advocacy

Comparisons or responses across the various stakeholder groups are presented in Figures 2 and 3.

Goals and Recommendations

The Task Force identified four goals that encompassed the breadth of interests conveyed by all stakeholders in APS international activities. (✷ = Priority identified by the Task Force*)

Goal 1: Offer new/expanded ways to participate in the APS community.

Recommendations:

- ✷ Enable geographic APS Sections outside of the United States.
- Create incentives for physicists outside of the U.S. to belong to both APS and the national physical society in their country of residence.

BACK PAGE continued on page 7

The Back Page is a forum for member commentary and opinion. The views expressed are not necessarily those of APS.
APS News welcomes and encourages letters and submissions from APS members responding to these and other issues. Responses may be sent to: letters@aps.org

APS Announces 2019 Prize and Award Recipients

APS extends congratulations to all recipients of these Society prizes and awards. Recipients will be honored at award ceremonies at various APS meetings throughout the year. The March and April meeting award ceremonies are open to all APS members and their guests. At the March Meeting, the APS Prizes and Awards Ceremony will be held Monday, March 4, 2019, 5:45 p.m. at the Boston Convention Center, Boston, Massachusetts. At the April Meeting, the APS Prizes and Awards Ceremony will be held Sunday, April 14, 2019, 5:30 p.m. at the Sheraton Denver Downtown Hotel, Denver, Colorado. In addition to the award ceremonies, many prize and award recipients will give invited talks during the meeting. Some recipients are recognized at APS unit meetings. For the schedule of APS meetings, please visit aps.org/meetings/calendar.cfm.

Prizes

2019 APS MEDAL FOR EXCEPTIONAL ACHIEVEMENT IN RESEARCH

Bertrand I. Halperin
Harvard University
For his seminal contributions to theoretical condensed matter physics, especially his pioneering work on the role of topology in both classical and quantum systems.

2019 HANS A. BETHE PRIZE

Ken'ichi Nomoto
The University of Tokyo,
Kavli Institute of Physics and Mathematics
For lasting contributions to our understanding of the nuclear astrophysics of the universe, including stellar evolution, the synthesis of new elements, the theory of core-collapse and thermonuclear supernovae, and gamma-ray bursts.

2019 TOM W. BONNER PRIZE IN NUCLEAR PHYSICS

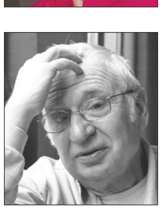
Barbara V. Jacak
Lawrence Berkeley National Laboratory,
University of California, Berkeley
For her leadership in the discovery and characterization of the quark-gluon plasma, in particular for her contributions to the PHENIX experiment and its explorations of jets as probes.

2019 HERBERT P. BROIDA PRIZE

Marsha I. Lester
University of Pennsylvania
For the development of innovative methods for generating and characterizing reactive intermediates using sophisticated laser techniques that elucidate important reaction pathways in atmospheric and combustion chemistry.

2019 OLIVER E. BUCKLEY CONDENSED MATTER PHYSICS PRIZE

Elihu Abrahams
University of California, Los Angeles



Alexei L. Efros
University of Utah

Boris I. Shklovskii
University of Minnesota

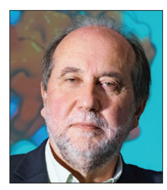
For pioneering research in the physics of disordered materials and hopping conductivity.

2019 DAVISSON-GERMER PRIZE IN ATOMIC OR SURFACE PHYSICS

Randall Feenstra
Carnegie Mellon University
For pioneering developments of the techniques and concepts of spectroscopic scanning tunneling microscopy.

2019 MAX DELBRUCK PRIZE IN BIOLOGICAL PHYSICS

Ken A. Dill
Stony Brook University



Jose Nelson Onuchic
Rice University

For independent contributions to a new view of protein folding, from the introduction and exploration of simple models, to detailed confrontations between theory and experiment.

2019 EINSTEIN PRIZE

Abhay Ashtekar
Pennsylvania State University
For numerous and seminal contributions to general relativity, including the theory of black holes, canonical quantum gravity, and quantum cosmology.

2019 PRIZE FOR A FACULTY MEMBER FOR RESEARCH IN AN UNDERGRADUATE INSTITUTION

Robert C. Forrey
Pennsylvania State University, Berks
For exceptional engagement of undergraduate students and wide-ranging contributions to theoretical physics, including ultracold atomic and molecular collisions, matter wave optics, metallic clusters and nanoparticles, and molecular astrophysics.

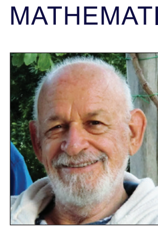
2019 HERMAN FESHBACH PRIZE IN THEORETICAL NUCLEAR PHYSICS

Barry R. Holstein
University of Massachusetts, Amherst
For seminal theoretical studies of fundamental symmetries in nuclei, including radioactive nuclear decays, parity-violating nucleon-nucleon interactions, and chiral dynamics of mesons and baryons.

2018 FLUID DYNAMICS PRIZE

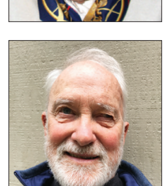
Keith Moffatt
University of Cambridge
For profound, elegant, and lasting contributions to fluid mechanics, including turbulence, Stokes flows, topological fluid mechanics, interfacial flows, and self-similarity

2019 DANNIE HEINEMAN PRIZE FOR MATHEMATICAL PHYSICS



Francesco Calogero
The Sapienza University of Rome

Michel Gaudin
CEA - Saclay



Bill Sutherland
University of Utah

For profound contributions to the field of exactly solvable models in statistical mechanics and many body physics, in particular the construction of the widely studied Gaudin magnet and the Calogero-Sutherland, Shastry-Sutherland, and Calogero-Moser models.

2019 LEO P. KADANOFF PRIZE

M. Cristina Marchetti
University of California, Santa Barbara
For original contributions to equilibrium and non-equilibrium statistical mechanics, including profound work on equilibrium and driven vortex systems, and fundamental research and leadership in the growing field of active matter.

2019 IRVING LANGMUIR PRIZE IN CHEMICAL PHYSICS

Devarajan Thirumalai
University of Texas, Austin
For the development of analytical and computational approaches to soft-matter systems and their application to the transitional behavior of supercooled fluids and glasses, folding dynamics of protein and RNA biopolymers, and functioning of molecular motors.

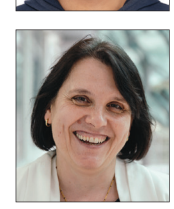
2019 JULIUS EDGAR LILIENFELD PRIZE

Katherine Freese
University of Michigan, Stockholm University
For ground-breaking research at the interface of cosmology and particle physics, and her tireless efforts to communicate the excitement of physics to the general public.

2019 JAMES C. MCGRODDY PRIZE FOR NEW MATERIALS

Bogdan Andrei Bernevig
Princeton University,
Max Planck Institute, Freie University

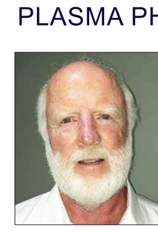
Xi Dai
Hong Kong University of Science and Technology



Claudia Felser
Max Planck Institute for Chemical Physics of Solids

For the theoretical prediction, design and realization of non-magnetic and magnetic topological semi-metals and new types of topological insulators.

2018 JAMES CLERK MAXWELL PRIZE FOR PLASMA PHYSICS

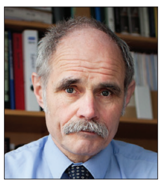


Keith H. Burrell
General Atomics
For pioneering research, including key experimental advances and diagnostic development, that established the links between sheared plasma flow and turbulent transport, leading to improved confinement regimes for magnetized plasmas through turbulent transport reduction by sheared flow.

2019 LARS ONSAGER PRIZE

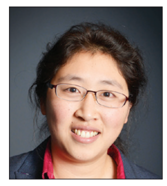
Christopher Jarzynski
University of Maryland, College Park
For seminal contributions to non-equilibrium thermodynamics and statistical mechanics that have had remarkable impact on experimental research in single-molecule and biological physics, engendering whole new fields of theoretical, numerical, and laboratory research, as well as for groundbreaking work on the thermodynamics of small systems.

2019 ABRAHAM PAIS PRIZE FOR HISTORY OF PHYSICS



Helge Kragh
Niels Bohr Institute, University of Copenhagen
For influential contributions to the history of physics, especially analyses of cosmological theories and debates, the history of the quantum physics of elementary particles and the solid state, and biographical studies of Paul Dirac and Niels Bohr, and his early quantum atom.

2019 I.I. RABI PRIZE IN ATOMIC, MOLECULAR, AND OPTICAL PHYSICS



Kang-Kuen Ni
Harvard University
For seminal work on ultracold molecules, including original contributions to the understanding of chemical reactions in the quantum regime, deterministic creation of individual molecules with optical tweezers, and development of novel, high-precision techniques to interrogate and control the complete set of internal molecular resources.

2019 ARTHUR L. SCHAWLOW PRIZE IN LASER SCIENCE

Steven T. Cundiff
University of Michigan
For pioneering contributions to the field of ultrafast laser spectroscopy, including optical multidimensional coherent spectroscopy applied electronic excitation in solids and atomic vapors, and the development and application of femtosecond frequency comb technology.

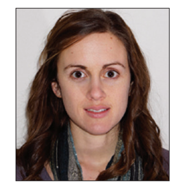
2019 W.K.H. PANOFSKY PRIZE IN EXPERIMENTAL PARTICLE PHYSICS

Sheldon Leslie Stone
Syracuse University
For transformative contributions to flavor physics and hadron spectroscopy, in particular through intellectual leadership on detector construction and analysis on the CLEO and Large Hadron Collider beauty experiments, and for the long-standing, deeply influential advocacy for flavor physics at hadron colliders.

2019 ANEESUR RAHMAN PRIZE FOR COMPUTATIONAL PHYSICS

Sharon C. Glotzer
University of Michigan
For innovative molecular dynamics simulations of the self-assembly of variously shaped particles which opened up new directions in soft matter and materials science research.

2019 GEORGE E. VALLEY, JR. PRIZE



Julia Mundy
Harvard University
For the pico-engineering and synthesis of the first room-temperature magnetoelectric multi-ferroic material.

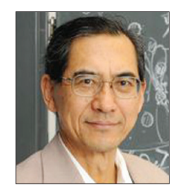
2019 EARLE K. PLYLER PRIZE FOR MOLECULAR SPECTROSCOPY AND DYNAMICS

Abraham Nitzan
Tel Aviv University and University of Pennsylvania
For deep physical insights in the fields of surface-enhanced Raman spectroscopy and molecular electronics.

2019 NORMAN F. RAMSEY PRIZE IN ATOMIC, MOLECULAR AND OPTICAL PHYSICS, & IN PRECISION TESTS OF FUNDAMENTAL LAWS & SYMMETRIES

Jun Ye
JILA, NIST/University of Colorado, Boulder
For ground-breaking contributions to precision measurements and the quantum control of atomic and molecular systems, including atomic clocks.

2019 ROBERT R. WILSON PRIZE FOR ACHIEVEMENT IN THE PHYSICS OF PARTICLE ACCELERATORS



Toshiki Tajima
University of California, Irvine
For the invention and leading the first realization of laser wakefield acceleration, which opened the way to compact acceleration applications such as ultrafast radiolysis, brilliant x-rays, intra-operative radiation therapy, wakefield beam dump, and high energy cosmic acceleration.

2019 POLYMER PHYSICS PRIZE

Ronald G. Larson
University of Michigan
For wide-ranging, multi-disciplinary contributions to understanding the structure, dynamics, and rheology of polymeric materials in melt, solution, glassy, mesomorphic, and multi-phase states, including viscoelastic instabilities, constitutive equations, alignment transitions, and phase behavior.

2019 J.J. SAKURAI PRIZE FOR THEORETICAL PARTICLE PHYSICS

Lisa Randall
Harvard University

Raman Sundrum
University of Maryland, College Park

For creative contributions to physics beyond the Standard Model, in particular the discovery that warped extra dimensions of space can solve the hierarchy puzzle, which has had a tremendous impact on searches at the Large Hadron Collider.

Awards

2019 DAVID ADLER LECTURESHIP AWARD IN THE FIELD OF MATERIALS PHYSICS

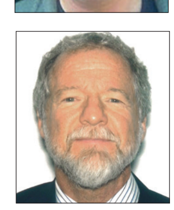
Giulia Galli
University of Chicago
For the invention of methods, especially for the enhancement of ab initio molecular dynamics, to understand, predict, and engineer the electronic and structural properties of materials.

2019 EDWARD A. BOUCHET AWARD

Carlos O. Lousto
Rochester Institute of Technology
For contributions to both numerical relativity, conducive to the solution of the binary black hole problem, and the understanding of the first detection of gravitational waves and service to the Hispanic scientific community, including the establishment of the Center for Gravitational Wave Astronomy, University of Texas at Brownsville in 2003.

2018 JOHN DAWSON AWARD FOR EXCELLENCE IN PLASMA PHYSICS RESEARCH

Todd E. Evans
General Atomics



Max E. Fenstemacher
Lawrence Livermore National Laboratory

Richard Alan Moyer
University of California, San Diego

For the first experimental demonstration of the stabilization of edge localized modes in high-confinement diverted discharges by application of very small edge-resonant magnetic perturbations, leading to the adoption of suppression coils in the ITER design.

2018 LEROY APKER AWARD

Eric S. Cooper
Pomona College
For outstanding contributions towards understanding the adaptive significance of ballistichory by modeling and comparing the flight of seeds dispersed by Acanthaceae fruits.

Nicholas E. Sherman
University of California, Davis
For outstanding undergraduate research in theoretical condensed matter and mathematical physics dealing with the subjects of quantum entanglement in mixed states, NMR in highly frustrated magnets and anyon dispersion in perturbed Toric Code models.

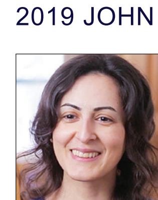
2019 JOSEPH A. BURTON FORUM AWARD

Shirley Ann Jackson
Rensselaer Polytechnic Institute
For distinguished application of her knowledge of physics to public service and increasing diversity in physics as Chair of the Nuclear Regulatory Commission and the president of Rensselaer Polytechnic Institute, and for service on many government, charitable, and corporate boards and committees.

2018 STANLEY CORRSIN AWARD

Anette Hosoi
Massachusetts Institute of Technology
For creative analysis of locomotion, contributions to the development of soft robotics as an emerging field, and her ability to combine mathematical analysis with physical insight.

2019 JOHN H. DILLON MEDAL



Zahra Fakhraai
University of Pennsylvania
For exceptional investigations of surface effects in polymer glasses and amyloid aggregation.

2019 GEORGE E. DUVALL SHOCK COMPRESSION SCIENCE AWARD

George T. Gray III
Los Alamos National Laboratory
For pioneering contributions in dynamic constitutive and damage response of materials; for leadership in developing programs and tools to advance our understanding of materials and structures in response to high-strain-rate and shock deformation; and for leadership in the technical community.

2019 EXCELLENCE IN PHYSICS EDUCATION AWARD

Learning Assistant (LA) model and the associated Learning Assistant Alliance (LAA)

Steven Iona
University of Colorado, Boulder
University of Denver

Laurie S. Langdon
University of Colorado, Boulder

Richard McCray
University of Colorado, Boulder

Valerie K. Otero
University of Colorado, Boulder

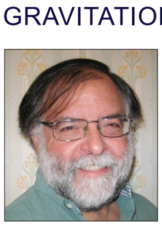
Steven Pollock
University of Colorado, Boulder

For the development of the Learning Assistant (LA) model and the associated LA Alliance, which has enhanced physics teacher education and recruitment, supported undergraduate course transformation, and physics instructor professional development.

2018 STUART JAY FREEDMAN AWARD IN EXPERIMENTAL NUCLEAR PHYSICS

Anna Kwiatkowski
TRIUMF
For outstanding and innovative contributions to precision mass measurements, commitment to mentoring of young researchers, and leadership in the low energy nuclear physics community.

2019 RICHARD A. ISAACSON AWARD IN GRAVITATIONAL-WAVE SCIENCE



Stanley E. Whitcomb
LIGO Laboratory
For extraordinary contributions to the conceptualization, design, construction, commissioning, and operation of the LIGO detectors; and for his stewardship of the global gravitational wave community, including developing the partnership between LIGO and Virgo, and establishing LIGO-India.

2019 JOSEPH F. KEITHLEY AWARD FOR ADVANCES IN MEASUREMENT SCIENCE

Zahid Hussain
Lawrence Berkeley National Laboratory
For the development of soft x-ray instrumentation such as monochromators and spectrometers for synchrotron radiation beamlines, leading to significant measurement improvements of angle resolved photoemission spectroscopy and resonant inelastic soft x-ray scattering.

2018 LANDAU-SPITZER AWARD

Yevgen Kazakov
Laboratory for Plasma Physics of the Royal Military Academy (LPP-ERM/KMS), Brussels, Belgium

Jozef Ongena
Laboratory for Plasma Physics of the Royal Military Academy (LPP-ERM/KMS), Brussels, Belgium

John C. Wright
MIT Plasma Science and Fusion Center, USA

Stephen J. Wukitch
MIT Plasma Science and Fusion Center, USA

For experimental verification, through collaborative experiments, of a novel and highly efficient ion cyclotron resonance heating scenario for plasma heating and generation of energetic ions in magnetic fusion devices.

2019 DISTINGUISHED LECTURESHIP AWARD ON THE APPLICATIONS OF PHYSICS

Cynthia Keppel
Thomas Jefferson National Accelerator Facility
For pioneering work in proton therapy and for the promotion of the applications of physics to both experts and non-experts.

2019 MARIA GOEPPERT MAYER AWARD

Alyson Brooks
Rutgers University
For contributions to theoretical astrophysics, in particular, the use of numerical hydrodynamic simulations compared with observations to elucidate the essential physics of galaxy formation.

2018 DWIGHT NICHOLSON MEDAL FOR OUTREACH

Ray Jayawardhana
Cornell University
For far-reaching, multi-faceted and impactful contributions as an educator and academic leader, including authoring popular books and articles about physics for adults and children, making frequent public speaking and media appearances, developing innovative outreach programs, and founding the Science Leadership Program.

2019 IRWIN OPPENHEIM AWARD

Todd R. Gingrich
Northwestern University

Jordan M. Horowitz
University of Michigan

For the article, "Proof of the finite-time thermodynamic uncertainty relation for steady-state currents," published in Physical Review E **96**, *020103(R) (2017), which demonstrated significance, rigor, and broad impact in the general area of non-equilibrium thermodynamics.*

2019 FRANCIS M. PIPKIN AWARD

Tanya Zelevinsky
Columbia University
For pioneering research on producing ultracold molecules confined in optical lattices and using them for precision spectroscopy, molecular clock techniques, and tests of fundamental physics.

2019 HENRY PRIMAKOFF AWARD FOR EARLY-CAREER PARTICLE PHYSICS

Nhan Tran
Fermi National Accelerator Laboratory
For wide-ranging contributions to the Compact Muon Solenoid experiment, including the development of a novel pileup subtraction method at the Large Hadron Collider, and the use of jet substructure for the analysis of high-energy collisions.

2019 ROLF LANDAUER AND CHARLES H. BENNETT AWARD IN QUANTUM COMPUTING

Jonathan Home
ETH Zürich
For the development and demonstration of trapped-ion quantum computing protocols, including Bell state stabilization by feedback control in mixed-ion chains, and the encoding of logical quantum states in the ion motion.

2019 JONATHAN F. REICHERT & BARBARA WOLFF-REICHERT AWARD FOR EXCELLENCE IN ADVANCED LABORATORY INSTRUCTION

Heather J. Lewandowski
University of Colorado, Boulder
For systematic and scholarly transformation of advanced laboratories in physics, for building leading assessment tools of laboratories, and for national service advancing our advanced laboratory educational community.

2019 EARLY CAREER AWARD FOR SOFT MATTER RESEARCH

Aparna Baskaran
Brandeis University
For pathbreaking advances in our understanding of the physics of soft materials out of equilibrium, especially active and granular matter.

2018 THOMAS H. STIX AWARD FOR OUTSTANDING EARLY CAREER CONTRIBUTIONS TO PLASMA PHYSICS RESEARCH

Frederico Fiuza
SLAC National Accelerator Laboratory
For seminal contributions that advanced the field of laboratory astrophysics through numerical simulations and leadership of experiments on particle acceleration, collisionless shocks, and magnetic reconnection.

2019 LEO SZILARD LECTURESHIP AWARD

Zia Mian
Princeton University
For promoting global peace and nuclear disarmament particularly in South Asia, through academic research, public speaking, technical and popular writing and organizing efforts to ban nuclear weapons.

2019 JOHN WHEATLEY AWARD

Federico Rosei
INRS
For sustained leadership and service to the international physics community, in particular for developing global collaborations through projects and networks in China, Mexico and several African countries, and for exceptional mentoring efforts.

Fellowships

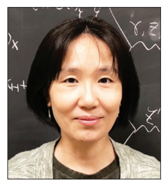
2018 M. HILDRED BLEWETT FELLOWSHIP

Asma Al-Qasimi
University of Rochester

Wafia Bensalem
Carleton University

Steph Kubala
University of Wisconsin at Madison

Tamar Mentzel
Harvard University



Satomi Okada
University of Alabama

Susmita Pal
University of Texas MD Anderson Cancer Center, Houston

2018 STANFORD R. OVSHINSKY SUSTAINABLE ENERGY FELLOWSHIP

Vivian E. Ferry
University of Minnesota
For proposed research developing improved photovoltaic systems using spectrally-selective photonic structures.

Dissertations

2018 ANDREAS ACRIVOS DISSERTATION AWARD IN FLUID DYNAMICS

Shabnam Raayai Ardakani
Massachusetts Institute of Technology
For experimental and theoretical contributions to understanding the mechanisms by which microtextured riblet surfaces can reduce (or increase) the viscous frictional drag experienced in high Reynolds number laminar boundary layer flows, and Taylor Couette flows.

2018 CARL E. ANDERSON DIVISION OF LASER SCIENCE DISSERTATION AWARD

Sara L. Campbell
University of Colorado, Boulder
For creating the world's first quantum gas optical atomic clock and demonstrating a record long coherence time for light-matter interactions at 10 s and clock measurement precision of 3 parts in 10 to the 19th power.

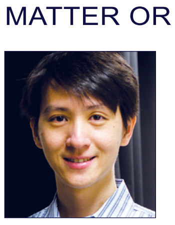
2018 OUTSTANDING DOCTORAL THESIS RESEARCH IN BEAM PHYSICS AWARD

Sergey Antipov
CERN
For experimental studies and analysis of the electron cloud build-up and corresponding instability in accelerators with combined function magnets and for the development of an effective mitigation technique applied in the Fermilab's Recycler ring.

2018 AWARD FOR OUTSTANDING DOCTORAL THESIS RESEARCH IN BIOLOGICAL PHYSICS

Jasmine A. Nirody
University of California, Berkeley
Outstanding thesis work on investigating the molecular mechanism underlying the dynamics of bacterial flagellar motor by using both computational modeling methods and experiments.

2019 RICHARD L. GREENE DISSERTATION AWARD IN EXPERIMENTAL CONDENSED MATTER OR MATERIALS PHYSICS



Edbert Jarvis Sie
Massachusetts Institute of Technology
For thesis topic, "Coherent light-matter interactions in monolayer transition metal dichalcogenides."

Uri Vool
Harvard University
For thesis topic, "Engineering synthetic quantum operations."

2018 DEBORAH JIN AWARD FOR OUTSTANDING DOCTORAL THESIS RESEARCH IN ATOMIC, MOLECULAR, OR OPTICAL PHYSICS

Rivka Bekenstein
Harvard University
For her work, "Electromagnetic waves in linear and nonlinear curved space systems."

2019 NICHOLAS METROPOLIS AWARD FOR OUTSTANDING DOCTORAL THESIS WORK IN COMPUTATIONAL PHYSICS

Evan E. Schneider
Princeton University
For exemplary achievement in computational physics, by leveraging new architectures to develop methods for astrophysical simulation on the world's fastest supercomputers.

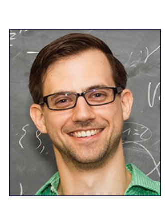
2019 DISSERTATION AWARD IN NUCLEAR PHYSICS

Grayson Rich
University of Chicago
For his outstanding contributions to the first observation of coherent elastic neutrino nucleus scattering as a member of the COHERENT neutrino experiment at the Oak Ridge National Laboratory.

2018 CECILIA PAYNE-GAPOSCHKIN DOCTORAL DISSERTATION AWARD IN ASTROPHYSICS

Gabriele Betancourt-Martinez
University of Maryland, College Park
Measuring and Interpreting the x-ray spectra of charge exchange.

2018 MARSHALL N. ROSENBLUTH OUTSTANDING DOCTORAL THESIS AWARD

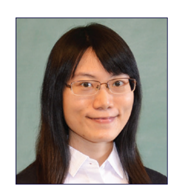


Seth Davidovits
Princeton Plasma Physics Laboratory
For major contributions to understanding, simulating, and diagnosing turbulence in compressing plasmas; for the identification of the sudden dissipation effect and suggestions for exploiting it; and for the derivation of a practical lower bound on turbulent dissipation in compressing plasma.

2019 J.J. AND NORIKO SAKURAI DISSERTATION AWARD

Nicholas L. Rodd
University of California, Berkeley
For developing powerful new techniques to search for dark matter signals in astrophysical datasets, for characterizing the excess of GeV gamma-rays from the inner Milky Way, and for cutting-edge predictions of annihilation signals from complex dark sectors and heavy weakly- interacting dark matter.

2019 DISSERTATION AWARD IN STATISTICAL AND NONLINEAR PHYSICS



Hong-Yan Shih
University of Illinois, Urbana-Champaign
For an outstanding doctoral thesis that relates the transition to turbulence in pipe flow and the evolution of interacting populations through collective effects.

2019 MITSUYOSHI TANAKA DISSERTATION AWARD IN EXPERIMENTAL PARTICLE PHYSICS

Benjamin Brubaker
Yale University
For outstanding contributions to the HAYSTAC (Haloscope At Yale Sensitive To Axion Cold Dark Matter) experimental detector, especially in its design and construction incorporating quantum measurement techniques, in addition to its operation including data acquisition and novel analysis techniques.

Nominate members for next years' prizes, awards, and fellows: aps.org/programs/honors/index.cfm