APS NEWS

A PUBLICATION OF THE AMERICAN PHYSICAL SOCIETY

WWW.APS.ORG/PUBLICATIONS/APSNEWS

December 2015 • Vol. 24, No. 11

APS physics

Physicists Study Spread of Disease
Page 4

Astronomy Allies Team Up to Confront Sexual Harassment

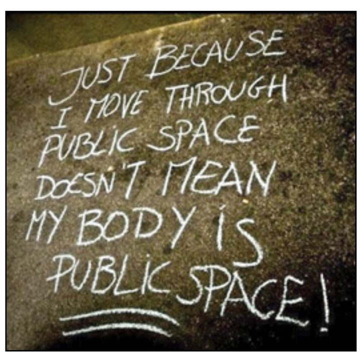
By Sophia Chen

When a fellow astronomer sexually harassed Heather Flewelling at an American Astronomical Society (AAS) conference, she didn't report him. At least not at first.

"I didn't think anyone would believe me," says Flewelling, a researcher at the Institute for Astronomy in Hawaii. "So I just kept it to myself."

But her harasser didn't stop. It happened again — and again. Flewelling felt physically threatened enough that it was affecting her participation in the conference. Between lectures, she would text a close friend, Carnegie Observatories postdoc Katey Alatalo, to walk with her from lectures or networking events in order to avoid interacting with her harasser. Finally, a few days after he harassed her again during the January 2014 AAS Meeting, Flewelling reported him.

This experience led Flewelling and Alatalo to start Astronomy Allies, a group that serves as a resource for people who feel unsafe at astronomy conferences.



womeninastronomy.blogspot.com

The group, which began in the summer of 2014, has grown to about 60 members. They act as confidants for astronomers who have suffered bullying, sexual harassment, or assault but aren't prepared to formally report it. (Institutional definitions vary, but sexual harassment generally includes unwelcome sexual advances and offensive remarks about a person's gender. Sexual assault usually refers to unwanted sexual contact and includes rape.) Members, who wear red badges at conferences to identify themselves, offer accompanied walks from lectures and informal networking gatherings for attendees who feel unsafe at AAS conferences.

"People set up these informal [support systems] all the time, so we thought, we should formalize this," Alatalo says. "We thought, what if the next Heather doesn't have a group of friends who can help her through this situation?"

The group also helps people navigate the formal reporting process. This role as an intermediary is important, Flewelling says, because the process for formal sexual harassment reports in astronomy

ALLIES continued on page 7

APS Appoints New Publisher

Matthew Salter will join the APS senior management team as publisher in January 2016 with responsibility for the business aspects of the society's journal operations.

"I am delighted to be joining APS as publisher and I look forward to the opportunity of working with colleagues to grow and develop the APS publishing program. It is an honor to be part of the world's largest physical society and to be associated with its prestigious journal portfolio" Salter said.

Before moving to APS, Salter was Associate Director for journals in the Asia-Pacific region based in the Tokyo office of IOP Publishing. Prior to that, he was Asia-Pacific publisher at MacMillan Science Communication, the parent company of Nature Publishing Group.

"Matthew will be working to ensure that our journals continue to excel in serving the physics community," said APS Chief Executive Officer Kate Kirby.

Salter received his Ph.D. in chemistry from Imperial College London and has held research and teaching positions at Tohoku University in Japan, King's College London, and the University of Tokyo. He is a native English speaker, fluent in Japanese, and also speaks Mandarin Chinese and Korean.

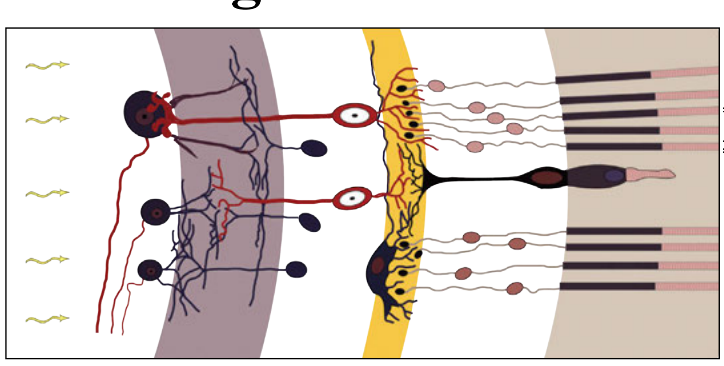
FRONTIERS IN OPTICS / LASER SCIENCE MEETING

Squinting to See a Single Photon

By Emily Conover

What's the dimmest flash of light the human eye can perceive? A handful of photons? What about a single photon? It's a basic biological question that has yet to be conclusively answered, but a group of quantum optics researchers could fill in the blanks soon. And if humans can see a single photon, those researchers may be able to test for quantum effects on human vision.

According to Rebecca Holmes, a graduate student at the University of Illinois at Urbana-Champaign, her group's research has already provided evidence that humans are capable of seeing a burst of several photons. She presented the results this October at the 2015 Frontiers in Optics / Laser Science meeting, a joint meeting of the APS Division of Laser Science and The Optical Society, in San Jose, CA. In the study, Holmes and her collaborators presented human subjects



wikimedia commons

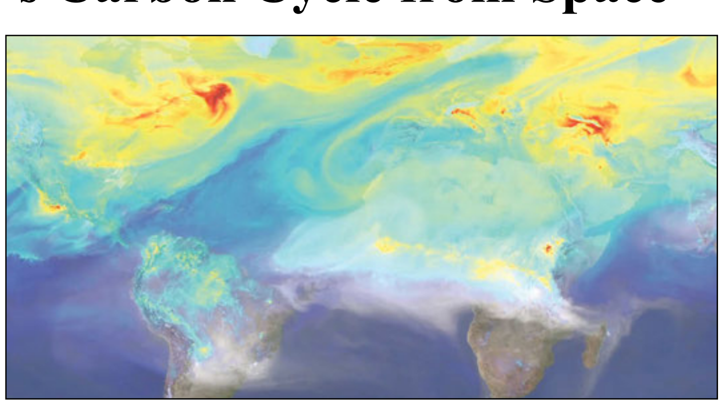
Photons entering the eye (from the left in this diagram) pass through several layers of tissue containing nerve cells before hitting the rods and cones at the back of the retina. These light-detecting cells are highly sensitive but can they detect single photons?

PHOTON continued on page 6

Tracking Earth's Carbon Cycle from Space

By Emily Conover

Across the globe, over a hundred monitoring stations regularly measure the carbon dioxide concentration in our atmosphere — cataloging both its seasonal fluctuations and its seemingly relentless rise. But to better understand the impacts of humanity's constant belching of greenhouse gases, scientists are making the case that CO_2 should be monitored more like the weather. The existing ground-based monitoring stations are not enough to precisely predict what CO_2 concentrations will look like in the future, they say. "Could we predict the weather if we had only 150 weather stations around the world? Yeah, we could, about as well as we did in 1930," says David Crisp of NASA's Jet Propulsion Laboratory.



NASA

Computer models of atmospheric carbon dioxide levels, like the one shown here, could be refined with data from remote sensing with lasers.

CYCLE continued on page 5

APS GOVERNANCE

First Elected APS Treasurer: James Hollenhorst

By Emily Conover

When APS revised its governance structure last year, a new elected position on the Board of Directors was created: treasurer. The first person to fill that role will be James Hollenhorst, senior director of technology at Agilent Technologies. He takes over for Interim Treasurer and Past President Malcolm Beasley on January 1, 2016.

As the first elected treasurer, Hollenhorst will play a part in defining the responsibilities of the position. "I think that it's an important role, and it's exciting that it's a new role that is being created, so there won't be a tremendous amount of legacy that I'll have to conform to," he said.

Emily Conover

James Hollenhorst

Hollenhorst believes that the governance reform that created his new role has strengthened the Society. "We're really on a much firmer foundation — a more professionally managed operation — now, through those corporate governance changes."

As treasurer, his main responsibilities, Hollenhorst said, will be to make sure that financial planning within APS is well managed, that the right processes are in place to monitor the Society's finances, and that there's a solid system of strategic budget planning. Finally, he will oversee the investment of the APS endowment. "Thankfully we don't have a bunch of volunteer physicists who are deciding how the money is invested, but we have professionals who do that for us," Hollenhorst joked. "But, we have some very smart physicists on the Investment Committee who are ... reviewing what our financial consultants are doing," he added. The Investment Committee reviews the performance of the Society's investments manager and the investment policies of the Society.

After completing his Ph.D. at Stanford, Hollenhorst worked at Bell Labs for over a decade, focusing on semiconductor device physics. He then moved to Hewlett-Packard (HP) Labs, and later the HP spin-off company Agilent. At HP he worked initially on superconductivity, before eventually becoming director of electronics research for Agilent. Later, he took on the role of director of life sciences and chemical analysis research, before assuming his current position as senior director of technology.

Through his years in laboratory management, Hollenhorst has experience budgeting and dealing with finances, and he's "always had an interest in the financial end of things," he said. But "I'm first and foremost a physicist and not a financial person."

APS is a healthy organization, Hollenhorst said. "They obviously have the best physics journals in the world and provide benefits to members and to society that are

TREASURER continued on page 3

Inside APS

Crystal Bailey, Careers Program Manager

In this new series to appear occasionally, *APS News* sits down with APS employees to learn about their jobs, their goals, and the things that make them tick. This month we chat with Careers Program Manager Crystal Bailey.

What do you do at APS?

In a nutshell, I work on programs to help inform students and their faculty mentors about the career opportunities for those with a physics degree, as well as create resources and guidance that will help students better prepare for their future careers, and help their faculty mentors become better career advisers.

What career resources should APS members be aware of?

Most of the resources that I have worked on are easily accessed through the careers website: aps.org/careers. The "Becoming a Physicist" section is for people who are exploring what physicists do. We also have a new section called "Job Prospects for Physicists," with profiles of career tracks — for example, physics bachelors working in the private sector. We try to emphasize nonacademic tracks, because the majority of graduates will go into the private sector. In the "Career Guidance" section, there are targeted resources for people who are moving towards actually getting a career. The best resource, I think, is the online Professional Guidebook, which kind of takes you through the key elements of a job search — everything from self assessment, to building a network, to doing informational interviews, writing a resume, doing a good interview, negotiation, the whole arc. Our job board is also one of the most highly visited pages on the entire APS website.

Do you have any exciting upcoming projects?

Industrial Physics Fellow Steven Lambert and I are working on getting an industry mentoring program off the ground. It's called IMPact, and currently it's for grad students and postdocs, but at some point in the future we might also open it up to undergrads.

How did you come to work at APS?

I got this job the way 80% of all human beings do — through

Emily Conover

Crystal Bailey

networking. I was nearing the completion of my Ph.D., and I was friends with APS Director of Education and Diversity Ted Hodapp. I let him know that I was looking for opportunities, and he said, "As a matter of fact there's a new position — you should apply for it."

I feel it proves a really important point about careers, which is that I would've never thought that this would be a job that I really enjoyed. I went from doing a Ph.D. in nuclear physics with an intention to go into physics education research, and here I am a program manager at a nonprofit talking about careers. That seems like a 180, but in my role at APS I'm actually still teaching. I go to colloquia; I talk to students; I talk to faculty. The point being — we all have little itches that we like to scratch, and unexpected careers can still scratch the same itch.

What do you enjoy about working at APS?

One of the reasons I was attracted to physics education research was that I loved the idea of serving my community, and I'm certainly still serving my community, probably in an even more impactful way, here, than I would have as a faculty member or a teacher, perhaps. This kind of a job gives you a bird's-eye view so you can help people make connections in the field, in ways that benefit everyone.

How did you first get interested in physics?

When I started as an undergrad I was an electrical engineering major. But in my second year I took a physics class on electricity and magnetism, and I remember this very specific moment. We were doing a lab. We had a fixed magnet and a wire and a battery. You were

BAILEY continued on page 4

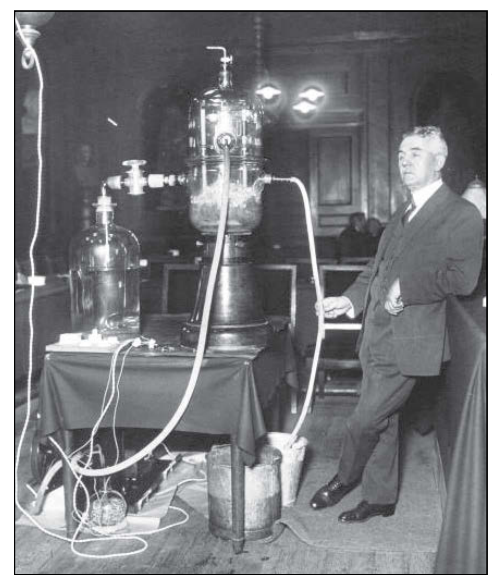
This Month in Physics History

December 1910: Neon lights debut at Paris Motor Show

Paris is known as the "City of Light," in part because it was the first to adopt gas street lighting. It also hosted the first neon lights, thanks to a French chemist and engineer who became known as the "Edison of Paris": Georges Claude.

Experiments over almost two centuries pointed the way towards the gas discharge tube. Back in 1675, French astronomer Jean Picard noticed that his mercury barometer was emitting a faint glow. Eventually, physicists understood that electrons from mercury atoms were captured by the glass barometer tube, and then released when the level of the mercury dropped; these electrons excited mercury atoms in the vapor above the liquid. Much later, in 1855, a German physicist and glassblower named Heinrich Geissler invented the "geissler tube," a long glass tube filled with gas that glowed when high voltage was applied across the tube.

The discovery of neon was part of the ongoing investigation of air. In 1775 Henry Cavendish observed a bit of gas residue after he tried to remove all the oxygen and nitrogen from a sample of air by fractional distillation. Then in the 1890s, the Scottish chemist William Ramsay identified neon, krypton, and xenon with M.W. Travers, and argon with Lord Rayleigh.



Wikipedia Commons

Georges Claude

These gases also glowed with bright colors when high voltage was applied. Ramsay noted neon's distinctive hue in his Nobel Prize lecture: it was "a brilliant flame-covered light, consisting of many red, orange, and yellow lines." (Travers described it as a "blaze of crimson light.") By the turn of the century, there were several varieties of electric discharge lighting available in Europe and the U.S.

Enter Georges Claude, who worked as an electrical inspector while dabbling in scientific invention. He figured out how to scale up the fractional distillation, and was soon capable of producing as much as 10,000 cubic meters of liquefied air each day. He co-founded his own company, L'Air Liquide, in 1902, selling his product to the steel industry in particular, and it quickly grew into an international corporation.

Claude had originally hoped to follow in Ramsay's footsteps and make his own noble gaseous discoveries, but soon realized that "there was nothing more to be done." Instead, he set about putting leftover neon produced as a byproduct from his liquefaction enterprise to good use. He disliked the overly bright electric lighting used at the time, and looked to all those previously invented gas discharge tubes for inspiration, as well as Edison's hugely successful incandescent bulbs.

He particularly liked the design of so-called "Moore lamps," invented by one of Edison's former workers, Daniel McFarlan Moore. These were tall glass tubes with electrodes at either end, filled with nitrogen or CO_2 at low pressure; they glowed white when high voltage was applied. But they were expensive and tended to leak, so Moore lamps never quite caught on. Claude replaced the CO_2 with neon, and added a carbon filter so that impurities from the hot electrodes would not cause the electrodes to sputter and light to dim. Eventually he built 20-foot neon tubes capable of glowing for 1200 hours.

Claude quickly filed a patent, and displayed his neon tubes in December 1910, at the Paris Motor Show. People were dazzled, but the tubes weren't ideal for general lighting.

But they were perfect for signage, and in 1912, Claude sold his first neon sign to a barbershop on the Boulevard Monmartre. Soon there was a large rooftop neon sign for Cinzano (an Italian vermouth) and entrance lighting for the Paris Opera. Claude founded his second company, Claude Neon, and made a fortune selling franchises for his neon lighting. He received a U.S. patent for neon lighting in 1915.

Automobile mogul Earle C. Anthony, the sole distributor in California for The Packard Motor Car Company, brought the first neon signs to America after seeing them during a visit to Paris. They were perfect for his showroom in downtown Los Angeles, and purportedly caused traffic jams because passersby kept stopping to admire the giant glowing orange-red tubes. It was dubbed "liquid fire." Claude monopolized the market until the 1920s, when his original patents expired and his trade secrets leaked out to competitors.

Ultimately, Claude fell afoul of his own government. Never a fan of the French democratic system, he supported restoring the monarchy. During the German occupation of France in World War II, he became a Nazi collaborator. When the war ended, he was sentenced to life imprisonment, although eventually he was paroled after his fellow scientists pleaded for leniency on his behalf. He died in 1960 when he was 90.

Pure neon lighting glows orange-red. Investigators soon realized they could make other colors by using different gases — carbon dioxide for white,

NEON continued on page 3

APSNEWS

Series II, Vol. 24, No. 11
December 2015
© 2015 The American Physical Society

Editor .... **David Voss**
Staff Science Writer .... **Emily Conover**
Contributing Correspondent .... **Alaina G. Levine**
Art Director and Special Publications Manager .... **Kerry G. Johnson**
Design and Production .... **Nancy Bennett-Karasik**
Proofreader .... **Edward Lee**

APS News (ISSN: 1058-8132) is published 11X yearly, monthly, except the August/September issue, 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. The 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 2015

President
Samuel H. Aronson*, *Brookhaven National Laboratory (retired)*

President-Elect
Homer A. Neal*, *University of Michigan*

Vice President
Laura H. Greene*, *University of Illinois, Champagne-Urbana*

Past-President
Malcolm R. Beasley*, *Stanford University*

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

Speaker of the Council
Nan Phinney*, *Stanford University*

Treasurer
Malcolm R. Beasley*, *Stanford University (emeritus)*

Corporate Secretary
Ken Cole, APS

General Councilors
Marcelo Gleiser, Nadya Mason, Gail McGlaughlin, Keivan G. Stassun*

International Councilors
Marcia Barbosa, Eliezer Rabinovici, Annick Suzor-Weiner*, Kiyoshi Ueda

Chair, Nominating Committee
Patricia McBride

Chair, Panel on Public Affairs
William Barletta

Division, Forum and Section Councilors
Miriam Forman *(Astrophysics)*, Timothy Gay *(Atomic, Molecular & Optical Physics)*, Jose Onuchic *(Biological)*, Amy Mullin* *(Chemical)*, Frances Hellman* *(Condensed Matter Physics)*, Steven Gottlieb *(Computational)*, Ann Karagozian *(Fluid Dynamics)*, Gay Stewart* *(Forum on Education)*, Eric Sorte, *(Forum on Graduate Student Affairs)*, Dan Kleppner* *(Forum on History of Physics)*, Gregory Meisner* *(Forum on Industrial and Applied Physics)*, Young-Kee Kim* *(Forum on International Physics)*, Lowell Brown *(Forum on Physics and Society)*, Nicholas Bigelow *(Laser Science)*, James Chelikowsky *(Materials)*, Wick Haxton* *(Nuclear)*, Philip Michael Tuts (*Particles & Fields)*, John Galayda *(Physics of Beams)*, Cary Forest *(Plasma)*, Mark Ediger *(Polymer Physics)*, Nan Phinney *(California Section)*, Carlos Wexler *(Prairie Section)*

Staff Representatives
Mark Doyle, *Chief Information Officer*; Amy Flatten, *Director of International Affairs*; Terri Gaier, *Director of Meetings*; Christine Giaccone, *Director, Journal Operations*; Barbara Hicks, *Associate Publisher/Director of Business Initiatives*; Ted Hodapp, *Director of Education and Diversity*; Dan Kulp, *Editorial Director*; Trish Lettieri, *Director of Membership*; Michael Lubell; *Director, Public Affairs*; Michael Stephens, *Director of Finance/Controller and Assistant Treasurer*; James W. Taylor, *Deputy Executive Officer/Chief Operating Officer*

*** Members of the APS Board of Directors**

Diversity Update

Travel Grants Available for 2016 PhysTEC Conference

Faculty from minority-serving institutions (MSIs) are encouraged to apply for travel grants to attend the 2016 PhysTEC Conference, the nation's largest meeting dedicated to physics teacher education. The PhysTEC Conference will be held March 11-13 at the Royal Sonesta Harbor Court in Baltimore, MD, immediately preceding the 2016 APS March Meeting. Learn more and register now at: phystec.org/conferences/2016

Join the APS National Mentoring Community

In your fall courses, do you have underrepresented minority undergraduates who have the potential to earn a degree in physics? Now is the time to nominate them to participate in the APS National Mentoring Community (NMC) as your official mentees. The NMC provides support to enable the development of a successful mentoring relationship. Visit aps.org/nmc/ to register for free as an NMC mentor, and then invite your mentees to join through the program.

APS Meetings — Child Care Grants

Small grants of up to $400 are available to assist 2016 APS March and April meeting attendees who are bringing small children or who incur extra expenses in leaving them at home (i.e., for extra daycare or babysitting services). More information and the online application can be found at: aps.org/programs/women/workshops/childcare.cfm

Professional Skills Development Workshop for Women Physicists

With support from the National Science Foundation, APS will host a Professional Skills Development Workshop for female physicists at the 2016 APS March Meeting. Postdoctoral associates and early-to-mid-career faculty and scientists are invited to apply. Applicants affiliated with a U.S. institution/facility are eligible for travel and lodging funding consideration. Those needing funding assistance are encouraged to apply early. The deadline for the workshop and a link to the online application can be found online at aps.org/programs/women/workshops/skills/index.cfm

APS Bridge Program Application Now Open

The APS Bridge Program is now accepting applications for Fall 2016. Underrepresented minorities interested in pursuing a Ph.D. in physics are encouraged to apply by the March 18, 2016 deadline. Visit apsbridgeprogram.org for more information or email bridgeprogram@aps.org

APS OFFICE OF EDUCATION AND DIVERSITY

2015 APS National Mentoring Committee and Bridge Program Conference

By Ana Aceves

The APS Bridge Program (BP) and the newly formed APS National Mentoring Committee (NMC) held a joint annual conference from October 9-11, 2015 at Florida International University (FIU). This is the third annual conference for BP and the first for NMC.

Bridge programs, of which this is one, aim to increase the number of underrepresented minorities — defined as African Americans, Hispanic Americans, and Native Americans — who earn a Ph.D. in physics. To help these students succeed, the NMC provides a national network of mentors at participating Ph.D.-granting institutions. APS funds six of the ten total sites across the country.

The NMC is an effort to increase the number of underrepresented minorities who complete a bachelor's degree in physics by pairing mentors and mentees. NMC's goal is to select mentors across the country who can provide students with guidance throughout their academic careers. According to APS, there are now 84 NMC mentors. Since mentoring is an essential part of the APS Bridge Program, holding these annual conferences together brings added value to the participants.

For Camila Monsalve, an undergraduate at FIU, the conference was a unique experience. "[This] conference was an eye-opener," she said. "I have never felt so comfortable and identified in an

MENTORING continued on page 4

Steering Small-Scale Satellites

By Emily Conover

Plasmadynamics and Electric Propulsion Lab at the University of Michigan

Small satellites called CubeSats can be steered and propelled by tiny ion and plasma thrusters.

The popularity of small satellites is skyrocketing; weighing a few kilograms or less, such spacecraft are an attractive way to launch instruments on a budget. But they have a problem — propulsion. Without it, the craft are unable to steer or move to different orbits. Traditional chemical thrusters are too large to cram onto a tiny, one-kilogram satellite, but scientists are now working on other types of thrusters that can be miniaturized. The thrusters would boost small satellites to higher orbits, let them fly in formation, or de-orbit them when their missions are complete.

Small satellites, like CubeSats — standardized cubes only 10 centimeters on a side — are easy to produce in large numbers and economical to launch, as they can piggyback on larger missions. But when the tiny spacecraft first came on the scene, people thought of them as toys — and they were right, said Paulo Lozano of the Massachusetts Institute of Technology (MIT). "You would launch one of these things into space; they would tumble along for a few orbits; they would work for perhaps one week … and then they would just burn up in the atmosphere."

One possible solution is ion thrusters. These typically work by applying an electric field to ions, expelling them out of the craft and thereby propelling it in the opposite direction. They have already been used successfully, including in NASA's Dawn spacecraft, currently in orbit around the dwarf planet Ceres. Such thrusters can operate more efficiently than chemical thrusters because the ions are expelled at higher speeds than chemical thrusters can achieve. But they too have proved challenging to miniaturize.

There are several thorny obstacles to miniaturizing ion thrusters. One is a buildup of electric charge on the satellite, which draws the emitted ions back in after they are expelled, negating the thrust. To avoid this, ion thrusters typically include a cathode that emits electrons — but the cathode takes up precious room on the spacecraft and is difficult to scale down. Additionally, such thrusters commonly ionize a gas, like xenon, to create plasma — the source of the ions. Unfortunately, such gases are difficult to store and take up more space than a solid or liquid propellant.

Therefore, said Ane Aanesland of Ecole Polytechnique in France, "You look at a system where you don't need these things." She and her team have developed a thruster that skirts these issues, which she presented this October at the 2015 APS Gaseous Electronics Conference in Honolulu. Aanesland's thruster uses a solid iodine propellant instead of gaseous xenon. And rather than accelerating ions with a constant voltage applied across a grid, it uses an alternating radio frequency voltage that enables it to emit both electrons and ions. She expects to be able to shrink her system to power a satellite as small as six kilograms. They aim to have an operating prototype in the next two years, she said.

Lozano's group employs a different style of ion propulsion, using liquid salts as the source of ions, he explained at a meeting of science writers at MIT in October. By applying an electric field to pull ions out of the fluid (a process known as field evaporation) and flinging them away at high speeds, the thruster creates a force in the opposite direction.

To enable the electric field to pull ions out of the fluid, Lozano's team fashioned an array of sharp, tiny points (each with a tip diameter of 10 thousandths of a millimeter) made of porous glass or nickel, covered with the ionic fluid, which enhances the electric field around the tip. In August, a laboratory test of the system, performed under vacuum to mimic the conditions in space, successfully rotated a magnetically levitated CubeSat.

If used for propulsion, the force generated by an array of eight such thrusters could take a satellite from an orbit at an altitude of 400 kilometers up to 800 kilometers, Lozano said, and this performance could be improved by packing more tips into each thruster. To avoid charge buildup on the satellite, the polarity can be switched at intervals to emit ions of the opposite charge.

Another satellite propulsion option presented at the Gaseous Electronics Conference, the CubeSat Ambipolar Thruster, is under development at the University of Michigan (U-M). The thruster generates plasma using radio-frequency power coupled to an inert gas, designed to generate a wave known as a "helicon" that is very effective at ionizing the gas. Permanent magnets create a magnetic nozzle that directs the plasma out of the ionization region and away from the spacecraft. The team was able to miniaturize this system into "a really small package" that can fit into a CubeSat, said Timothy Collard, a graduate student at U-M.

Their system is also adjustable for different types of flight. High powered, energy-intensive flight can be alternated with lower power, fuel-efficient flight, said Collard. And it can use solid or liquid propellants, from iodine to water, "allowing you to pack more punch into a smaller system," Collard said.

Although small satellites were first developed for students, they quickly caught on. Hundreds of small satellites were launched as start-up companies began using them to take images of Earth. This was especially so after NASA started a launch program to help scientists and students get their cubes off the ground and perform serious research.

The craft also provide a viable option for countries without a space program: "We are trying to give space access to people that currently don't have space access," Lozano said. The ease of creating a fleet of small satellites means they could be useful tools for communications, navigation, or climate studies, Lozano said.

And scientists are setting their sights higher still. "You can theoretically do missions ranging from Earth observation and weather monitoring in Earth orbit, all the way up to sending them out to provide basic measurements of other bodies in the solar system," said Collard. "You can actually escape Earth."

TREASURER continued from page 1

something to be very proud of." But navigating the waters of the open-access publishing movement is a prominent challenge he foresees. "That's a trend that goes well beyond scientific publishing," he said. "Everybody these days wants all information to be free, and yet it costs a lot of money to produce quality information."

However, the physics community has been ahead of the curve on open access, he points out. Physicists created the preprint repository arXiv, and were early adopters of online dialogue. "We've in fact invented some of the technologies that are prominent in communication these days," he said, citing the development of the World Wide Web at CERN. Managing the challenges and harnessing the opportunities of communicating in this landscape will be prominent issues for APS, Hollenhorst said.

The proliferation of low-quality, unreliable sources of information online only makes APS's role more essential, he said. APS "has the opportunity — but also has the responsibility — to be a voice of reason and the voice of information you can trust about science, and physics in particular." Hollenhorst believes APS should leverage its reputation as a reliable source as much as possible. "That will be possible only if we're financially stable," he added.

NEON continued from page 2

argon with a trace of mercury for blue, or helium for gold — and later expanded the palette even more by the judicious addition of phosphor coatings. In the 1950s and 1960s, neon tubes were key components in digital computer circuits, and in the first desktop calculators. The golden age of neon lighting is now over, but neon is still used for small simple signage, and fans of retro chic still seek out neon tubes out of nostalgia.

Further Reading

Boyd, Jane, and Rucker, Joseph. "A Blaze of Crimson Light: The Story of Neon," *Chemical Heritage Magazine*, Summer 2012.

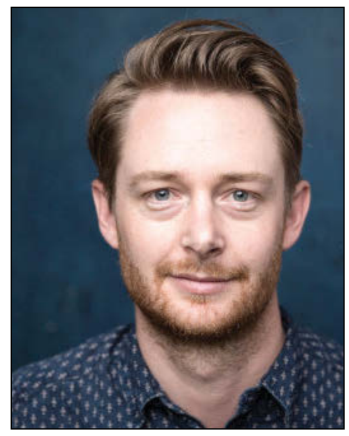
Claude, Georges. "The Development of Neon Tubes," *The Engineering Magazine*, November 1913, pp. 271-274

Profiles in Versatility

Physics Ph.D.s Study the Spread of Disease

By Alaina G. Levine

Kevin McCarthy



Ewan Cameron

At the Massachusetts Institute of Technology, Kevin McCarthy was tidying up his dissertation on direct detection of dark matter when his mind began to wander. Ennui wasn't a factor. "The research I was doing in astrophysics was exciting and fun," he says, and yet, "I realized that a career along the academic track would constrain what I wanted to do. … My potential impact from discovering new particles was far in the future." So he wondered if he could make a more accelerated impact in another field.

McCarthy wound up diving head first into epidemiology, the study of disease patterns and transmission in human populations. It's a field that requires the same data-intensive drive and skills on which many physics fields also rely. Through some creative networking, he learned of the Institute of Disease Modeling (IDM), which is part of Intellectual Ventures, an enterprise founded by Nathan Myhrvold, a physicist who completed his post-doc under Stephen Hawking.

IDM is devoted to identifying and analyzing epidemiological models of transmission of diseases such as malaria, polio, and HIV. In addition to understanding how diseases ebb and flow through populations, "We seek to translate the epidemiological model into reasonable policy actions," he explains. "The work is less on 'long-shot' research and more on engagements with countries to aid programs to reduce disease burdens."

After joining IDM in 2013 as a research scientist, one of his first projects was related to malaria. McCarthy used his extensive computational skills to fine-tune a model of malaria transmission that simulated the actions of both mosquitoes and humans, such as mosquito-biting behavior and human-immune-system responses. "I calibrated the model to different regions in Africa [that] had good data on mosquito biting, prevalence of malaria in kids and adults, fever vs. age," and various other aspects of the disease, he says. The aim was to determine the efficacy of a malaria vaccine candidate in fighting the disease. His team discovered that the vaccine could reduce malaria infection in vaccinated children across a range of transmission conditions.

More recently, McCarthy has focused on understanding the dynamics of polio transmission in northern Nigeria. Since outbreaks of polio there are localized, this work focuses on the effect of population movements, especially from rural areas to urban centers.

Ewan Cameron is another astrophysicist who has made the move to epidemiology. After a postdoc in astronomy at ETH Zurich, he returned to his native Australia to go in a radically different direction: Bayesian statistics at Queensland University of Technology. There he worked on a project that utilized routine point-of-care surveillance data to infer trends in the incidence of chlamydia. "I really enjoyed doing something relevant in the real world," he shares. "As exciting as astrophysics is, there's something special about the potential to change people's lives."

Today he is a senior computational statistician in the spatial ecology and epidemiology group (SEEG) in the department of zoology at the University of Oxford. Cameron researches the geospatial distribution of malaria, and in particular he models the relationship between the prevalence of parasites in the bloodstream vs. the annual rate of clinical illness. By analyzing data from hundreds of different sites in Africa, drawing from government and non-governmental organization (NGO) surveys, demographics, and health records, he and his team have developed highly detailed geospatial maps of malaria prevalence. Nations and NGOs can use his information to decide what protective and treatment measures should be deployed in specific regions.

SEEG's contribution to quantifying malaria movement across the continent of Africa is no small feat. Between the 1970s and 2000, there was very little research on how to effectively monitor malaria outbreaks, says Cameron. People were getting sick, and yet it was not known in what numbers, since most data was only qualitative. Now, in collaboration with the World Health Organization (WHO) and funded by the Gates Foundation, SEEG "develops high-fidelity data sets with rigorous statistical controls," he says. WHO and host countries can utilize this information to create effective healthcare programs on the ground.

As McCarthy and Cameron migrated into epidemiology, they experienced culture shock in working with human subjects. "All electrons are the same," notes McCarthy, "but every person is different. … And there are always unexpected sociological factors. You have to understand the human side along with the disease issues."

Teams also tend to be highly interdisciplinary. Both McCarthy and Cameron work with scientists and engineers from fields as varied as computer science, biosciences, mathematics and statistics, remote sensing, cartography and geography, chemical engineering, veterinary science, and sociology. Career paths are assorted and attuned to the individual's personal passions. "Epidemiologists are a diverse population," says Cameron. "Some focus on fieldwork in-country, some focus on one disease or another on the medical side, where others center on the computational and mathematical aspects of disease modeling."

"It was not an easy transition," says McCarthy of his career choice, "but my training in physics helped foster a mindset that, given some system I am studying, I can take the broader view and identify what are all the things that play a role in how the system behaves." This mountain-top perspective has aided him as he examines the available information about disease incidence. "In the health field, data often comes in through national-level reporting structures," where patients often self-report to clinicians, he explains. But that accounting system could have gaps, especially since the data often emanate from diverse sources and in diverse formats. And since McCarthy and his team are not on the ground obtaining the information first hand, "You have to be somewhat creative" in how you handle, interpret, and mine the data and how you use it to construct models, he says. "We are consumers of the data, while building relationships with the [reporting] countries."

For example, in analyzing polio cases in Nigeria from 2002 to 2015, it was necessary to consider that the reporting rate might not have been constant over that period of time. When McCarthy and his team noticed that the number of polio cases jumped in 2006, they suspected it was not because more people were contracting the illness, but rather that the reporting rate had increased in that year. Furthermore, "Our thoughts were that surveillance and vaccination systems had gotten better" since 2006, he says. Consequently, the scientists recalibrated their models.

Despite the challenges of a career change, McCarthy and Cameron are thrilled they made the choice to switch gears and go into epidemiology, and they encourage other physicists to consider it as well. "You can do it!" exclaims McCarthy. "It's a very different field but don't be intimidated. Your skills will translate very well."

Alaina G. Levine can be reached via her website at www.alainalevine.com or on twitter @AlainaGLevine.

MENTORING continued from page 3

academic environment."

Of the 180 people registered for the conference, 50 to 60 were students. The list of attendees included representatives from APS, bridge programs, and colleges and universities from across the country.

Following welcoming remarks by Ted Hodapp, director of APS Education and Diversity, Mary James, dean for institutional diversity at Reed College, gave the first plenary talk of the conference, addressing the question of what access really means. She described the "Marie Curie effect" — the idea that someone from a marginalized group needs to be a prodigy to succeed in physics — an effect that could be an impediment for most minority physics students. James stressed the value of savviness, resilience, and perseverance in physics research.

In his plenary talk, Richard Reddick from the University of Texas at Austin explained that students benefit the most from mentoring by being responsive, understanding reciprocity, and having many mentors. He also discussed the "cultural taxation" that results from not compensating faculty of color for mentoring a disproportionately large number of students (since students of color seek them out). He advised mentees on how to find a mentor, stating the importance of getting to know personalities since people are not "brains on a stick."

Joseph Brown from Stanford University gave a plenary talk on the topic of increasing diversity by changing the culture of the academy. He explained "stereotype threat" as: "a vigilant state in which a person is alert for signals that confirm stereotypes." In disciplines that appear to emphasize innate talent, such as physics or math, he noted, this can be an unfortunate distraction to minorities during an exam. Brown suggested that in disciplines that do not appear to emphasize innate talent, such as sociology or anthropology, this threat is not as apparent. He recommended that faculty confront stereotype threat by allowing their students to write down what is valuable to them before any "high-stakes" exam. This would grant them perspective and relieve them from added pressure to do well.

In addition to plenary talks, there were several parallel sessions conducted throughout the conference. These were designed so that one session would target mentors — typically faculty and graduate students — and the other session would target mentees — typically undergraduates. These sessions had panelists from APS, directors of bridge programs, various faculty, and peer-mentor students. The focus here was on providing mentorship training and career options for both undergrad and graduate students.

In one such session, graduate student Pierre Avila, of the University of Houston, Clear Lake, shared the ways in which he learned how to effectively communicate with mentors and the impact of a positive mindset on one's performance.

The conference concluded with a series of plenary talks focusing on graduate school admissions and the value of the GRE to the process. Brian Beckford — the former manager of the APS Bridge Program and now at the University of Michigan — and Ted Hodapp suggested to admissions offices that "recommend" the GRE, but do not look at it, to remove the recommendation from the website because it may discourage underrepresented minorities from applying.

Although faculty dominated the conference in numbers, their voices did not. During discussions, undergrad, and graduate students freely voiced their opinions and concerns. The result was a vigorous dialogue with students and each other on how to best address these issues.

"The major message of addressing culture and valuing students was loud and clear," says Dimitri Dounas-Frazer, physics postdoctoral research associate at University of Colorado Boulder.

Ana Aceves is a freelance writer based in Boston, MA. She co-facilitated one of the parallel sessions at the meeting.

BAILEY continued from page 2

supposed to clip one end of the wire to the battery, and then touch the other end of the wire to the other pole of the battery, creating a magnetic field, which interacts with the magnetic field of the fixed magnet, making the wire jump out. I wasn't surprised by what happened, it was more that I had this intense moment where I could see the entire process unfolding. I understood the math; I could see the field lines; it all just came together in this beautiful elegant picture. And the intimacy between the abstract world of math and the actual physical reality just struck me as profoundly mysterious. So, it was like angels sang and the heavens opened up and I thought, "Wow, this is beautiful, I have to do this for the rest of my life." That was an intensely emotionally moving experience for me. I think that scientists tend to discredit the emotional component of science. Emotion shouldn't affect their judgment or their work, but science would not exist if there was not an emotional reward for understanding new things.

What do you like to do in your spare time?

I do Morris Dancing (a type of English folk dancing); I'm the foreman of the Rock Creek Morris Women, which is the local women's team, and that's a load of fun. We have a lot of performances we do in the fall and the spring, which are also incidentally the two busiest seasons of my professional life. I also play traditional Irish music, so I play the fiddle and the banjo. I love yoga, and in the summer I garden, if I can manage to find some time.

This interview has been edited and condensed.

FRONTIERS IN OPTICS / LASER SCIENCE MEETING

CYCLE continued from page 1

At the Frontiers in Optics / Laser Science meeting this October in San Jose, researchers discussed efforts to collect hundreds of thousands of measurements daily from space using sunlight and laser remote sensing, with the goal of amassing enough data to tease out the complex web of carbon dioxide sources and sinks, and predict how they might change as the planet warms.

Carbon dioxide is constantly being emitted and absorbed, by both natural and human processes. As plants burst into growth in the spring, they take up carbon, and CO_2 levels in the atmosphere drop, only to rise again in the fall. But CO_2 in the atmosphere doesn't stay put — it travels around the planet with global wind patterns.

"We're already measuring a bunch of things from space," Crisp says — including important climate variables such as precipitation and albedo (the reflectivity of Earth's surface). But concentrations of CO_2 in the atmosphere vary by only a few percent overall, so satellite instruments must be accurate to within a few tenths of a percent to be useful. "We've never been able to make a measurement as precise as the one we need to make to measure carbon dioxide until recently," Crisp says.

Of the more than 30 billion tons of carbon dioxide that are emitted each year, only about half stays in the atmosphere. The remainder is taken up in the biosphere, with much of it going into the oceans, which absorb about 10 billion tons a year. The rest goes into plants and soil, but scientists haven't been able to account for exactly where it all ends up. "There's a missing sink," says James Abshire of Goddard Space Flight Center, "so there's an absorption of CO_2 that can't be accounted for in the present climate models." Understanding this missing carbon sink is important for predictions of future carbon dioxide levels, and their effect on our climate.

In July 2014, NASA launched the Orbiting Carbon Observatory-2 (OCO-2), dedicated to capturing a satellite's-eye view of the carbon cycle. It is now training its three high-resolution grating spectrometers on Earth from an altitude of 700 kilometers. These spectrometers observe sunlight reflecting from Earth's surface, and monitor three near-infrared wavelength bands for absorption signatures of CO_2, and, for reference, O_2. OCO-2 makes a million measurements as it orbits Earth each day. Due to imperfect atmospheric conditions, only about 100,000 to 200,000 of those measurements are useable. The results can then be used to calculate the CO_2 concentration in the path the sunlight traversed through the atmosphere. "It's really a pretty simple device; it basically is the spectrometer you used in physics class," says Crisp, the science team lead of OCO-2.

The mission follows earlier efforts to measure CO_2 from space with spectrometers, including a Japanese effort, GOSAT, which launched in 2009.

These satellites make passive measurements that rely on the sun, and as a result are easily foiled by cloudy skies or haze, which can impede measurements at high latitudes in particular, Abshire says. And polar regions are dark one season a year, making sunlit measurements impossible. "And if you're studying problems like what's happening in Siberia in the summertime, or even in northern Canada, having coverage up there is obviously essential," Abshire says. "It's a tremendously challenging remote sensing experiment."

But according to Abshire, a satellite equipped with Light Detection and Ranging (LIDAR) — the laser version of radar — would avoid many of these issues. Such experiments would beam a laser down to Earth's surface, and use a telescope to monitor the reflected light. The wavelength of the laser would be targeted to a particular absorption line, and could be varied to measure several points along the line. And with a pulsed laser, timing can be used to calculate the path length the light has travelled, which is important for estimating the CO_2 concentration.

Such experiments will be better at making meaningful measurements in a variety of atmospheric conditions, with even better spatial resolution: Whereas passive sensors typically observe a spot a few kilometers across, the corresponding width for LIDAR could be about 50 to 100 meters, Abshire says.

NASA has future plans for such a mission: Active Sensing of CO_2 Emissions over Nights, Days, and Seasons (ASCENDS). Preliminary tests of LIDAR systems in aircraft have been consistent with traditional gas sampling measurements.

Measuring carbon dioxide will be useful in understanding how to deal with our climate crisis, Crisp says. The measurements can improve models, and provide more information to policy makers. In the future, such methods could also allow remote monitoring of what a country is emitting — and whether it is sticking to its end of climate treaties that limit greenhouse gas emissions.

But treaty validation is only one step of the process. "Not only do they tell you whether or not somebody's following the rules, they tell you whether or not the rule that you're following works in reducing carbon dioxide emissions," Crisp says. For example, if you plant trees, does that really reduce carbon dioxide levels? Space-based measurements could provide a means of finding that out.

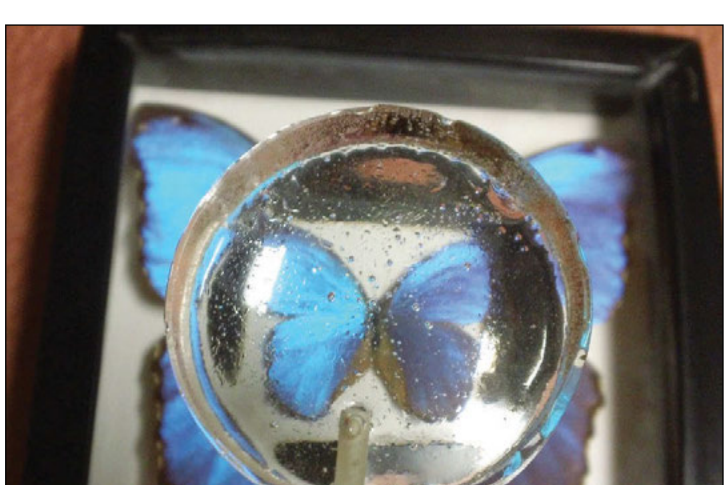
Edible Optics, Tracking Bugs, and More

By Emily Conover

Optics research and applications of all types were on display and under discussion at this year's Frontiers in Optics / Laser Science (FiO/LS) a joint meeting of the Optical Society and the APS Division of Laser Science, held in San Jose, California.

3D-printed optics

At first glance, 3D printing seems unsuitable for creating optics components, which must have incredibly smooth surfaces that are not achievable with standard 3D printers. "Fortunately there are always crazy enough people," said Jyrki Saarinen, of the University of Eastern Finland. Saarinen discussed a process, developed by the company Luxexcel, to 3D print custom optics components in a variety of shapes. The technique uses UV-curable materials, printed with liquid drops that harden when exposed to ultraviolet light. The drops merge together as they are printed, smoothing out the rough edges.



Edible Optics

Lollipop lenses are delicious and amusing but also offer a way to teach optics.

Edible optics

Ever wish you could eat your optics? Two University of Arizona students did, and they created a start-up company, Edible Optics,

OPTICS continued on page 7

Inside the Beltway

Science and the Political Pendulum

By Michael S. Lubell, APS Director of Public Affairs

In politics, 10 years is an eternity. A decade ago, in the aftermath of dramatic Democratic successes in the 2006 election, pundits were sounding the death knell of the Republican Party. They were dead wrong.

Like the mythological phoenix, the Republican Party has risen from the political ashes. It now has a commanding majority of 247 to 188 seats in the House of Representatives — its largest margin since 1930 — and a controlling margin of 54 seats in the Senate. It also counts 33 governors, including two in the heavily Democratic states of Massachusetts and Maryland, as well as 68 out of 98 state legislative chambers. (Nebraska has a nonpartisan, unicameral legislature.)

Today, pundits are predicting Democrats will be wandering the political wilderness for decades to come. Don't bet on that prediction either!

The public is fickle, and in politics the pendulum is constantly swinging. So too is political support for research and trust in science.

Ten years ago, the Republicans and Democrats were of one mind: federal support of science needed a big boost. In 2006, the Bush Administration unveiled the American Competitiveness Initiative, with the goal of doubling funding over a decade for three agencies: the Department of Energy's (DOE) Office of Science, the National Science Foundation (NSF), and the National Institute of Standards and Technology. Democrats, who took control of Congress the following year, unveiled their own Innovation Initiative and swiftly moved forward with the America COMPETES Act of 2007 that drew wide bipartisan support for setting science agencies on a seven-year doubling path.

Scroll forward to 2015. Today if you open a conversation with the average Republican member of Congress about America's flagging global scientific leadership, you will likely get a tepid response. Spending less, not more, on any government activity, save defense, is central to the GOP budget goals laid out by Paul Ryan (R-Wisc.), the newly elected speaker of the House of Representatives.

After his Republican colleagues elected him to the top slot with 236 out of 247 possible votes, Ryan pledged to repair what he characterized as a "broken" House of Representatives. Unlike his predecessor, John Boehner (R-Ohio), who was a quintessential insider and dealmaker, Ryan said he would devolve legislative power to House committees and the rank-and-file membership. And he pledged to "wipe the slate clean," making deficit reduction and tax reform top priorities.

As you might imagine, Democrats don't share the same vision for a future legislative agenda, unless tax reform means increasing taxes on the wealthy. For Democrats, addressing the wealth, income and opportunity disparities gets top billing.

On such a politically polarized landscape, it's easy to see why bipartisanship is an extraordinarily rare commodity. When political jousting takes precedence over reaching compromises, and intransigence becomes the guiding principle of either party, gridlock becomes inevitable. For science, that's bad news. As U.S. global scientific leadership wanes, continuing to put research on autopilot will not have a happy ending.

The latest budget deal, which will probably avert government shutdowns during the next two years, provides a ray of hope. Under the agreement, which takes sequestration off the table, non-defense domestic discretionary spending, in which science is embedded, is poised to rise by slightly more than seven percent, not including the effects of inflation. Still, at the end of the two-year period, research spending in constant dollars will remain well below its fiscal year 2004 peak.

What will almost certainly remain unchanged for the duration of President Obama's term is the acerbic relationship between the White House and congressional Republicans, who have reflexively opposed almost all of the president's spending priorities since he took office in 2007. From that perspective, it's hard to see how President Obama's support of science will have much impact on the final deliberations of a GOP congressional majority that has strayed from its traditional pro-science stance.

To be sure, there may be some exceptions, most notably Sen. Lamar Alexander of Tennessee, Reps. Michael McCaul and John Culberson of Texas, and Randy Hultgren of Illinois.

Unfortunately, the partisan science divide is likely to extend beyond disagreements over spending levels. Trust in science and trust of scientists, once overwhelmingly embraced by Republicans, has fallen victim to disputes over the role science should play in policymaking and the conduct of scientists more generally.

The House Science, Space and Technology Committee, for example, has repeatedly questioned the validity of science used by the Environmental Protection Agency and the National Oceanographic and Atmospheric Administration in advancing policies on climate change and pollution. The committee has also questioned the impartiality of peer-review practices at NSF in setting agency priorities and evaluating proposals. Finally, the committee has supported legislation that would bar the federal government from using the results of any DOE-sponsored research in developing policies and regulations.

There is little doubt the political pendulum has swung substantially over the last decade. And there is little doubt it will continue to swing. But which way it will swing and how it will affect science remains anybody's guess.

In Recognition of the 2015 APS Fellows

The APS Fellowship Program was created to recognize members who may have made advances in physics through original research and publication, or made significant innovative contributions in the application of physics to science and technology. They may also have made significant contributions to the teaching of physics or service and participation in the activities of the Society. Each year, no more than one half of one percent of the Society membership is recognized by their peers for election to the status of Fellow of the American Physical Society. For more information on the 2015 recipients, visit aps.org/programs/honors/fellowships/

Division of Astrophysics

Laura Baudis
Roland Diehl
Fiorenza Donato
Douglas Finkbeiner
Stefan Funk
Bhuvnesh Jain
Eiichiro Komatsu
Abraham Loeb
Grzegorz Madejski
Feryal Ozel
Scott Ransom
Patrick Slane
Rodger Thompson
Benjamin Wandelt

Division of Atomic, Molecular & Optical Physics

James Babb
Immanuel Bloch
Gretchen Campbell
Diego Alejandro Dalvit
Brian DeMarco
Stavros Demos
Michael Drewsen
Oliver Gessner
Thomas Gorczyca
Vasili Kharchenko
Roman Krems
Marcos Rigol
Alexei Sokolov
Jelena Vuckovic
Vladislav Yakovlev

Division of Biological Physics

Krastan Blagoev
Carson Chow
Anatoly Kolomeisky
Andre Levchenko
V. Adrian Parsegian
Alan Perelson
Eugene Shakhnovich
Pieter Ten Wolde
Dave Thirumalai
Jie Yan

Division of Chemical Physics

Stephen Bradforth
Majed Chergui
Pablo Debenedetti
Tianquan Lian
John Maier
Timothy Minton
David Osborn
Kenneth Suslick

Division of Computational Physics

Noam Bernstein
Martin Grant
Francesco Mauri
Stephane Mazevet
Ivan Oleynik
Daniel Sanchez-Portal
Frederick Streitz

Division of Condensed Matter Physics

Artem Abanov
Daniel Arovas
Silke Buehler-Paschen
Erica Carlson
David Cobden
Per Delsing
Daniel Dessau
Tomasz Dietl
Gleb Finkelstein
Mark Freeman
Daniel Haskel
Hulikal Krishnamurthy
Mark Lumsden
Vidya Madhavan
Thomas Maier
Ivar Martin
Prabhakar Misra
Vesna Mitrovic
Cedomir Petrovic
Filip Ronning
Kirill Shtengel
Irfan Siddiqi
Frank Steglich
Janet Tate
Yaroslav Tserkovnyak
Ilya Vekhter
Latha Venkataraman
Thomas Vojta
Michael Zudov

Division of Fluid Dynamics

Stuart Dalziel
Anne De Wit
Jerzy Floryan
Guowei He
Jeffrey Koseff
Satish Kumar
Viswanathan Kumaran
George Lauder
Omar Matar
Igor Mezic
Joseph Niemela
Leonid Pismen
Troy Shinbrot
Todd Squires
Federico Toschi
Xiaohua Wu

Division of Laser Science

Andrea Alu
Hiroshi Amano
Hou-Tong Chen
Zhigang Chen
Stefan Hell
Mackillo Kira
Xiaoqin (Elaine) Li

Division of Materials Physics

Eric Bauer
Scott Chambers
Craig Fennie
Jaime Fernandez-Baca
Sergei Kalinin
Ron Lifshitz
Junming Liu
Michael Manfra
Carlos Meriles
Ning Pan
John Pendry
Antoni Planes
Ramamurthy Ramprasad
Tanusri Saha-Dasgupta
Liling Sun
Yang Yang

Division of Nuclear Physics

Mark Alford
Lee Bernstein
Peter Blunden
Roderick Clark
John D'Auria
Matthias Grosse Perdekamp
Yu-Gang Ma
James Nagle
Filomena Nunes
Kostas Orginos
Eli Piasetzky
Gulshan Rai
Alexander Saunders
Kai Vetter

Division of Particles & Fields

Lothar Bauerdick
Thomas Blum
James Cochran
Hooman Davoudiasl
Kaushik De
Maurice Garcia-Sciveres
David Gerdes
Tony Gherghetta
Michael Gronau
Christopher Hearty
Graham Kribs
Konstantin Matchev
Vivian O'Dell
Alexey Petrov
Roger Rusack
Stefan Soldner-Rembold
Hirohisa Tanaka
David Toback

Division of Physics of Beams

Sergey Belomestnykh
Zhirong Huang
Dinh Nguyen
Matthew Poelker
Ferdinand Willeke

Division of Plasma Physics

Steven Batha
Ivo Furno
Frank Jenko
Yakov Krasik
Niels Madsen
Pierre Michel
Thomas Pedersen
Yuan Ping
Sean Regan
Daniel Sinars
Vladimir Smalyuk
Edward Thomas
Glen Wurden

Division of Polymer Physics

Jeff Chen
Alfred Crosby
Liliane Leger
Kalman Migler
Elie Raphael
Charles Roland
Rachel Segalman

Forum on Education

Daniel Claes
Peter Shaffer

Forum on History of Physics

Thomas Greenslade
Bruce Hunt
Dwight Neuenschwander
Richard Staley

Forum on Industrial & Applied Physics

Dean Evans
Marco Fanciulli
Hans Hallen
Giuseppe Iannaccone
Gamani Karunasiri
Ki Kim
Tariq Manzur
Thomas Meitzler
John Rumble
Xinfeng Tang
Michael Wright
Zhuomin Zhang

Forum on International Physics

Xiao-Gang He
W Mochan
Jorge Morfin
Choo-Hiap Oh
James Proudfoot
Javid Sheikh
Eric Suraud
David Vitali
Manuel Bibes
Julie Grollier
Roland Kawakami
Roderich Moessner

Forum on Outreach & Engaging the Public

James Kakalios
Shane Larson
Don Lincoln
Daniel Steinberg

Forum on Physics & Society

Douglas Arion
Ashton Carter
Roger Hagengruber
Benn Tannenbaum

Topical Group on Energy Research and Applications

Sue Carter
Steven Frautschi
Mengyan Shen

Topical Group on Few-Body Systems

Jose D'Incao
Shina Tan

Topical Group on Gravitation

Emanuele Berti
Laura Cadonati
Yanbei Chen
Dennis Coyne
Daniel Sigg
Mark Trodden
Alan Weinstein
Bernard Whiting

Topical Group on Hadronic Physics

Richard Lebed
Xiaochao Zheng

Topical Group on Instrument & Measurement Science

Hsiao-Mei Cho
Tolek Tyliszczak

Topical Group on Magnetism

Johan Akerman

Topical Group on Physics Education Research

Steven Pollock
Richard Steinberg
Michael Wittmann

Topical Group on Plasma Astrophysics

Michael A Shay
Dmitri Uzdensky

Topical Group on Precision Measurement & Fundamental Constants

Ricardo Decca
Stephan Schlamminger

Topical Group on Quantum Information

David Cory
Berge Englert
Kae Nemoto
Charles Tahan
Philip Walther

Topical Group on Shock Compression of Condensed Matter

Tariq Aslam
Damian Swift

Topical Group on Soft Matter

Haim Diamant
O. Lavrentovich
Thomas Truskett

Topical Group on Statistical & Nonlinear Physics

Byungnam Kahng
Michel Pleimling
Ira Schwartz
Mary Silber
Stefano Zapperi

PHOTON continued from page 1

in a dark room with faint flashes of light and asked them to record what they observed.

When light enters your eye through your pupil, it is focused on the retina, in the back of the eye. This area is chock-full of photoreceptor cells: cones, which operate best in bright light and provide our color vision, and rods, which are important for night vision, and are highly sensitive to small amounts of light.

In a laboratory dish, a rod that absorbs just a single photon springs to life, producing an electrical signal in response. But the question of whether a single-photon signal can make it all the way through the visual pathway to the brain is still unanswered — the visual system may filter out such tiny signals to avoid unwanted noise. And testing whether humans can observe a lone photon isn't straightforward: "It turns out it's really hard to answer that question if you can't actually make precise numbers of photons," Holmes said.

This is where the quantum optics expertise of her group, which is led by Paul Kwiat of the University of Illinois, comes into play. Previous experiments have used classical light sources that produce a small but indeterminate number of photons, making the result less clear-cut. Kwiat's team will utilize a quantum source — a device that produces individual photons and is standard in quantum optics labs — but turn it on human subjects. They shine an ultraviolet laser on a nonlinear crystal, in which photons produce pairs of lower-energy photons. The researchers detect one photon in a pair, using it to herald the other, which is sent to the subject. The laser is tuned so that the output photons will be at a wavelength of 500 nanometers, where sensitivity of the rods is highest.

Holmes' apparatus randomly sends each photon to one of two optical fibers, directed at the left and right sides of the subject's retina. The subject then must say what side it was on. The design is an improvement on previous studies — which simply asked subjects if they saw a flash of light — because subjects may hesitate to give a response that could be a false positive, the researchers say.

In preparation for their experiment with single photons, the team first measured the result with an average of 3 or 4 photons on the retina. The subjects picked the correct side 54 ± 1% of the time — only slightly better than chance, implying that humans can just barely see these dim flashes.

To get those 3 or 4 photons to the retina, the researchers send in 100 photons — 70% of these are lost in the optical apparatus, and only about 10% of the photons that go on to hit the eye actually make it to the retina. But inefficiency in the visual pathway or lapses in attention could be just as important: "Maybe a bigger problem is that the observers don't always seem to notice the stimulus, even though it was probably technically bright enough for them to see it," Holmes said.

In the final version of their experiment, the researchers will allow only one photon through at a time, making it crucial to increase the efficiency of the system so that as many photons make it to the retina as possible. "Every trial where that doesn't happen [the subjects] really are just randomly guessing — that's just noise," Holmes said. The researchers are now optimizing their setup to improve optical efficiency before photons reach the eye.

And the researchers have ideas on how to improve the human part of the equation as well. Adaptive optics could compensate for aberrations or eye motion, and an EEG might help monitor subjects' attention, allowing the researchers to send photons only when the observer is most likely to see them. And, if researchers' anecdotes are to be believed, subjects watching for single photons may get better with practice. "I've done it a lot of times and I'm definitely better than anyone else," Holmes said.

If humans can serve as single-photon detectors, the researchers have more ideas in store. "Since we're quantum physicists, we'd love to try to test quantum effects on the visual system," Holmes said. For example, rather than sending the photon to the left or the right, they could send the subject a superposition, and study what the subject observes. Quantum mechanics predicts a superposition would look no different. "But that's not something that's been tried before," Holmes says.

ANNOUNCEMENTS

APS BRIDGE PROGRAM

The APS Bridge Program is an effort to increase the number of physics Ph.D.s awarded to underrepresented minority (URM) students, defined by the project as African Americans, Hispanic Americans, and Native Americans. APS-BP has done this by creating sustainable bridge programs at six sites around the country.

The student applications for the Bridge Program will be open from December 1, 2015 to March 18, 2016.

More information at apsbridgeprogram.org

APS Council of Representatives Approves Three New Statements

Three statements were drafted by the APS Panel on Public Affairs, reviewed by the APS membership and the Board of Directors, and received final Council approval on November 14:

Women and Physics: http://go.aps.org/aps_15_2
Earth's Changing Climate: http://go.aps.org/aps_15_3
Civic Engagement of Scientists: http://go.aps.org/aps_15_1

2016 PhysTEC Conference

Physics Teacher Education Coalition

March 11-13, 2016
Royal Sonesta Harbor Court
Baltimore, Maryland

Register by Feb. 26, 2016

Join us for the nation's largest meeting dedicated to physics teacher education. This conference will be held in conjunction with the 2016 APS March Meeting.

Topics include:

- Recruiting high school physics teachers
- Physics teaching methods
- Advocacy and working effectively with administrators
- Assessments for physics teacher education
- Educating elementary and middle school teachers
- Building effective pathways to degree and certification

Travel support is available for faculty from minority-serving institutions.

phystec.org/conferences/2016/

APS physics AAPT PHYSICS EDUCATION NSF

Physics Teacher Education Coalition

The **5+ Club** recognizes institutions that graduate 5 or more physics teachers in a given year. Can your institution join the club?

Apply by January 11, 2016
phystec.org/the5plus/

APS physics

NOMINATE A HISTORICAL PHYSICS LANDMARK

to be considered as an APS Historic Site

Each year, APS recognizes a small number of historic physics sites in the U.S. (and occasionally abroad).

Nominations received by January 15, 2016 are eligible for consideration in 2016.

go.aps.org/historic-sites-2016

ALLIES continued from page 1

is confusing and intimidating. It took a long time for her to figure out that what she experienced was covered under the AAS anti-harassment policy. Ultimately, Flewelling had to talk about her harassment to the AAS Council, a group of well-established astronomers. "It's awkward to introduce yourself to someone senior with the story, 'I was harassed,'" she says.

The Astronomy Allies publicized itself via "Women in Astronomy," a blog run by the AAS Committee on the Status of Women, and Flewelling presented a poster on the group at the January 2015 AAS Meeting in Seattle. Alatalo says the astronomy community has been "very supportive" of their efforts.

"It's a very valuable service," says Chryssa Kouveliotou, the senior vice president of AAS, who is not in the group. "I hope that they provide a means for young females to feel comfortable to attend meetings and interact with senior scientists."

The group's services seem particularly relevant on the heels of the Geoff Marcy scandal in October, when the online news site *BuzzFeed News* reported that the famous Berkeley astronomer was the subject of a university investigation that concluded he had serially harassed women between 2001 and 2010. But research suggests sexual harassment and assault in academia extends beyond a handful of high-profile cases.

This September, the Association of American Universities (AAU) released survey results across 27 different universities that showed that 11.7 percent of students had experienced some sort of sexual misconduct. A 2014 survey from the Massachusetts Institute of Technology (MIT), which surveyed 35 percent of its student body, found that 16 percent of female grad students and 5 percent of male grad students had experienced some type of sexual misconduct, which included sexual harassment, sexual assault, rape, and unwanted sexual behavior. A 2014 study published in *PLOS One* found that in the field of anthropology, two-thirds of both men and women were sexually harassed. Trainees — people at the bottom of the career hierarchy — were more likely to be harassed.

All three studies found that their respondents were not likely to report their harassment. The AAU survey found that depending on the type of behavior, between 5 and 28 percent reported the sexual misconduct. The *PLOS One* study found that fewer than 5 percent of their respondents knew how to report sexual harassment, and fewer than 2 percent actually reported it. MIT's survey found that less than two-thirds told someone else about the experience, and fewer than 5 percent officially reported harassment.

The physics community does not have a group like Astronomy Allies — but it could use one, says Julia Thom-Levy, an associate professor of physics at Cornell University and adviser to the school's women in physics group, whose membership includes faculty, staff, and students in physics and applied physics departments. Levy also participates in the APS Physics Department Climate Site Visits, a program that works to improve the culture for women and minorities in national labs and universities. "There are clear policies and clear expectations in most places that [harassment] is absolutely unacceptable," Thom-Levy says. However, the networks in place to report harassment aren't so clear. She says that people need a safe place to report their experiences and that the information is given to the right administrative levels.

"The most powerful thing is when senior people talk about [harassment and assault]," says a physics graduate student who attends a Tier 1 research university. This student, who spoke under conditions of anonymity because she did not want to damage her career, was raped by her adviser as a second-year graduate student.

She says she didn't report the rape until four years after it happened, partly because she feared the consequences for her own career and blamed herself for what happened. "I worked up the courage to report [the rape] partly because we started having lunches with senior women faculty at my university. One of the senior women faculty brought up that she was sexually harassed as a graduate student. Hearing a senior person whose career you admire speak about it is the best resource."

Sophia Chen is a freelance writer based in Tucson, Arizona.

OPTICS continued from page 5

to make those dreams come true. Their wares are candy lollipops, made in the shape of various types of lenses. Instead of glass or plastic, these lenses are made out of sugar. Their products, which were on display at FiO/LS, are designed for use in hands-on science education. The founders of Edible Optics hope to provide schools with an affordable and fun (and tasty) way of teaching optics to kids.

Keeping an eye on insects

Optics applications were everywhere at FiO/LS. One of the most unusual was an insect-monitoring system that can detect and study wild insects in flight. The system, presented by Alem Gebru, a graduate student at Stellenbosch University in South Africa, can work using two different methods: either with a telescope viewing a dark cavity and watching for flashes caused by insects reflecting sunlight, or with a light-detecting-and-ranging (LIDAR) system using a laser and viewing the backscatter the insects produce. The sampling rate is more than two thousand times a second, so the system can observe the insects' wings beating, and by comparing shortwave infrared and near infrared scattered light, determine if the insect is a dark or light color, providing a handle for identifying the species. Examining how the signals evolve in time can provide a sense of what direction the insects are traveling. Gebru hopes the system will help farmers monitor their fields. "They want to know what kind of pollinators or pests are in their environment," he says.

Ceci n'est pas un laser pointer

Green laser pointers are ubiquitous at scientific meetings, but at FiO/LS, attendees got schooled about how they work. While brandishing such a pointer during a plenary talk, Elsa Garmire of Dartmouth College said, "This is not a green laser pointer." Garmire's talk gave an overview of nonlinear optics (a field she helped pioneer), which deals with the behavior of light in nonlinear media (for example, the generation of harmonic frequencies of light). The green laser pointer, she explained, is an example of nonlinear optics at work. To produce the bright green beam, infrared laser light is doubled in frequency by a nonlinear crystal. "From now on, every time you use this, call it a nonlinear pointer," Garmire proclaimed.

The Back Page

Once More, Into the Breach

By Daniel Kleppner and Richard A. Meserve

In 1986 and 1988 Henry (Heinz) Barschall, a respected nuclear physicist at the University of Wisconsin, editor of *Physical Review C* and what was then the APS Publications Oversight Committee, wrote articles in *Physics Today* that presented the results of a study of the cost of library subscriptions to physics journals. The consequences of Barschall's studies provide a cautionary tale on what can go wrong when scientific and commercial interests collide.

Barschall found the cost of physics journals published by the American Institute of Physics (AIP) and APS was low, while the highest cost was for the publisher Gordon & Breach (G&B). The difference in cost among various publishers spanned a factor of about 40. Barschall's articles evidently infuriated Martin Gordon, head of the firm, because in 1989 he launched a series of lawsuits against APS, Barschall, and AIP (the publisher of *Physics Today*). The litigation went on for ten years. In 1991 one of the authors (DK), wrote an article for *Physics Today* calling attention to the bizarre situation. AIP, however, declined publication arguing, quite reasonably, that the essay would certainly precipitate yet another lawsuit by G&B.

The defense was led by Richard A. Meserve, a partner at Covington & Burling LLP and a Fellow of the APS. The defense involved litigation in four jurisdictions and in three different languages. Meserve was ably assisted by the multilingual capacities of Barschall, Harry Lustig (then treasurer of APS), and Marc Brodsky (then executive director of AIP). Barschall died in 1997, Gordon & Breach went out of business in 2001 and was acquired by another publisher, and Gordon died in 2015. At last it is safe to make the history public without fear of retaliation. What follows is the 1991 essay by Kleppner and a postscript by Meserve.

Into The Breach, by Daniel Kleppner (1991)

The heroes I admire most are those heroes whose modesty matches their courage — Clark Kent and the Scarlet Pimpernel, for instance. They ask for no reward but the satisfaction that comes only from brave deeds done anonymously. But when I jeopardize my safety for the public good, I want the world to know. So here it is. Steely eyed and level headed, my veins throbbing with sangfroid, I do now express the opinion that SOME GORDON & BREACH PUBLICATIONS MIGHT BE CONSIDERED A LITTLE BIT PRICEY.

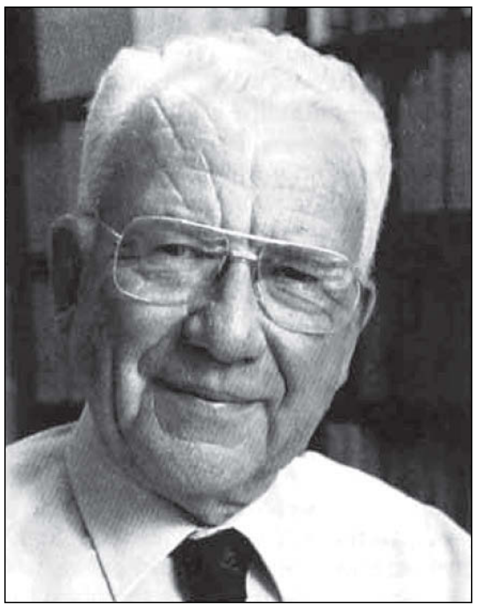
If this act of recklessness fails to leave you breathless, let me assure you that to criticize G&B is to risk the wrath of a deeply litigious corporation. In this nation of ours, where litigation has become a blood sport, taunting such an adversary is not for the faint of heart. Henry Barschall learned this the hard way, and so have others who suddenly found themselves flat on their backs, staring up at G&B's blockhammer of litigation.

In 1986 *Physics Today* published the results of a survey by Henry Barschall on the cost of library journals. Barschall ranked journals according to the average cost per word and also calculated the ratio of cost to frequency of the journal citations. Some journals came out cheap, some journals came out expensive, and some journals, mostly G&B journals, came out very very expensive. This was too much for G&B. It did the only thing that a red-blooded corporation could do: G&B sued.

G&B sued Barschall,
G&B sued the American Institute of Physics,
G&B sued the American Physical Society,
G&B sued in Zurich,
G&B sued in Frankfurt,
G&B sued in Paris.

So what, you may be wondering, happened? To make a long story short:

G&B lost in Zurich,
G&B lost in Frankfurt,
and the case is still pending in Paris.



AIP

Henry (Heinz) Barschall (1915-1997)

That, you might think, would be the end of it. Hah! Don't underestimate the will of a corporation whose honor is at stake.

G&B is appealing to the Supreme Court in Germany,
G&B is hoping for the best in Paris.

Where will this end? Possibly it will go on until Barschall, AIP, APS and G&B are all bankrupt. Meanwhile, life is no bowl of cherries for Heinz Barschall, who cannot munch a *weisswurst* in Marienplatz without looking for a *rechtsanwalt* over his shoulder, nor sip a *cafe filtre* by the Seine without worrying about the *flics* descending on him to serve a *procès*, nor return home without worrying whether his car, his house and perhaps even his family have been attached as a down payment on costs — life is grim. And for the folks at AIP and APS who have to rush to Europe at the drop of a hat, and whose files are now meters long, the wasted time is mounting up.

Barschall is not the only victim of G&B's litigation mania. When Octave Levenspiel of Oregon State University complained of G&B's prices in *Chemical Engineering Education*, he got an ominous letter from the G&B attorneys. And when Joel Rutstein of Colorado State University complained of a rise in G&B's subscription prices in a letter to *Early Child Development and Care*, he also received an ominous letter (more precisely, he described it as a "nasty" letter). G&B also read its riot act to the American Mathematical Association. And at this point I can no longer hide the observation that James Thompson of the University of Riverside reputedly was threatened by a suit from G&B if he failed to retract his observation that G&B was threatening to sue people.

There is also the Mystery of the Foundation for International Scientific Cooperation and whether it did or did not sponsor the survey carried out by G&B under the Foundation's letterhead, which asked for all sorts of information, including whether by any chance any librarian has been induced to drop any subscriptions because of Barschall's survey. The Foundation appeared to be on the up and up except that the return address for the questionnaire was a Washington law firm, and the postal meter belonged to G&B.

So why do I thrust myself into the breach of danger to tell you these things? Perhaps because the thought of a greedy corporation in a frenzy of litigious madness monkeying with our freedom of speech makes my blood boil, or the thought of some journal costs make my blood run cold, or perhaps it's just, as John Wayne would put it, "A guy's gotta do what a guy's gotta do."

The author would thank his friends and the magazines and journals who provided the facts for this case, but that would be to put them in needless danger.

Postscript, by Richard A. Meserve (2015)

Some stories have a happy ending and fortunately this one does. G&B ultimately filed suit in Germany, Switzerland, France and the United States claiming that Barschall's work constituted unfair and illegal comparative advertising. G&B ultimately lost everywhere, although not without pursuing appeals. So Barschall, the APS, and AIP achieved a complete victory.

The litigation in the United States involved a seven-day trial in a federal court in New York City. Judge Sand wrote an extensive opinion outlining the facts of the case and his legal analysis. He ultimately concluded:

"Barschall's methodology has been demonstrated to establish reliably precisely the proposition for which defendants cited it — that defendants' physics journals, as measured by cost per character and cost per character divided by impact factor, are substantially more cost-effective than those published by plaintiffs. Plaintiffs have proved only the unremarkable proposition that a librarian would be ill-advised to rely on Barschall's study to the exclusion of all other considerations in making purchasing decisions. This consideration in no way makes Barschall's study or defendants' descriptions thereof false, and accordingly judgment is granted to defendants."

"Some stories have a happy ending and fortunately this one does."

The opinion also includes an extensive discussion of G&B's efforts to intimidate its critics. The judge commented that "defendants introduced extensive evidence that G&B has engaged in an aggressive corporate practice of challenging any adverse commentary upon its journals, primarily through threatened (and actual) litigation. This evidence persuasively demonstrated that the present suit is but one battle in a 'global campaign by G&B to suppress all adverse comment upon its journals.'" One might appropriately wonder why the judge commented on the unclean hands of G&B, particularly given his decision that the Barschall work was beyond reproach. I conclude that the judge wanted to put G&B's tactics on the record so as to undercut any further efforts to intimidate others.

References to the Barschall articles

H. Barschall, *Physics Today*, Dec. 1986, p. 34 and *Physics Today*, July 1988, p.56. The underlying data were published in the *Bulletin of the American Physical Society*, July 1988, Vol. 33, p. 1437. Links to the articles and other materials relating to the dispute are found at http://www.library.yale.edu/barschall/index.html

References to the litigation

OPA Amsterdam BV v. American Institute of Physics, 973 F.Supp. 414, 429 (S.D.N.Y., 1997), *aff'd*, 166 F.3d 438 (2d Cir. 1999); also *id.* at 420, *quoting* Defendants' Post-Trial Mem.

Daniel Kleppner is Lester Wolfe Professor Emeritus, Massachusetts Institute of Technology. Richard A. Meserve is President Emeritus, Carnegie Institution for Science, and Senior Counsel, Covington & Burling LLP.

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