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2017 APS General Election

Voting will run from June 19 until July 31. Members should watch for an email with voting instructions. Those who are elected will begin their terms on January 1, 2018. Information on voting, and the candidates' full statements and biographical information, are available at go.aps.org/aps-vote-2017

Vice President

Philip H. Bucksbaum
Stanford University

"The common values that bind physicists together are stronger today than ever. These include a firm belief in the value of scientific inquiry and the importance of progress in science, not only to enable tomorrow's technologies but also as part of our nature as intelligent beings ... This community has helped me find and develop my own identity as a physicist over more than four decades. I am honored to have an opportunity to give something back to the members of the APS by serving as a candidate for the presidential leadership line."

Patricia M. Dehmer
former Deputy Director, DOE Office of Science

"APS must educate, communicate with, and advocate for science to policymakers, citizens, and students at all levels ... APS should play a major role in expanding and diversifying the physics workforce, and this will require very new ways of thinking about who studies physics, who doesn't, and why these choices are made. ... If elected, I would be honored to serve as Vice President of the APS."

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Deborah Jin's Legacy Honored by DAMOP

By Rachel Gaal

The sudden passing of Deborah Jin in September 2016 struck a sorrowful chord within the physics community. The internationally renowned atomic physicist—affiliated with the University of Colorado at Boulder, and JILA, a joint institute of the National Institute of Standards and Technology and the University of Colorado—was known as a pioneer in ultracold atomic and molecular research. Her legacy will be prominently recognized, however, thanks to the efforts of the APS Division of Atomic, Molecular, and Optical Physics (DAMOP).

Deborah Jin

The Deborah Jin Memorial Endowment campaign, announced by DAMOP in December 2016, aimed to raise an additional $100,000 to supplement the existing "APS Award for Outstanding Doctoral Thesis Research in Atomic, Molecular, or Optical Physics." Not only does this award acknowledge thesis research of outstanding quality and achievement, but it provides travel allowances for finalists to attend the annual DAMOP meeting, up to $1000 each. The winner of the award, chosen at this meeting, receives a $2,500 stipend.

Within five months of the campaign start, over $135,000 was raised in Jin's honor and DAMOP members renamed the thesis award "Deborah Jin Award for Outstanding Doctoral Thesis Research in Atomic, Molecular or Optical Physics." Over 40 individuals donated to her endowment, including seven individuals who each contributed over $10,000.

With this additional funding, the division hopes to fund more final-

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SESAME Opens its Doors

By Rachel Gaal

Starting as a small seed, the Synchrotron-Light for Experimental Science and Applications in the Middle East (SESAME) blossomed into a fruitful and global collaboration over the course of 20-some years. The official opening ceremony of the light source—held on May 16 in Allan, Jordan—was the end of a long road to establish the first synchrotron light source in the Middle East, and the starting point for future science. King Abdullah II of Jordan officiated at the ceremony in honor of his support of the project.

Among the attendees was 2017 APS President Laura Greene and APS Director of International Affairs Amy Flatten, who both said the event was truly inspiring. "This is an important step forward in international science diplomacy," Greene told *APS News*. "It was terrific to see people from these diverse countries talking to each other, sharing ideas, and being so positive about the future."

So far, some $90 million is invested in SESAME, including the value of the land, the building which houses the synchrotron, and equipment—all of which was either provided by the government

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The SESAME synchrotron facility was formally opened on May 16 by King Abdullah II of Jordan (fourth from right) along with representatives of member and supporting organizations.

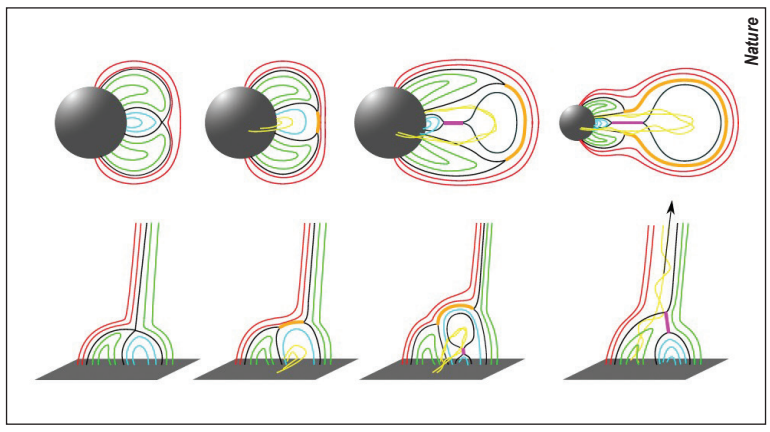
Research News: Editors' Choice

physics.aps.org

A Monthly Recap of Papers Selected by the Physics Editors

New Model for Solar Outbursts

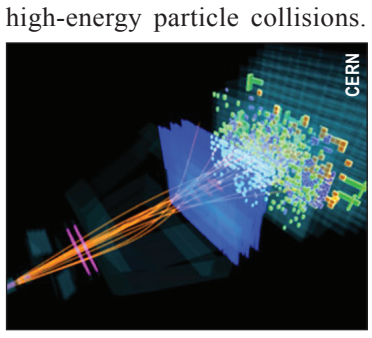
Explosions from the Sun's surface come in all shapes and sizes, but new simulations suggest a common origin of two different types of eruption. Coronal mass ejections are attributed to a kink or other instability that pushes blobs of plasma outward, while leaving nearby magnetic field lines unbroken. Coronal jets, on the other hand, are assumed to result from magnetic reconnection, a highly energetic event that occurs when field lines are stretched to the breaking point and then snap into a new configuration. Observational data have hinted that coronal jets may in fact be miniature versions of coronal mass ejections. If so, it is still unclear whether the root cause is a plasma instability or reconnection. As reported in *Nature* (doi: 10.1038/nature22050), Wyper et al. carried out high-spatial-resolution 3D simulations of a coronal jet to resolve this question. The simulations revealed that the jet's energy release involves "magnetic breakout," a positive-feedback mechanism in which reconnection weakens the fields holding back the plasma eruption, which in turn amplifies the reconnection. Breakout can occur over a wide range of spatial scales, which points to reconnection as the origin of both coronal mass ejections and jets.



High-spatial-resolution simulations indicate that coronal mass ejections (top) and coronal jets (bottom) may arise from the same mechanism.

Five New Particles in One Go

The Large Hadron Collider beauty experiment (LHCb) has discovered a collection of five new baryons. The newly discovered particles are excited states of the Omega-c-zero (Ω_c^0)—a baryon made up of one charm quark and two strange quarks. The existence of these particles was expected since the Ω_c^0 was discovered in 1994, and researchers previously attempted to produce them in high-energy particle collisions.



Particle production

But the low production rate of the particles and their complex decay modes made them hard to observe. As reported in *Physical Review Letters* (doi: 10.1103/PhysRevLett.118.182001), LHCb succeeded in seeing the states thanks to the analysis of large datasets from LHC's first two runs and to the ability of LHCb's detectors to distinguish different products of the baryons' decays. The collaboration next intends to measure the particles' spin and parity. Such information will help researchers establish whether the five states are standard baryons or more exotic states like pentaquarks. The results may guide researchers toward refined theories of the strong interaction that binds quarks together. (For more, see the Synopsis in *Physics* "Five Charming New Baryons" at go.aps.org/2oYhH8v)

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Revised 06/15/17

Spotlight on Development

Aleksandar Svager Plans Ahead

When APS Life Member Aleksandar Svager began thinking about how he wanted to be remembered for his long-standing and generous support of the Society's diversity programs, he recalled a story about a small town. "The people in the village were talking about how to honor one of the eminent local residents," he says. "One person said 'Well, let's build him a monument.' The other person said 'No, we can't do that. We don't build statues of living people!'" At this point, Svager chuckles at the punchline: "'Well' said the first villager, 'We can always kill him off.'"

Such stories are characteristic of Svager's sense of humor, but rather than a statue, he opted to include APS in his estate planning. He took out an insurance policy in the amount of $1 million that will fund diversity programs at APS when he passes away, and he chose this route for two reasons. "One is that I get a tax break," but more importantly, he says "This is how I continue my work as a mentor and teacher even after I die."

His work has been crucial to the lives of many young African-American students who later went on to achieve masters and Ph.D. degrees in science at Central State University in Ohio. As a child in 1941, Svager escaped from Nazi-occupied Yugoslavia, where he and his family were only hours away from being transported to Auschwitz. In 1960, while teaching at the University of Sarajevo, he left Yugoslavia again to come to the U.S., where he obtained a master's degree in physics from Texas Christian University. From 1960 until 1996, Svager taught physics at Central State University, where he met his wife Thyrsa Frazier Svager, one of the first African-American women in the U.S. to obtain a Ph.D. in mathematics (Thyrsa passed away in 1999.)

Over the years, Aleksandar Svager has made many donations to APS programs in education and diversity. His advice to other members is that this is a way to make a lasting impact. "I was considered a good teacher, but I had to quit teaching," he says. "So even if I can't do it, somebody can."

If Aleksandar Svager's story has inspired you, please consider making APS part of your legacy. Keep in mind that planned gifts need not cost anything in your lifetime.

Please complete and return the form below to tell us about an existing gift that will provide for APS in the future, or to request more information on establishing such a gift.

- ☐ Yes, I have left a gift in my will, trust, or by beneficiary designation to APS.
- ☐ Please recognize me in the APS Legacy Society.
- ☐ I would like to remain anonymous.
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APS physics

This Month in Physics History

June 16, 1657: Christiaan Huygens Patents the First Pendulum Clock

Being bedridden is never much fun, but sometimes it can lead to scientific insight. Such was the case with 17th century Dutch astronomer Christiaan Huygens. He became the first to report the phenomenon of coupled oscillation in two pendulum clocks (which he invented) in his bedroom while recovering from an illness in 1665.

Huygens was born in 1629 in The Hague, Netherlands, to a wealthy and influential family; his father, Constantijn, was a diplomat with many useful connections in government, science, and intellectual circles. Young Christiaan was largely home-schooled as a child by private tutors, showing aptitude for math, mechanics, and drawing, and none other than Rene Descartes—a frequent visitor to the house at the time—praised his skill at geometry. Huygens next studied mathematics and law for two years at the University of Leiden, before matriculating at the nascent College of Orange in Breda, completing his studies in 1649.

Christiaan Huygens

Huygens Senior hoped his son would follow in his footsteps and become a diplomat, and the young man did travel to Denmark in 1649 on a diplomatic mission. But eventually his father realized he had no interest in such a career, and this, combined with a shift in the political winds, left Christiaan free to devote himself full-time to research at his father's house in The Hague. His early publications on mathematics earned him a solid reputation in Europe, and he traveled to Paris for the first time in 1655, easily finding a place in the best social and intellectual circles there.

Huygen's interests soon turned to astronomy. He came up with an improved method for grinding and polishing lenses for telescopes, and designed his own eyepiece, using his upgraded instruments to scan the skies at night. He discovered the first moon of Saturn in 1655, and in 1659 he was able to determine the true shape of the rings around the planet, although his findings were disputed for the next ten years, until continued improvements in telescopes finally convinced the remaining skeptical astronomers.

His interest in astronomy led him to the precise measurement of time, since it was so crucial to his observations. He was also intrigued by Galileo's discovery of isochronism (pendulums of the same length have the same oscillation period). Huygen completed a prototype of his first pendulum clock by the end of 1656, and hired a local clockmaker named Salomon Coster to construct others. He patented the device on June 16, 1657. (He also designed a pocket watch in 1675.) His designs proved far more accurate at keeping time than the basic spring-driven table clocks of the era, with a drift of only fifteen seconds per day versus fifteen minutes for other forms of timekeeping. Further improvements increased that accuracy, so much so that pendulum clocks dominated the timekeeping sector for hundreds of years, until the invention of the quartz clock in 1927.

Also around this time, the scientific community was deeply engaged in grappling with the problem of measuring longitude at sea. The English scientist Robert Hooke, for instance, was experimenting with a spring-regulated clock. Huygens' own attempts at such a design weren't sufficiently accurate, but he believed he could adapt his pendulum device to resolve the problem. He built several pendulum clocks for this purpose, which were duly tested at sea in 1662 and 1686, with mixed results.

In 1673, he published a seminal treatise of all his work on pendulums, the *Horologium Oscillatorium*. In it, he described various related phenomena such as the fact that the periods of pendulums depended on their width of swing. (Wide swings took slightly longer than narrow swings.) He also described coupled oscillation—what he called "an odd kind of sympathy"—having noticed, while bedridden by a brief illness, that when he placed two pendulum clocks next to each other, they would synchronize and start swinging in opposite directions. He hoped to exploit this effect to solve the longitude problem, thinking two such clocks could regulate each other, but the Royal Society by then had lost faith in pendulum clocks as a possible solution.

Huygens suggested that this effect was due to "imperceptible movements" in the wooden beams supporting the clocks. In 2000, Georgia Tech physicists conducted experiments and found that Huygens' intuition on this score was correct. The culprit is indeed small vibrations: as the pendulums swing, the clocks exert tiny forces on the beam that connects them.

Huygens was elected to the Royal Society of London in 1670 and was a founding member of the French Academy of Sciences in 1666, modeled after the corresponding institution in England. But when his health began failing in 1670, he instructed that any unpublished papers be donated to the Royal Society in London instead. He was concerned that the Academy might eventually be dissolved because it was "mixed with tinctures of envy because it was supported upon suppositions of profit because it wholly depended upon the humour of a prince and the favour of a minister." Those fears proved unfounded: The Academy thrives to this day, although the outbreak of the Franco-Dutch War in 1672 strained Huygens' relations with the Society.

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SCOAP³ and APS: What You Need to Know

The APS Board of Directors voted on April 23 to enter into an agreement with the European Organization for Nuclear Research (CERN) to participate in the Sponsoring Consortium for Open Access Publishing in Particle Physics (SCOAP³). Here's what it means for you as a member, author, and researcher.

1. What is SCOAP³?

SCOAP³ is a global consortium of more than 3,000 libraries, research institutions in 44 countries, and 3 intergovernmental organizations, convened and managed by CERN, based in Geneva, Switzerland. The consortium is designed to realize large-scale dedicated open access publishing of high energy physics (HEP) research. Launched in 2014, the first phase ran for three years until the end of 2016. Phase II of the project, from 2017-2019, was approved by CERN in 2016.

2. Who is involved?

SCOAP³ involves researchers (who create and use the literature), publishers (such as APS), librarians (who maintain collections and facilitate access), and national funding organizations, with CERN as the hub.

3. What is the role of APS?

APS will be joining SCOAP³ from January 2018 and will publish HEP content (as defined in the arXiv.org taxonomy) in three of its journals—*Physical Review C*, *Physical Review D*, and *Physical Review Letters*—in open access format under a Creative Commons CC-BY license. APS will join the scheme for two years (2018-2019). Prior to this, APS has had a separate bilateral agreement with SCOAP³ to support HEP open access publishing.

4. How does open access publishing differ from subscriptions?

In the subscription system, research institutions pay publishers either directly or through a consortium of libraries for access to content, which is behind a paywall. Some publishers, including APS, have long offered "hybrid open access" in which authors can pay an "article processing charge" (APC) to have a paper available with no paywall. In the SCOAP³ system, the research institutions pay CERN, which pools the funds and pays APCs to publishers. HEP papers are then open access at no direct charge to authors.

5. How is SCOAP³ funded?

SCOAP³ collects money from participating libraries and institutions that would have otherwise been used for subscriptions for high energy physics content in journals. These funds are redirected to pay partner publishers for making their high energy physics content open access. Partner publishers then reduce their subscription prices in proportion to the fees they receive from SCOAP³. As not all libraries participate in SCOAP³, funding is topped-up by CERN and by contributions from its 44 member nations.

6. How does this affect me as a member of APS? As an author? As a reader?

As a member, you'll be part of a major step forward in APS' continuing support of open access publishing in keeping with the Society's position on OA. As an author of high energy physics papers, your HEP results will be published open access at no charge to you, and you retain copyright. As a reader, you will be able to benefit from wider free access to HEP papers.

7. Will APS charge subscription fees for its HEP articles while at the same time receiving payment from SCOAP³?

No. APS is committed not to "double dip" for papers made open access and will be reducing its subscription prices to customers commensurate with the level of funding it will receive from SCOAP³.

JIN continued from page 1

ists to attend the annual DAMOP meeting, and pay for more students to attend, with the goal of enhancing the diversity of student attendees.

"Debbie Jin was dedicated to mentoring young scientists ... three of her former students won the DAMOP thesis award," the campaign page states. "To her friends, family and students, it seems particularly appropriate that her memory be honored by the renaming of that same APS Award."

HUYGENS continued from page 2

As his health continued to deteriorate—he suffered all his life from bouts of depression, among other ailments—Huygens retreated to the family home in Holland, although he expressed sadness at the intellectual isolation he experienced as a result. He did manage to compose a treatise, *Cosmotheoros*, one of the earliest published discussions of the possibility of extraterrestrials. It was published posthumously in 1698. Huygens died at home in The Hague on July 8, 1695.

Further Reading:

1. Klarreich, E. "Huygens's Clocks Revisited," *American Scientist 90*, July-August 2002.
2. Van den Ende, H. et al. *Huygens' Legacy: The Golden Age of the Pendulum Clock*. Castle Town, Isle of Man: Fromanteel Ltd. 2004.
3. Yoder, J. *Unrolling Time: Christiaan Huygens and the Mathematics of Nature*. Cambridge University Press. 2004.
4. Ramirez, J. P. et al., "The sympathy of two pendulum clocks: beyond Huygens' observations," *Sci. Reports* 6, 23580 (2016).

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Chair-Elect of the Nominating Committee

Larry Gladney
University of Pennsylvania

"Finding the best candidates for the positions in APS that will be needed to maintain the existing connections and foster new ones is the primary job of the Nominating Committee. I would be honored to work with the Nominating Committee on such a vital task and would bring my perspective from working across several fields (particle physics, astrophysics and cosmology, and physics education and outreach) to find the best candidates possible and convince them to stand for election."

Philip Pincus,
University of California Santa Barbara

"Our increasingly technological society needs us to provide the enabling science for new inventions and developments as well as educating the upcoming generations ... APS has a leadership role to play in this endeavor ...The role of the Nominating Committee is to ensure that there are appropriate candidates to provide APS the leadership talent that is required for the coming years. As Chair-Elect, I would work with the Nominating Committee to achieve this goal."

International Councilor

Chang Hee Nam
Gwangju Institute of Science and Technology, Korea

"As international councilor, I would like to further strengthen the worldwide gathering of physics societies to share knowledge and experience in science and discuss what is ahead of us ... In addition to this, being a chair and a steering member of numerous international conferences has enabled me to promote worldwide collaboration programs. Using this strong network, I am willing to work as a bridge between the physics societies around the world and build a strong bond between APS and them."

Ahmadou Wagué
Dakar Cheikh Anta Diop University, Senegal

"APS is playing an important role in the development of physics worldwide. In Africa, promotion of outreach and capacity building in physical sciences programs is of great importance to build a future in science for millions of young scholars, both girls and boys, and APS could be one of the key elements in realizing this future."

General Councilor

Vivian F. Incera, ***City University of New York/ College of Staten Island***

"I accepted to run for this position for two main reasons. One is to join the voices in APS that are actively advocating for the need to increase federal funding for physics research in general, but in particular, for fundamental research, which has been badly underfunded and has often come under attack even within the government agencies for many years in a row. The other is because I would like to be part of the APS leadership that is developing initiatives to increase the representation of minorities and women in our discipline ... If I am elected, I will work hard for this agenda."

Ramon E. Lopez
University of Texas at Arlington

"We need to expand the diversity of the physics enterprise and do what we can to make physics courses positive experiences for students who are or will be voters and decision-makers ... We must do a better job of providing the kind of education that leaves students with a positive impression of physics and attracts talent from all groups ... I will strongly support these initiatives and represent APS members who recognize that the APS has a major role to play in education and diversity in physics."

CIFS Briefs: Connecting Human Rights and Science for the Physics Community

Since its creation in 1980, the APS Committee on International Freedom of Scientists (CIFS) has advocated for and defended the rights of scientists around the globe. In this column, CIFS describes some of the issues that the Committee is monitoring, as well as the Society's other human rights activities.

CIFS Outreach Event at the 2017 APS March Meeting

CIFS organized an event for students and early career scientists at the 2017 APS March Meeting in New Orleans to provide an opportunity for them to learn about APS activities in defense of the rights of scientists. Speakers included APS President Laura Greene, CIFS Chair Don Howard, and CIFS member Lucas Hackl, who also serves as the APS graduate student representative on the American Association for the Advancement of Science (AAAS) Science and Human Rights Coalition. The event attracted approximately 75 young scientists and students for discussions about the rights of scientists and how they and APS can help defend those rights.

Nominations for the APS Andrei Sakharov Prize

The Andrei Sakharov Prize recognizes outstanding leadership and/or achievements of scientists in upholding human rights. The Prize consists of $10,000 and a travel allowance to attend the APS meeting at which the Prize is presented. The Prize is named in recognition of the courageous work of Andrei Sakharov on behalf of human rights.

APS is currently accepting nominations for the Sakharov Prize. The deadline is Friday, June 30, 2017. Please consider nominating your colleagues for this honor. Nominations can be submitted online at: aps-awards.fluidreview.com/

AAAS Science and Human Rights Coalition

APS is a member of the AAAS Science and Human Rights Coalition, a network of scientific societies that facilitates communication and cooperation on human rights within the scientific community as well as between the human rights and scientific communities. Coalition members recognize the connection between science and human rights and the important role that scientists play in the Coalition's work.

The Coalition will hold its next meeting at AAAS headquarters in Washington, D.C. this summer,

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APS Launches *Physics Next* Meetings

By Jessica Thomas

Bernd Matthias, a physicist who discovered hundreds of superconducting compounds over the course of his career, famously credited his success to some basic "rules." Among these were: avoid oxygen and magnetism, stick to highly symmetric crystal structures, and stay away from theorists.

That last rule is one that Darrell Schlom, who studies the properties of oxide materials at Cornell University, says he finds himself breaking a lot these days.

Schlom was speaking in May at a workshop on materials design and discovery, where theorists and experimentalists had gathered to discuss collaborating in the hunt for new or improved materials—for solar cells, quantum computers, and many other applications. Hosted by the editors of the *Physical Review* journals at a hotel in Riverhead, New York, the three-day meeting was the first in a new series of workshops called "Physics Next."

APS Editor in Chief Pierre Meystre says he started these informal meetings to encourage better communication between scientists in emerging research areas, and to give editors more opportunities to meet the key players in these fields.

"We really want to make sure that when fields get 'above the noise,' we know about it," he said in his welcoming remarks.

The detective work to find new materials has typically played out in the lab. But theorists have scored several high-profile predictions. For example, researchers calculated in 2014 that a compound of hydrogen and sulfur under pressure would superconduct at relatively high temperatures, which experimentalists observed a year later.

Giulia Galli, a theorist at the University of Chicago and one of the organizers of the workshop, believes that by following a common strategy theorists and experimentalists will have more success discovering exciting materials. That's one of the reasons she and her co-organizer Mercouri Kanatzidis, a chemist at Northwestern University, invited roughly equal numbers of theorists and experimentalists. Such a mixture is rare, said Kanatzidis, and he hopes that such meetings will connect scientists who specialize in theory, synthesis, or characterization.

Most of the roughly 30 scientists in attendance gave short overview talks. To name but a few, Andrew Millis of Columbia University highlighted how researchers are improving the treatment of electron correlations in computations that describe real materials; Efrain Rodriguez of the University of Maryland described new x-ray techniques for monitoring solid-state reactions; and Paul Canfield of Iowa State University and Ames Laboratory recounted stories from his career of sniffing out interesting materials from the infinite number of possibilities that chemistry allows.

By design the workshop had the relaxed feel of a Gordon conference. From the meeting room, attendees could gaze out the window at boats bobbing in the Peconic river, all of the meals were taken together, and there were long breaks for excursions and informal conversation.

There was also time between talks for group discussions. At one such discussion, Paul Kent of Oak Ridge National Laboratory in Tennessee, who uses simulations to predict material properties, launched a lively debate over the value of studying materials that are not stable under normal conditions. Andrew Rappe, a theoretical chemist from the University of

PHYSICS NEXT continued on page 5

Editor in Chief Pierre Meystre and the editors of the *Physical Review* journals hosted the first "Physics Next" workshop on materials design and discovery (May 15-17, 2017).

Profiles in Versatility

Upping Her Geek Game

By Alaina G. Levine

Mika McKinnon was pursuing a master's degree in geophysics at the University of British Columbia when a mysterious email began to bounce around her department. It seemed that the producers of *Stargate: Atlantis*, a sci-fi television show being filmed in nearby Vancouver, needed some sci-fact assistance. They were hoping to tap the brain of a string theorist to ensure that they got the science right on the series.

"I wasn't a string theorist, but I found out later that they'd requested one because they thought a string theorist was the smartest scientist ever," she recalls "I called them up and pitched myself: 'You need a creative scientist, plus I'm a huge fan and know the context.'"

They gave McKinnon her shot. The props department tasked her with explaining how a solar flare would interact with a black hole for a time-travel episode. McKinnon needed to write the equations out on a series of whiteboards for a scene in which the actors on the series would discuss the equations and fill in the missing variables. "My job was to create real equations to support their plot lines," she says.

McKinnon's value was quickly noticed, and soon she was tapped by the visual effects and set decoration departments, and later the writers. One gig turned into another and another. "I was creating plausible extensions of real science to support the fictional plots," she says. One project involved helping the writers of an episode come up with something in space that needs to kill everyone every 22 minutes. "They wanted a pulsar," she explains. "But the problem with having this as the big baddy is that it doesn't produce enough electromagnetic radiation to do so. So

Mika McKinnon

my solution was a pair of stars—a pulsar and feeder star. It was a small background detail and literally changed one sentence in the script. But it was enough to change the impossible to the plausible."

By the time she finished her graduate degree in 2010, she had freelanced for both *Stargate: Atlantis* and its next iteration, *Stargate: Universe* for a total of five seasons over three years. Today, she runs a diversified business that includes projects in science entertainment consulting and science communications, including a great deal of science journalism. Her freelance entertainment work is varied—she has written briefs about scientific topics that end up in scripts, helped set decorators put the right scientific touches in the background of shots, and even rented out her physics textbooks for a film with George Clooney. "I asked to have his autograph as my fee, but I failed and they paid me instead," she says with a laugh.

Right now almost all the entertainment work she is doing is related to pilots, the shows that could end up as the first episode of a series. "I love that you get a chance to set the science for an entire universe," she says. "When I'm doing pilots, it's very conceptual. If the writers are thinking of doing a post-apocalyptic dystopia set in the desert, they are asking 'what kind of science would be useful to know?' I teach them about desert ecology, cave geology, and technology in the boonielands, and get them started on the basic scientific framework."

Although it's a frustrating fact that a lot of pilots don't get made into a series, there is another especially gratifying aspect to her work: She gets to go to sci-fi conventions and promote the projects. For example, she has appeared on panels at Dragon Con, one of the largest science fiction and gaming conferences in North America, attended annually by almost 80,000 nerds and geeks. "Having scientists on shows adds credibility to your

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Science and Entertainment Exchange Helps Put the Sci in Sci-Fi

By Alaina G. Levine

When the writers and producers of the Marvel comic book film, *Thor: The Dark World*, wanted to incorporate a scientific element into the story, they didn't have to look far to find expertise. They dialed 1-844-NEED-SCI and got a direct line to the Science & Entertainment Exchange, an outreach program of the National Academy of Sciences. The Exchange connects entertainment industry professionals with leading scientists and engineers to "create synergy between accurate science and engaging storytelling," according to its website.

The Exchange arranged for the film's creatives to speak with Sean Carroll, an astrophysicist at Caltech. He suggested they incorporate an Einstein-Rosen bridge into the story, linking the film's fantasy world and the "real" world. Even better, he also recommended that the character played by Natalie Portman, originally a nurse, be an astrophysicist instead, in order to more accurately explain the wormhole. And thus the cinematic universe of "Thor," which dealt with super powers, magic, and Norse mythology, got an additional sprinkle of science.

In its effort to add scientific and engineering elements to entertainment projects, the Exchange does not overpower the narrative with scientific facts, because doing so would render a blockbuster superhero film into a science lesson. "A Hollywood screenwriter is there to tell a good story, not to create a documentary," says Rick Loverd, Program Director of the Exchange since 2012. "If the writers agree that Superman flies, let's have the conversation about how Superman can complete his mission in a way that is grounded beside that. We hope to insert some accuracy to help to create the conversation organically and bring better science to the story line."

So say you're a writer and you have an idea for a movie. Maybe a posse of autonomous robots descend into a volcano and want to turn it into a portal for time travel. You might want to consult a roboticist, volcanologist, physicist, or mechanical engineer. "You can think of our organization as the Hollywood hotline to the sciences," says Ann Merchant, Deputy Executive Director in the Office of Communications of The National Academies.

When the phone rings, Loverd goes into superhero mode and starts combing through his extensive database of scientists and engineers who might help writers, producers, directors, and even set designers. Projects range from TV shows to feature films to video games. "We facilitate face to face meetings as much as possible," he says. And experts don't have to be based in sunny LA. "We source talent all over the country and we fly people in."

"If you can have a conversation at a critical moment in the story, you can impact how your science is portrayed on screen to millions of people," adds Loverd. "There are plenty of scientists who are happy to take that time."

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News from the APS Office of Public Affairs

APS OPA Enjoys Success with New Integrated Advocacy Strategy

By Tawanda W. Johnson

Constituents are five times more likely to persuade a member of Congress on a particular issue than influential DC lobbyists, according to a study by the Congressional Management Foundation.

And it is for that reason that the APS Office of Public Affairs (OPA) recently began a new integrated advocacy strategy to accomplish its science policy goals.

The strategy begins with APS OPA gathering information on positions held by members of Congress. The office then identifies and works with APS member/constituents to deliver a local message that is amplified through a locally based grassroots campaign. In the last step, OPA staff meets with congressional staffers in DC to reinforce the message.

APS OPA refined the strategy through recent state-based campaigns in Texas and South Dakota. It then put the full strategy to the test. The goal: urge U.S. Sen. Rob Portman (R-OH) to reject President Donald Trump's proposed cuts to science. Trump had proposals for cuts in both the fiscal year 2017 and 2018 budgets.

"We put this strategy in play in Ohio after we learned that Sen. Portman had become very influential with the new administration," said Francis Slakey, interim director of public affairs for APS OPA. "If Portman—an administration confidant—could be encouraged to reject Trump's proposed cuts to science, it would become easier for other Republicans to do the same."

To implement the Ohio strategy, Greg Mack, OPA government relations specialist, contacted Jessica O. Winter, a professor at The Ohio State University, who had a compelling story to tell about beating cancer due to advances in science.

Winter worked with APS OPA staff to publish an op-ed in *The Hill*, a leading Capitol Hill newspaper.

After the op-ed was published, APS OPA sent an alert to Ohio APS members encouraging them to contact Portman and amplify the message in the piece. APS OPA provided tweets, a sample email, and even a draft phone script to aid the effort. APS members took advantage of all the options — Portman's office was contacted more than 100 times, urging him to reject the proposed funding cuts.

APS OPA staff followed up those actions with a meeting in Portman's DC office to reinforce the message.

When Congress released its budget bill to close out the remainder of fiscal year 2017, it did not contain the deep cuts to science that Trump had proposed. "You can never know how much influence any one action has," said Slakey, "but certainly APS members' voices were heard."

With Congress asserting its authority and rejecting deep cuts, APS OPA has plans to work with APS members in numerous districts and states during the next few months, using this integrated advocacy approach to support science in the fiscal year 2018 budget.

"This new integrated advocacy approach has worked well for APS OPA. We've been able to mobilize our members to use a variety of techniques to contact their congressional members about important policy issues," said Mack. "We've come a long way from the days of simply taking meetings with congressional staffers on Capitol Hill. Our strategy is based on data and consistent with new ways of communicating on diverse platforms."

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

Be a Voice for Physics

OPA's website has a new Advocacy Dashboard that highlights active advocacy issues for APS and allows APS members to easily take action on them through emails, phone calls, or tweets. It also includes background information on policy and the APS position on each issue, as well as statistics for member involvement.

APS OPA wants to provide APS members easy access to resources on such issues as the federal science budget, STEM education, climate change, and more. The Dashboard will be updated periodically, especially as active issues evolve or new ones are added.

Check out the site: aps.org/policy/issues/

PHYSICS NEXT continued from page 4

Pennsylvania, argued that researchers shouldn't disregard hypothetical materials. "You can discover interesting physical relationships in materials that can't be made," he said, "even if they're explosive."

But Canfield was a strong advocate for better vetting of theoretical materials, noting that he'd "burnt off bits of his facial hair" chasing unstable materials in the lab. Schlom, however, said that he finds it useful to know about "slightly metastable" materials, since such materials might be stabilized by an underlying substrate.

Meystre says he hopes for more such discussions at future meetings. Upcoming workshops include applications of quantum-field theory and string theory in condensed matter, scheduled for August 2017, and the physics of active matter, planned for the spring of 2018.

The author is Editor of Physics.

Coasters, G-Force and Velocity, Oh My!

By Rachel Gaal

Depending on your taste, roller coasters are the best—or worst—ride in an amusement park. Steadily climbing the steep slope ahead, and your stomach in knots, you might wonder: Is the barometric pressure increasing or decreasing? Or how much is the total g-force going to change once I hurdle over the first drop?

Not everyone will be thinking this, but kids who attended the annual Physics Day at Six Flags America had to answer these questions during countless thrill rides. The park closed its doors to the public on April 28th for the private event, which drew in hundreds of high school physics students from Northern Virginia, Maryland, and the D.C. area.

While many students were spotted walking around with pens, paper, and calculators in hand, others darted toward the staffed stations outside thrill rides to strap on accelerometers. With the help of APS volunteers, students were able to track the change in barometric pressure (coinciding with their change in altitude during the ride), along with a measurement of the g-forces acting on them. The best part: The results were graphed from start to finish of the ride, and were printed off as a souvenir for the kids.

"We've been learning a little bit about g-force in class," said a group of students from Springbrook High School in Silver Spring, Maryland. "It's helping us a ton that we apply what our teacher is talking about in real life … and maybe this type of question will be on our next test?"

Chris from Northwood High School holding his winning egg-drop container

To get more students involved in the all-day event, Becky Thompson, Head of APS Public Outreach, emceed the popular egg-drop contest, where teams of students had to build a homemade container to keep the egg from cracking. Their eggs had to survive a drop of 50 feet at the park's Gotham City Arena.

"We made a new rule that students couldn't use parachutes to help in the contest," Thompson explained to *APS News*. "I thought they couldn't beat it, but all [of the students] impressed me."

The winner of the prize, a boy named Chris from Northwood High School in Silver Spring, Maryland, strapped his egg inside of a pinwheel-like paper tube. "I thought of the mechanisms of a falling maple leaf when making my container," said Chris. "I honestly had no idea I was going to win a prize … but I'm super excited that I learned new physics in the competition."

The winners of all the contests, including the build-your own-roller coaster challenge, were given a season pass to Six Flags America. The roller coaster challenge tested the minds of students to make their own realistic and thrill-filled ride that would safely transport a marble from start to finish. Each setup, made from all kinds of household materials, included a unique theme. The winner of this year's contest sent marbles through loops, twists, and turns along the "Millbrook High" Rollercoaster — equipped with a goal post, the Millbrook mascot, and a replica of the Millbrook High School Building as the starting point of their ride.

"We judge the designs based on theme, the quality of realistic features you would see on an actual roller coaster, and whether or not you would find the ride to be 'safe'," said one of the judges, who volunteered from the Six Flags America park and the U.S. Air Force. "We also like to give extra points to the groups who can pull off vertical loops, without the marble falling off."

As an annual event, Thompson and the other coordinators of the event strive to make Physics Day bigger and better than the last. "We had 30% more egg drop entries and 20% more roller coaster building competitors compared to last years event," Thompson exclaimed. "This year was a great success, and I love that we've 'upgraded' our accelerometer equipment to cell phones, instead of the bulky vests that we used in previous years."

Judges of the build-your-own roller coaster challenge viewing the winning team's roller coaster in action

APS News Survey: We Have a Winner

At the 2017 APS March Meeting in New Orleans, *APS News* asked attendees to fill out a brief survey for a chance to win an Apple iPad. The survey asked readers to tell us what sections of the publication they found most useful.

The winner of the iPad raffle is APS member Lucas Wilkins of New Oxford, Pennsylvania. Lucas just finished up his sophomore year at Lycoming College in Williamsport, PA, where he is a physics major. This summer he is participating in the NSF-REU (Research Experiences for Undergraduates) program in condensed matter physics at the University of Florida. "My hobby is working on cars," he says. "My biggest project is a 1984 Jeep CJ7 that I bought at 12 years old and did a complete restoration and upgrade. Other projects include a Mazda Miata and an MG Midget."

In general, those responding to the questionnaire wanted to see more news about research, more international news, and more history of physics. Readers are invited to send comments about what *APS News* should cover to apsnews@aps.org — *The Editor*

Education & Diversity Update

Free Faculty Mentoring Webinar June 19

The APS National Mentoring Community will host a webinar on June 19 at 1:00 pm EDT, featuring mentoring expert Christine Pfund from the University of Wisconsin–Madison. She contributes to several initiatives there, including the Center for the Improvement of Mentored Experiences in Research and the National Research Mentoring Network. Pfund will address current mentoring research and recommend resources to further promote faculty development in mentoring. This free webinar is open to faculty members at all levels of experience who are interested in mentoring. Learn more and register for the webinar at aps.org/nmc.

Request a Professional Skills Seminar for Women in Physics

Visit go.aps.org/psdwseminars for a list of physicists who will come to your college or university and lead a two-hour interactive workshop for undergraduate and graduate women in physics.

Participants will learn to:

- Articulate goals
- Enhance personal presence
- Negotiate for jobs and
- Develop alliances as women in academia and the workplace.

These seminars are free, thanks to funding from the National Science Foundation.

2018 Physics Teacher Education Coalition Conference

Save the date! The 2018 Physics Teacher Education Coalition (PhysTEC) Conference is the nation's largest meeting dedicated to educating physics teachers. It will take place February 9-10 at the American Center for Physics in College Park, Maryland. The Conference features workshops, poster sessions, panel discussions on best practices, and presentations by national leaders in physics teacher education, as well as excellent networking opportunities.

- The Conference will feature a one-day Physics and Everyday Thinking workshop on February 8. Funding for travel to the workshop will be available.
- Faculty from minority-serving institutions are eligible to apply for Conference travel grants.

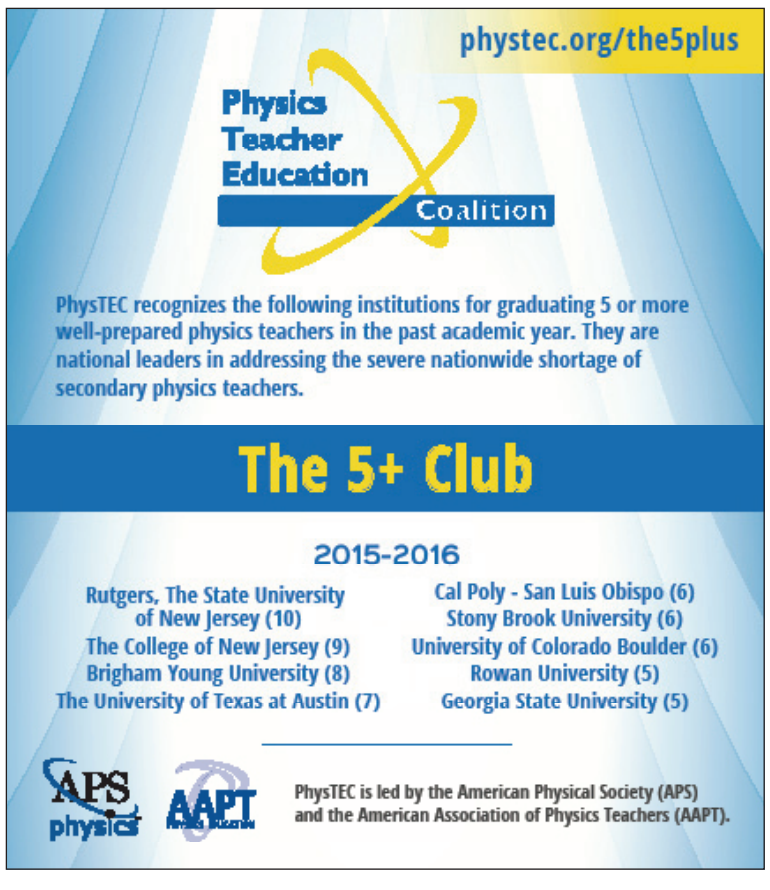
Building a Thriving Undergraduate Physics Program Workshop

Following the PhysTEC Conference on February 10-11 there will be a Building a Thriving Undergraduate Physics Program Workshop. For more information visit phystec.org

The goal of the workshop is to assist departments in developing strategies for increasing enrollment of physics majors. Institutions are invited to send teams of two to four faculty members to analyze their current departmental situation and decide how to take actions that will help them achieve their goals and sustain progress.

Experienced faculty from departments that have had large increases in their numbers of physics majors will facilitate workshop activities in small groups and describe their own experiences through plenaries and case-study talks.

For more information see go.aps.org/2rSbyvh



SCI-FI continued from page 4

Launched in 2008 by the National Academy of Sciences, the Exchange's first advisory board comprised scientists recruited by Merchant and entertainment professionals recruited by producers Janet and Jerry Zucker. Jennifer Ouellette, a blogger and science writer (and former staff writer for *APS News*), was hired as the Exchange's inaugural program director and spent over a year there. Ouellette quickly got to work leveraging her own network as a journalist, in combination with the vast network of STEM professionals available to the National Academies, to build a database of scientists and engineers who could serve as information sources.

Public events such as movie screenings and panel discussions are a hallmark of the Exchange, and it regularly hosts and promotes STEM public engagement activities, lectures, and other events that tie in with the latest in science and engineering and new entertainment projects. "We were targeting Hollywood to let them know we are there to help them," says Ouellette. Indeed, by being proactive through outreach endeavors, the Exchange is able "to stimulate new contacts, consults, and conversations to have about science," adds Merchant.

Ouellette notes that physicists can play a special role in helping writers. "When you are setting up the rules of your world, that's physics," she says. "It's a functional physics, but it is physics nonetheless, and increasingly screenwriters are looking to get that kind of input from physicists."

"Many times, scientists think their job is to come in and set Hollywood straight and they go into lecture mode," says Ouellette. "But from the beginning at The Exchange, we understood that the story comes first and science is in service of the story."

And yet, not all Exchange projects have entertainment as the end goal. When *Thor: The Dark World* was being promoted in 2013,

Exchange leaders were given the opportunity to leverage the fact that the Natalie Portman character, Jane Foster, was an astrophysicist, to have a strong, female scientist role model. Disney, Marvel's parent company, approached the Exchange about ways to showcase the science in the film. The resulting partnership between the Exchange, Disney, Marvel, and Underwriters Laboratories, Inc. led to the Ultimate Mentor Challenge, which gave girls in grades 9–12 the chance to connect with successful women in STEM. "The response to the initiative was kind of astounding," says Merchant. "It all comes from going to a movie and seeing this character and thinking she is cool. It's a great way for kids to connect the dots" about how science is accessible to them.

The Exchange continues to look for new ways to strengthen the portrayal of scientific fact for fun. "We are bridging the gap between these two communities that don't necessarily hang out together," says Loverd. "From the point of the storytellers, the more understanding you have between the entertainment professionals and scientists, the more it helps to create better representation of science on the screen." As for the physics community, "Most physicists care about whether their science is represented well in film and television," says Merchant, "and the Exchange helps make this happen."

CIFS continued from page 3

on July 27-28. The meeting will focus on the human right to enjoy the benefits of scientific progress and its applications, as recognized in Article 15 of the United Nations' International Covenant on Economic, Social and Cultural Rights.

Radio Interview with CIFS Chair

CIFS Chair Don Howard and APS member Eugene Chudnovsky were recently interviewed for the Australian Broadcasting Corporation's radio program *Science Friction*. The episode "When being a scientist is politically dangerous" describes the cases of scientists who have been persecuted for trying to keep the pursuit of science alive. APS members can listen to the program at: ab.co/2sjmPBe

Travel Restrictions: Scientists and Students from Gaza

CIFS has advocated for the ability of scientists and students from Gaza to be able to travel freely to attend scientific conferences or to pursue advanced study abroad. In response to reports that a student and invited speakers from Gaza were not granted permission to travel to conferences at the Arab American University of Jenin last year, Laura Greene wrote to the Israeli prime minister in April. She asked that the government permit students and faculty in Gaza the opportunity to travel as necessary as part of their scientific work, consistent with security needs.

Imprisonment of Baha'i Educators in Iran

In Iran, people who practice the Baha'i religion are forbidden by the government from pursuing higher education. As a result, the Iranian Baha'i community has created its own, informal higher education system known as the Baha'i Institute for Higher Education (BIHE). In 2011, several BIHE educators were arrested and detained. CIFS has since advocated for the release of these individuals. In April, APS President Laura Greene wrote to the Iranian government to urge it to unconditionally release the imprisoned BIHE educators.

Help Protect the Rights of Scientists

APS members are encouraged to inform CIFS of cases in which scientists' rights have been violated or appear to have been violated. Such incidents can be reported to CIFS via the APS Office of International Affairs at international@aps.org

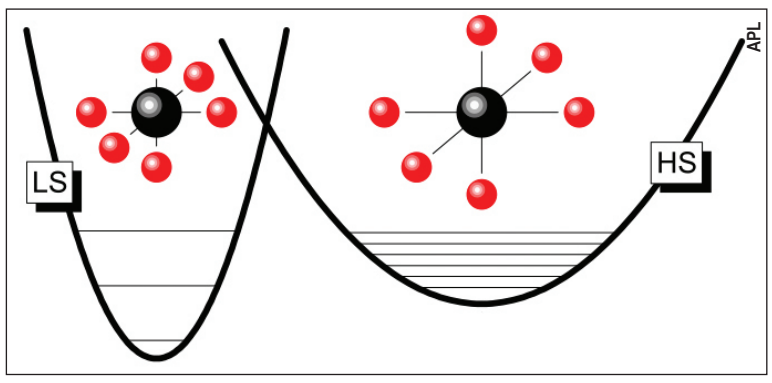
Nominate Someone to Serve on CIFS

Every year, APS solicits nominations for the Society's advisory committees. APS members are encouraged to identify members who are committed to helping defend the rights of scientists and to nominate them for CIFS. Self-nominations and nominations of young scientists are welcome. Nominations can be submitted online at: go.aps.org/2rContM

RESEARCH continued from page 1

Cooling Off by Putting the Pressure On

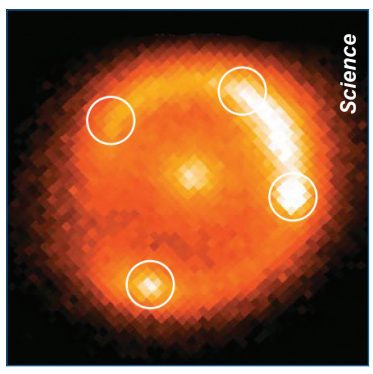
Efficient and environmentally friendly solid refrigerants might soon be poised to replace chlorofluorocarbons in cooling devices. According to work published in *Applied Physics Letters* by Pedro Jorge von Ranke (doi: 10.1063/1.4982792), a class of materials called spin-crossover systems should exhibit pressure-induced entropy changes of a magnitude sufficient to work in a practical cooling cycle. In the past, researchers have studied many different solid refrigerants that respond to magnetic fields (the magnetocaloric effect) but they required very high field strengths to achieve useful cooling. Pressure-driven materials have drawn interest following the discovery of a giant barocaloric effect in ammonium sulphate, and more recently, in spin-crossover systems. In the latter, pressure induces a transition from a low-spin state to a high-spin state, which is accompanied by a large change in entropy. Von Ranke studied an iron-based chlorophenyl sulfonate spin-crossover compound using an Ising-like microscopic model and found that for a pressure change from 1 bar to 4.1 kbar, the compound had a theoretical refrigerant capacity of 2160 joules per mole. This is a factor of six higher than the magnetocaloric materials and points to spin-crossover systems as promising compounds for room-temperature solid-state refrigeration.



Cooling with spin crossover

Gravity Lens Produces Four Images of Stellar Explosion

When a distant star went boom last summer, astronomers got not one but four views of the fireworks. The multiple images, published by Goobar et al. in *Science* (DOI: 10.1126/science.aal2729) resulted from gravity bending the path of the exploding star's light—marking the first time that this so-called strong gravitational lensing has been observed for a supernova.

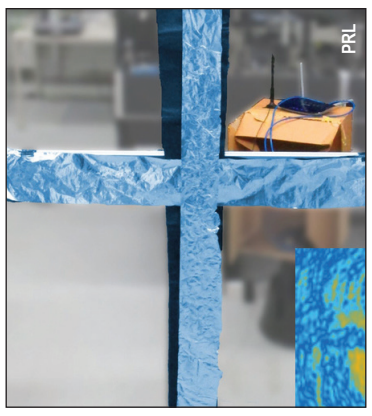


Lensing of a supernova

The event was picked up by the intermediate Palomar Transient Factory (iPTF)—a large sky survey based at the Mount Palomar Observatory in California. On the night of 5 September 2016, the iPTF team detected a bright spot that they christened "iPTF16geu." Follow-up observations revealed that the light originated from a type 1a supernova located 5 billion light years away. However, the explosion appeared brighter than expected, implying that the gravitational lensing of a galaxy between us and the supernova had magnified the light. High-resolution images uncovered four spots all coming from the same supernova. This gravitational lensing offers a unique opportunity to probe the distribution of matter in the foreground galaxy. In particular, the relative brightness of the different images suggests substructures, or clumps, in the galaxy's architecture.

Snapshots with a Hotspot

The signals emitted by a commercial Wi-Fi router can act as a kind of radar, providing images of the transmitter's environment, according to results published in *Physical Review Letters* (doi: 10.1103/PhysRevLett.118.183901). It's not a new idea, but previous attempts at Wi-Fi imaging have needed specially adapted systems: either short pulses of ultrawideband signals or highly directional Wi-Fi beams from which images are reconstructed based on the angle of the signal's arrival. Now Holl and Reinhard have found a way to implement Wi-Fi imaging using a standard, commercial Wi-Fi router, or "hotspot," despite its narrow bandwidth. The trick was to use all of the Wi-Fi signal that reaches a detector, rather than discarding some of the data, as previous methods have done. The authors analyzed the two-dimensional Wi-Fi wave front as though it were a hologram—a 2D encoding of a 3D image. They placed a 1-meter-wide metal cross nearby and the resulting image revealed the clear outline of the cross. To demonstrate the potential of the approach on a larger scale, Holl and Reinhard carried out a computer simulation of the Wi-Fi signal they would detect from a small building and reconstructed a series of 2D slices of the virtual building. (For more, see the Focus article in *Physics*, "Imaging with Your Wi-Fi Hotspot" at physics.aps.org/articles/v10/50)



Wi-FI imaging

GEEK continue dfrom page 4

plot line," she says. "When I go to Dragon Con and speak about it, I am competing against people with star power and yet I get rooms filled with people who are excited about the science."

McKinnon, who calls herself a Master of Disaster, also works as a hazards-assessment geophysicist. She has done several projects for Natural Resources Canada (NRCan), and recently completed a multi-year contract working as a research analyst for the U.S. Federal Emergency Management Authority (FEMA), studying disaster preparedness and response. "We can use science to update how we respond to disasters and how emergency managers plan for disasters to increase the chance of saving human lives," she says. "It is both a depressing and rewarding job. It is always hard to work on this type of assignment when you know that you can't address everything in advance. But it's rewarding because if you can make things incrementally better, fewer people will die in a disaster."

Her next geophysics gig is as a co-investigator on NASA Project ESPRESSO (Exploration in Science Pathfinder Research for Enhancing Solar System Observations). McKinnon will be modeling landslides on asteroids. "It's the same family of work I've done before for NRCan and FEMA, but in space! I'm very excited. This will allow us to do better hazard evaluation during robotic exploration or even asteroid mining."

McKinnon hopes to continue her entertainment consulting enterprise. In the last year, she worked on seven pilots, as well as several movies. Confidentiality agreements are commonplace, so she is not allowed to share what shows or movies she is involved in until they are released. And because of extreme secrecy, sometimes even she doesn't know what project she is working on at that moment. But she doesn't mind, as she finds the mystery of not knowing entertaining in and of itself.

A few years ago, a production company reached out to her in the early stages of a project that was yet to be named to ask her about how tornados operate. She prepared a brief on the subject, and then one production cycle later, *Sharknado*, a made-for-tv movie in which a monstrous storm devastates Los Angeles, leaving the streets flooded and infested with sharks, premiered. McKinnon noted that it was the only film associated with tornados from that production company. "I may or may have not been a consultant for *Sharknado*, she says.

SESAME continued from page 1

of Jordan or donated by other supporting countries.

"Today sees the fulfilment of many hopes and dreams," said Chris Llewellyn Smith, the president of the SESAME Council, at the ceremony. "As well as being a day for celebration, the opening is an occasion to look forward to the science that SESAME will produce, using photons provided by what will soon be the world's first accelerator powered solely by renewable energy."

Initial research will soon begin at SESAME, which houses three beamlines that will be operational this year. Early experiments will focus on pollution in the Jordan River valley, new drugs for cancer therapy, and cultural heritage studies ranging from ancestor cultures to investigations of ancient manuscripts.

With nine member countries (Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, the Palestinian Authority, and Turkey), and support from UNESCO, the SESAME project will host many experiments involving international collaboration. To keep up to date with SESAME news, visit their webpage at sesame.org.jo

The Back Page

What Life is like as a Scientist in Congress

By Bill Foster

Every politician develops a narrative about why they turned to public service. As the only Ph.D. physical scientist remaining in the U.S. Congress, I spend a fair amount of time trying to recruit my future replacement(s). The following is drawn from a presentation—really a recruiting talk—that I have given everywhere from the Yale Physics Department to junior high schools in my district. It is a personal narrative of my well-trodden path from theatrical stage lighting, to high-energy particle physics, to the U.S. Congress. Its aim is to plant a seed that may someday germinate to convince a few good scientists, after enjoying the career possibilities in science, technology, and business, to spend part of their lives in public service.

My story starts when I was a 19-year-old undergraduate studying physics at the University of Wisconsin, when my brother and I started a company in our basement to build computerized theater lighting controls. This was at the dawn of the microprocessor era, when the name of the game was to squeeze every ounce of performance out of 1 MHz microprocessors with 8-bit data paths. After many near-death experiences, and thanks to decades of wise leadership from my brother, our company is now the most successful lighting company in the country. Today, it employs nearly a thousand people and manufactures in the Midwest. Our technology has been used on Broadway shows, Rolling Stones tours, Olympic ceremonies, and at hundreds of churches, schools, and community theatres across the country. In many audiences, though, I have found that all of these accomplishments are eclipsed by the fact that in the early 1980s, I designed and programmed the control system for the Disneyland Main Street Electrical Parade.

"When we had the Congressional reception celebrating the discovery of the Higgs Boson, I had the honor of congratulating many of my former colleagues at having discovered the second heaviest form of matter..."

As my attention span in business seemed to be limited to less than 10 years, I soon returned to my first love and entered graduate school to study physics. At Harvard, I studied under Professor Larry Sulak, the inventor of the large ring-imaging water Cerenkov detectors and their use for studying neutrino oscillations and proton decay. My Ph.D. thesis involved the construction, instrumentation, and data analysis of the IMB (Irvine-Michigan-Brookhaven) Detector, and the (non) discovery of proton decay through the channel $P \rightarrow e^{+} + \pi^{0}$ predicted by the SU(5) Grand Unified Theories favored at the time. Although our experiment did not discover proton decay, it scored a significant unanticipated success when it was one of three experiments to observe the burst of neutrinos from SN1987a, a supernova that occurred 158,000 years ago in the Large Magellanic Cloud.

After receiving my Ph.D., I spent the next 23 years at Fermi National Accelerator Lab in Illinois, then the highest-energy particle accelerator in the world. The first decade was spent designing, building, and analyzing the data from giant particle detectors used to observe the debris from proton-antiproton collisions to observe particles which had not been in existence since the Big Bang. I was a member of the team that discovered the top quark, the heaviest known form of matter, and quite possibly the heaviest particle that will ever be discovered. So in Congress, when we had the Congressional reception celebrating the discovery of the Higgs Boson, I had the honor of congratulating many of my former colleagues at having discovered the *second* heaviest form of matter!

I spent my second decade at Fermilab designing and building particle accelerators. With my collaborator Gerry Jackson, we invented and designed the Fermilab Antiproton Recycler

Ring, which was used to greatly increase the number of collisions and keep the physics program at Fermilab's Tevatron competitive until the end of its lifetime. With a large team of collaborators, I also helped design and build prototype elements of future, large Hadron colliders.

At this point in my presentation, I almost always get asked the following question: After a reasonably successful career as a businessman and scientist, why, on God's green Earth, would I decide to enter politics, especially as it is practiced in the United States today?

My quick answer is that I tragically fell prey to my family's recessive gene for adult onset political activism. My parents met on Capitol Hill in the 1950s when my mother worked for Senator Paul Douglas, known to economists as the co-inventor of the Cobb-Douglas production function. Like me, my father was trained as a scientist, and during World War II he designed fire control computers for the Navy. During his service, he started getting reports on how many people were killed each week by the equipment his team built. He became very unhappy at the idea of his scientific skills being used that way. When he came back from the war, he decided to spend part of his life in service to his fellow man. He became a civil rights lawyer and went on to write much of the enforcement language behind the Civil Rights Act of 1964, one of the greatest steps forward for human rights in the history of our country.

"When you speak with voters, you must lead with conclusions rather than complex analysis of underlying evidence—something that is very unnatural to a scientist."

After my father passed away, I began to read his papers, and they prompted me to begin contemplating a question that science cannot really answer for you: What fraction of your life should you spend in service of your fellow man?

For me, the idea of not spending a significant fraction of my life in service to my fellow man did not feel right. And that's why I decided to run for Congress in the special election to replace former Speaker of the U.S. House, Dennis Hastert, in 2008. Before I committed to running, I volunteered on candidate Patrick Murphy's campaign and then served as a 51-year-old intern in newly-elected Congressman Patrick Murphy's office. So I like to say that I started the 110th Congress as an intern and ended it as a sitting Congressman. (So no one should think that an internship won't get you anywhere.)

On the campaign trail, I learned that there is a long list of neurons that you have to deaden to convert a scientist's brain into a politician's. When you speak with voters, you must lead with conclusions rather than complex analysis of underlying evidence—something that is very unnatural to a scientist. You also have to repeat your main campaign message over and over again, since you will be lucky if a typical voter will hear you speak for a few seconds—and those few seconds have to include your campaign message.

Life as a Member of Congress requires dedication and a heavily scheduled day. In Washington, DC, I attend committee hearings, meet with constituents, and, of course, evaluate and vote on legislation. It requires a huge amount of reading. I serve on two committees—the Financial Services Committee and the House Committee on Science, Space, and Technology. Almost every weekend, I return to Illinois for meetings with constituents and to attend public events.

When I entered Congress in 2008, our country was reeling from the Great Recession. Millions of families had lost their homes, jobs, and economic security. As a Member of the Financial Services Committee, I was proud to help craft the Dodd-Frank Wall Street Reform Bill, because competent regulation is essential to prevent another crisis.

On the Science, Space, and Technology Committee, I've helped bring issues to the committee's attention that I think require us to act. One example is the CRISPR/Cas9 gene editing technology discovered in 2012. This technology raises the prospect for cures for diseases like sickle-cell anemia, but also has the potential to disrupt society. At my urging, the Science Committee held a hearing on this topic, and I have been told that it was one of the best-attended hearings in the committee's history.

"We need people with strong scientific backgrounds not just in Congress, but at all levels of elected office as well as our federal agencies..."

As the only Ph.D. physicist in Congress, my background became important during the debate of the Iran Nuclear Deal. During this time, I had over a dozen classified briefings, many of them individual briefing by the technical experts at the Departments of Energy, State, and Treasury, and intelligence agencies. Because of the technical complexity of the agreement, members of both parties would routinely ask my opinion on aspects of the proposed agreement. Ultimately, my support was based on verification and science, not trust of the Iranian regime.

Defending the science budgets during the annual appropriation cycle is an ongoing challenge. Many members of Congress make the mistake of seeing science as an enterprise that can be stopped and restarted at will—like road construction or equipment purchases. They do not appreciate the damage that can be done to a scientific enterprise in a single budget cycle, where projects and careers that take decades to build can be irreversibly destroyed in a single fiscal year.

I want to close by emphasizing that we need people with strong scientific backgrounds, not just in Congress, but at all levels of elected office as well as our federal agencies. We need scientists and engineers on our school boards and city councils just as much as we need them in Washington. No matter what party you lean towards, if you have any interest in starting down this path, please do not hesitate to contact me.

Congressman Bill Foster represents the 11th District in Illinois.