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The Physics of Slipping on a Banana

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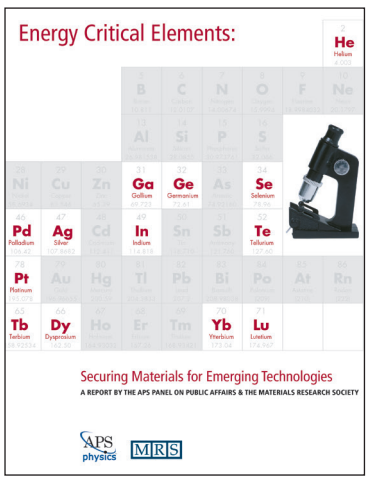
Next Steps for Energy Critical Elements

By Michael Lucibella

Three years after APS and the Materials Research Society issued a joint report on securing supplies of rare elements important to energy research, Congress has yet to act on the recommendations. However, federal agencies and some states have started implementing policies designed to shore up access to so-called energy critical elements.

The report highlighted 29 elements, mostly rare earth elements such as neodymium, terbium, and ytterbium, for which substitute materials are difficult to find and whose supplies could easily be threatened or cut off. They're often used in wind turbines, photovoltaics and batteries. China is by far the biggest and in some cases the only supplier of many of these elements, but it has in the past imposed export restrictions and dramatic price increases, disrupting the supply



lines to the US.

"There are possibly transformative energy technologies that could have a major impact on the climate future of the world that depend on chemical elements that are potentially in short supply," said Robert Jaffe, a physicist at MIT who is chair

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New Local Links Chapters Bring Physicists Together

By Michael Lucibella

New APS Local Links chapters across the country rang in the new academic year in September with get-togethers hosted by all five groups.

"We're trying to bring together students, postdocs, and physicists working in industry, national labs, and academia, so all of those stakeholders can build relationships," said Crystal Bailey, the careers program manager at APS. "We see a lot of collaborations between industry and academia from a research perspective, and this helps build those connections."

Groups in the Denver, Tampa Bay, Silicon Valley, Austin and Washington DC regions hosted events for scientists and students to meet and network with each other. "APS Local Links are grassroots, locally-based associations of physicists in a geographic area," Bailey

Michael Lucibella

The APS Local Links meeting in College Park drew about thirty attendees. From L to R: Diane Wong (Quantel), Ben Stuhl (NIST), Siddartha Santra (Army Research Laboratory).

said. "They're informal gatherings, usually at a bar or coffee shop or some other public space."

The first one was held in Denver during the spring. Since then, the five groups across the country have met about a dozen times altogether. The September meetings attracted on average about thirty local physicists to each. Each local group has a lot of latitude for how and where to meet.

Each chapter usually coor-

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Blewett Scholarship Winners Announced

By Michael Lucibella

The American Physical Society awarded five M. Hildred Blewett scholarships this year to women returning to their careers after a hiatus, the largest number of winners since the beginning of the program.

Chosen by the APS Committee on the Status of Women in Physics, the five include three new recipients and two returning recipients from last year. Amy Daradich of the University of Ottawa and Leslie Kerby at Los Alamos National Laboratory first received scholarships in 2013, while Ani Tshantshapanyan of North Carolina Central University, Monique Tirion of Clarkson University, and Lusaka Bhattacharya of Oklahoma State University are new.

The scholarship is a one-year grant of up to $45,000 that can be used towards a wide range of necessities, including equipment procurement, salary, travel, tuition, and dependent care. This is the tenth year the scholarship has been awarded.

Ani Tshantshapanyan was first drawn to physics during high school in Armenia. "My parents are chemists, they're also PhDs," she said. "I grew up in that environment of science."

She received her PhD in semiconductor physics from the Yerevan State University. At the same time, she had also been working as a laboratory assistant and then as a senior lecturer at the department of applied physics at the Russian-Armenian University, also in Yerevan, Armenia.

Then in 2012 her husband Karen, who also has a doctorate in physics, took a job in Durham, North Carolina. "We moved to

Ani Tshantshapanyan

Monique Tirion

Lusaka Bhattacharya

a different country and finding a secure job was not easy," Tshantshapanyan said.

After her third child was born last June, Tshantshapanyan decided to step away from research for a short while to spend more time raising her three children. "After about one year I started to search for a position," Tshantshapanyan said.

Through her husband, she found a postdoc position at North Carolina State University studying the complex geometry of quantum dots, which have been used in detectors and lasers.

"My research is about the physical properties of so-called quantum dots," she said.

"Properties of quantum dots can be controlled by their external shape and many other physical properties."

With the help of the Blewett fellowship, she hopes to publish more papers on her research, as well as develop software to further her work. She hopes also to establish contacts with other research institutions nearby and ultimately find a private company to collaborate with in order to commercialize the kind of quantum dots she's been helping to develop.

Monique Tirion is returning to physics in order to work on better understanding the dynamics of proteins. X-ray crystallography is a well-established method for studying the makeup of proteins that make life possible. However, it turns out that scientists have been

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Vote Now!

The membership voting period on proposed changes to the APS Constitution and Bylaws opened on October 6 and closes on November 10.

For more information see
www.aps.org/about/reform

DOE Joins the CHORUS

By Michael Lucibella

After more than a year of consideration, the Department of Energy (DOE) announced its plan to allow the public to freely read academic journal articles by researchers supported by federal funding. On August 4, DOE unveiled a beta version of its new Public Access Gateway for Energy and Science (PAGES) website, an online hub that gives a link to the publisher's website, in addition to providing author manuscripts or links to institutional repositories. According to the new policy, researchers must make such articles freely available to the public after a year-long embargo.

This policy responds to a memorandum issued in February of last year by the Obama administration's Office of Science and Technology Policy (OSTP). The White House has directed federal agencies to come up with a plan to open up the results of research conducted with federal funds. Following the memo, publishers and open access advocates began working with DoE to come up with a workable policy. "We used that memo as a sort of guidebook…of the elements that our public access plan should contain," said Brian Hitson, the associate director of administration and information services at the DOE's Office of Scientific and Technical Information (OSTI). "[The policy] took into account the diverse views of the stakeholders."

Anyone interested in reading one of these journal articles can access it through a portal on the PAGES website. The PAGES website acts as a switchboard to supply articles directly via the publisher's website, or will direct the reader to an institutional repository. Prior to this policy, readers had to pay for access to these journal articles, though policies varied by publisher.

The Clearinghouse for the Open Research of the United States (CHORUS), of which APS is a member, is a group of publishers working with DOE and other agencies to develop a policy that would satisfy the OSTP requirements at no additional cost to those agencies. "I think it is generally a very good response to the OSTP mandate," said Joseph Serene, former Treasurer/Publisher of APS and board

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Members in the Media

"They are very precious particles."

***Andrew Westphal**, University of California, Berkeley, on the space probe Stardust returning dust that originated outside the solar system,* CBSNews.com*, August 14, 2014.*

"If some version of illusory 'time travel therapy' can help people make better decisions in the future, and come to a better understanding of bad decisions, they have made in the past–then I am all for it."

***Robert Nemiroff**, Michigan Technological University, on a psychological experiment that used virtual reality to "simulate time travel,"* BBCNews.com*, August 22, 2014.*

"You stick with us, and we're sticking with you."

***Ernest Moniz**, Secretary of Energy, addressing workers at a nuclear waste depository after it was temporarily closed because of a radiation leak,* Los Angeles Times*, August 23, 2014.*

"Determining how space-time is constructed is a pretty big deal for a physicist.… A holographic model aims to improve on the conventional view of how space-time relates to matter, which has been problematic and paradoxical since quantum mechanics was invented."

***Craig Hogan**, Fermilab,* NBC-News.com*, August 27, 2014.*

"This epidemic will take time to control…, but what we want to see is deviation from this trend."

***Alessandro Vespignani**, Northeastern University, on statistically modeling the growth and spread of Ebola,* The Washington Post*, September 8, 2014.*

"Most likely it will take [10^{100} years for a Higgs boson to destroy the universe], so probably you shouldn't sell your house and you should continue to pay your taxes.… On the other hand it may have already happened, and the bubble might be on its way here now. And you won't know because it's going at the speed of light so there's not going to be any warning."

***Joseph Lykken**, Fermilab, on the Higgs boson creating a vacuum bubble and destroying the universe,* The Christian Science Monitor*, September 10, 2014.*

"Ed has the unique skills, knowledge and experience to lead the design, construction and commissioning of the [Giant Magellan Telescope]."

***Wendy Freedman**, The University of Chicago, on Ed Moses leaving the National Ignition Facility for the telescope project,* San Francisco Chronicle*, September 13, 2014.*

"These rankings support what our students, alumni, staff, friends, and collaborators know, that Imperial is one of the world's great universities.… Imperial has a rare ability to turn outstanding research into discoveries that have a real impact on the world."

***Alice Gast**, Imperial College London, on her school's high scores in this year's world university rankings by educational analysts at Quacquarelli Symonds,* The Guardian*, September 15, 2014.*

"Every now and then, nature becomes whimsical… I think nature is whispering in our ear, 'Psst, I can do something funky.'"

***Paul Canfield**, Iowa State University, on the 25th anniversary of the discovery of quasicrystals,* The New York Times*, September 15, 2014.*

"Physics is among the least diverse of the sciences, with only 20 percent of bachelor's degrees going to women and fewer than 10 percent to underrepresented minorities. The field needs to catch up to biology and chemistry, which have almost closed the gender gap at the undergraduate level."

***Rachel Scherr**, Seattle Pacific University,* The Seattle Times*, September 16, 2014.*

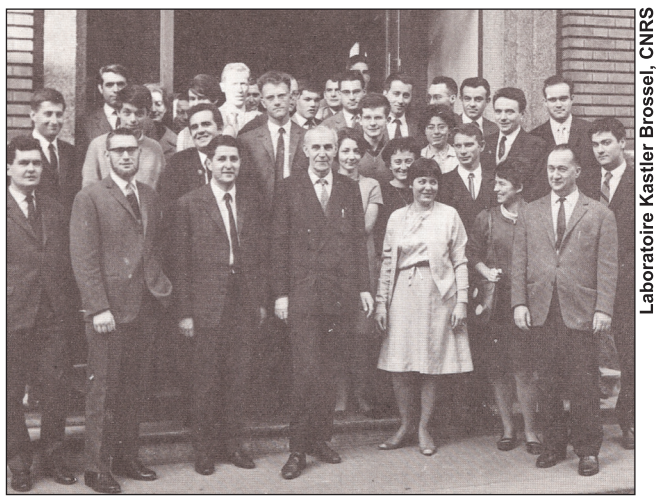
This Month in Physics History

October 13, 1967: Kastler reviews his Nobel-winning work on Hertzian resonances in *Science*

When we think of the invention of the laser, we inevitably go back to Albert Einstein's 1917 paper, in which he first broached the possibility of stimulated emission: An incoming photon inducing an excited atom to emit another photon. In a laser, this produces a beam of coherent light as excited atoms emit photons in a rapid chain reaction. But few remember the contributions of an Alsatian physicist named Alfred Kastler, whose work on Hertzian resonances (using microwaves or radio waves to excite an atom in a magnetic field into low-lying energy levels that today physicists call hyperfine structure) played a crucial role in the subsequent development of the laser.

Born in 1902 in the Alsace region of what was then the German Empire, in the village of Gebweiler, Kastler told a *New York Times* reporter that he recalled being "attracted to nature as a child, and was once deeply impressed by the eclipse of the sun." He went to school in the nearby town of Colmar, where his interest in math and science was encouraged by his teachers.

That said, his early ambitions were comparatively modest: He wanted to become a carpenter, although his plans were interrupted by the outbreak of World War I, when he was drafted to serve in the German army. After the war, Alsace once again became part of France. Kastler was not fluent in French, but nonetheless he applied to the prestigious École Normale Supérieure in Paris. Although he failed the entrance examinations, he was admitted as part of a special program to help reintegrate Alsatians into French culture. There he first learned about quantum physics and the Bohr model of the atom, and encountered Arnold Sommerfeld's book on atomic structure and spectral lines, which would have a profound impact on his own research. He also met and married Elise Cossett, a former student there who became a secondary school history teacher.


Laboratoire Kastler Brossel, CNRS

Alfred Kastler with colleagues after winning the Nobel prize in 1966.

He received his PhD in physics in 1936, and went on to teach at various universities over the next several years, including the University of Bordeaux. The light teaching duties meant he had more time to devote to his research in atomic fluorescence and spectroscopy. The Second World War broke out in 1939, and by 1941, the Germans had occupied Paris. At the invitation of a colleague, Georges Bruhat, Kastler returned to the École as a faculty member, and as director of its nascent Hertzian spectroscopy group (later renamed the Laboratoire Kastler-Brossel in honor of Kastler and his graduate student, Jean Brossel). He would remain there until his retirement in 1968, when he became director of research at the National Center for Scientific Research (CNRS).

Kastler was particularly intrigued by how atoms could jump to higher discrete energy levels and then emit specific wavelengths of light as they returned to their ground states, producing a telltale pattern of spectral lines. For instance, in 1937 he studied the luminescence of sodium atoms in the upper atmosphere, demonstrating that the mechanism for this optical resonance was solar radiation. He also built upon prior research in the observation of the polarization of such fluorescence–known to be affected by magnetic fields–by carefully delineating the relationship between an atom's spatial orientation and how its radiation is polarized.

This was an area of great interest to many physicists, but by the time Kastler undertook his research, the field had encountered a significant obstacle: The hyperfine spectral lines were so closely spaced that the usual optical and magnetic techniques used to probe the energy structure of atoms failed to yield measurements of sufficient precision.

During the war, French scientists were isolated from much of the world's research community, but they could send graduate students overseas for study. Kastler sent Brossel to MIT to work with Francis Bitter. It proved an astute move. Brossel returned with an idea for combining optical resonance with magnetic resonance to study the excited states of atoms, gleaned from the work of I. I. Rabi, among others, who had used Hertzian resonances to calculate the magnetic and electrical moments of magnetic nuclei.

Eventually Brossel successfully used such a "double resonance" approach to study the excited states of the mercury atom. In double resonance, polarized light tuned to the frequency of an atomic transition populates the sublevels of this transition unequally. Applied microwaves or radiofrequency can then induce Hertzian resonances between the sublevels.

Concurrently, Kastler's scattering research led him to propose, in 1950, an optical pumping method to excite the energy states of the atoms. As they returned to their ground states, the atoms would emit light waves. It proved a useful method for supplementing double resonance. Charles Townes

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Education Corner

APS educational programs and publications

Creating Sustainable Physics Teacher Preparation Programs

A new study (see article on page 4) has identified two factors that characterize sustainable university and college programs designed to train highly qualified physics teachers in greater numbers. Specifically, one or more faculty members who choose to champion physics teacher education in combination with institutional motivation and commitment can ensure that such initiatives remain viable. Shortages of qualified teachers are especially acute in physics, where fewer than half of all high school physics classrooms have a teacher with a degree in physics. The Physics Teacher Education Coalition (PhysTEC) Sustainability Study was publicly released Tuesday, July 29 at the 2014 American Association of Physics Teachers (AAPT) summer meeting. PhysTEC is a project of APS and AAPT, with major support from the National Science Foundation. The report can be downloaded at: http://www.phystec.org/sustainability

Save the Date for the 2015 PhysTEC Conference: "Building Thriving Programs"

The 2015 PhysTEC Conference will be held on February 5-7 in Seattle, WA. The theme for the Conference is "Building Thriving Programs." The Conference will feature a half-day pre-conference Learning Assistant Workshop on February 5th. In addition, a post-conference workshop on "Building a Thriving Undergraduate Physics Program"(February 6-8) will assist departments in developing strategies for increasing enrollment of physics majors. More information on both meetings can be found at: http://www.phystec.org/conferences/2015

Free Graphs and Raw Data on Education Issues

APS generates statistical reports on issues in undergraduate physics education. These reports are freely available for your use. You may use the graphs in reports and presentations or you may use the raw data to create new graphs and charts, but please credit APS and the U.S. Department of Education. Access the reports here: http://www.aps.org/programs/education/statistics/index.cfm

Join the APS Topical Group on Physics Education Research (GPER)

In GPER, physics education researchers engage with working physicists to strengthen research on teaching and learning in physics departments and in the physics community. By joining GPER you will strengthen the APS commitment to physics education research (PER) as a research field within the physics community and physics departments; support dissemination of the results of PER to the broader physics community; and be informed of current PER events through newsletters and other communications.

KASTLER continued from page 2

and others later adapted optical pumping to create the foundation for the laser, since the technique produced such intense narrow beams of the same wavelength. (In a laser, the atoms or molecules of the lasing medium are "pumped" by the action of light or electricity.) Optical pumping techniques led to highly sensitive magnetometers and atomic clocks.

Kastler won the 1966 Nobel Prize in Physics–the first French citizen to be so honored in 37 years–"for the discovery and development of optical methods for studying Hertzian resonances in atoms." The following year, on October 13, 1967, the journal *Science* published a review article by Kastler, based on his Nobel lecture.

Kastler also had interests outside of science. He wrote poetry in German, even publishing a volume of his work in 1979, and served as chairman of Action Against Hunger. Perhaps because he lived through two world wars, in military-occupied regions, he was a powerful advocate for peace and nuclear non-proliferation, staunchly opposing the French presence in Algeria. Such opinions were not universally popular: Right-wing extremists once bombed his apartment. Yet he died peacefully on January 7, 1984, at age 81, on the French Riviera in Bandol, France.

Further Reading:

Kastler, Alfred. (1967) "Optical Methods for Studying Hertzian Resoances," *Science* 158 (3798): 214-221.

Zero Gravity

the lighter side of science

2014 Ig Nobel Prizes Honor Banana-Shoe Interactions, Alimentary Alignment, and More

By Michael Lucibella

Research into banana frictional coefficients, magnetically aligned dog defecation, and the neuroscience of seeing Jesus in burnt toast were among the offbeat topics honored at this year's annual Ig Nobel award ceremony, held on September 18 in Cambridge, Massachusetts. The awards honor "science that makes you laugh then makes you think," especially research that sounds silly or inexplicable at first, but that often has a kernel of legitimate science.

Michael Lucibella

Kiyoshi Mabuchi brandishes a banana after winning this year's Physics Prize for studying the frictional coefficient of slipping on a banana peel.

The winner of this year's physics prize went to Japanese researchers Kiyoshi Mabuchi, Kensei Tanaka, Daichi Uchijima, and Rina Sakai, for their investigations "measuring the amount of friction between a shoe and a banana skin, and between a banana skin and the floor, when a person steps on a banana skin that's on the floor."

Mabuchi, who was on hand to receive the award, hopes to use their findings to develop better ways to reduce friction in human joints. "This is a banana, everybody knows you," Mabuchi sang as he accepted the prize.

Sabine Begall and her team from Germany, Zambia and the Czech Republic were honored with this year's biology prize for their work showing that when dogs defecate, they prefer to align their bodies along the Earth's magnetic field.

"We had 50 dog keepers who went out with their dogs. We had in total 70 dogs, and they went on their usual walk. [The keepers each] had a compass, and then they observed the dogs when they did their business and they noted the head direction of the dogs [bodies]," Begall said. The team collected their data over two years in a range of weather and other conditions. Hynek Burda, the primary investigator and dog walker, was blindfolded as he led the dogs on their walks so as not to inadvertently influence the direction they would chose to face.

"When the magnetic weather is calm, the dogs align in a north-south direction," Begall said. "If the magnetic field is a little shaky, the dogs align randomly."

Other large mammals, such as red foxes, have also shown some ability to detect the Earth's magnetic field. However, because foxes are wild animals and difficult to work with, the team hopes that domesticated dogs can yield insight into how these animals can sense

IG NOBEL continued on page 7

WINNERS continued from page 1

seeing only part of the story. "So people have been admiring these static images for a long time," Tirion said. "We can take it a step further… We can make those static images [into] dynamic images."

Using software she has been helping to develop, she has been able to calculate the normal vibrational modes of the different proteins based on their shapes. The work has helped explain some of the finer points of how these protein systems behave. "It's not an easy computation, but if you carry it through, the insights you gain from it can be very exciting," Tirion said. "The static images really can't elucidate how all of these little mysteries are resolved."

She said she's always been driven by her fascination with the biological sciences and trying to understand how the world works and what makes things happen. "It's just a natural evolution," Tirion said. "The world around us is so astounding, the trees and the flowers and whatnot. My effort to understand that naturally came to this scale, nanoscale where I'm working."

Tirion attended Texas A&M University for her undergraduate degree in physics, and then Boston University for her PhD. There she met Daniel Ben-Avraham, her future husband. Shortly after receiving her doctorate, her husband took a job at Clarkson University in upstate New York. The two moved to the small town of Potsdam, and a short time later her son Yoel was born.

Yoel was born with three health issues. "All three individually take some effort to supervise, but all three at the same time was a bit overwhelming, so I decided to give it my full attention."

She carefully monitored his diet and homeschooled Yoel until he started the 7th grade, and today he is much healthier. With Yoel doing well, Tirion has been able to return to research. Thanks to the Blewett support, she hopes to take the recent work she's been doing on proteins even further.

"I would like to make it more easily available to the crystallographers," Tirion said. "I'm not sure where it will go, but I'm just analyzing these systems and sharing them with the crystallographers, and seeing where it takes me."

Lusaka Bhattacharya grew up in India and had always been interested in the sciences. "Physics is very interesting to me because in physics you have mathematics, a theoretical part, and you have an experimental part," Bhattacharya said. "My mom is also a mathematician so I decided that that means I would study physics."

She studied theoretical nuclear physics at the Saha Institute of Nuclear Physics in India and received her PhD from the University of Calcutta in 2012. Studying nuclear physics there, she focused on studying the quark-gluon plasma, and traveled a great deal to present her work around the world. "It is a very new field so you can explore a lot," Bhattacharya said. She added that the idea of learning about what made up the universe just an instant after the Big Bang was what attracted her to the field.

While working on her doctorate, she met her husband, and the two married in 2010. He finished his degree early and traveled first to Helsinki, and then to Oklahoma, for his postdoc work. After Bhattacharya finished her doctorate in 2012, she moved to Oklahoma to join her husband. "My husband is a theoretical physicist like me, but it is very difficult to get a postdoctoral position in the same university," she said.

It was the first time the two had been able to live in the same city for an extended period of time. Bhattacharya decided to take some time away from research and start a family. Earlier this year, her first child was born. "Now he's almost nine months old so now I think I should start my career again," she said.

She started volunteering at Oklahoma State University and collaborating with her mentor at Kent State University. She's helping to develop a photon probe for detecting when particle collisions have created a quark-gluon plasma .

For more on the Blewett scholarships, see http://www.aps.org/programs/women/scholarships/blewett/index.cfm

International News

...from the APS Office of International Affairs

New US-China Young Physicists Forum:
Opportunity for Graduate Students at 2015 March Meeting

By Amy Flatten

The International News columns usually provide guest authors the opportunity to inform APS members of events at the intersection of international affairs and physics. Here, however, I want to inform APS members of an exciting new initiative, led by the APS Office of International Affairs: the "U.S.-China Young Physicists Forum" (YPF), to be held February 28 and March 1, 2015, in San Antonio, Texas (the weekend before the 2015 APS March Meeting). The event is cosponsored by APS and the Chinese Physical Society (CPS), as part of a larger effort to strengthen communication and collaboration between the US and Chinese physics communities. We hope you will encourage your graduate students to participate, and to visit www.aps.org/international for application details.

Leaders of both APS and CPS have underscored the importance of building connections among younger scientists, and have been enthusiastic about creating joint programs for graduate students from their respective countries. The APS March Meeting, which attracts 9,000-10,000 physicists worldwide, provides an ideal venue for bringing together graduate students from the United States and China for a combination of science-focused sessions with career development and networking opportunities. Because many graduate students from China will already plan to attend the 2015 March Meeting in San Antonio, APS and CPS will hold the U.S.-China YPF the weekend before the March Meeting begins. The program will especially encourage participation by US graduate students who have had little or no experience in China.

The U.S.-China YPF will span a day and a half, with approximately 30 graduate students from each country. It will be modeled after the biennial Canadian-American-Mexican Physics Graduate Student Conferences (CAM) that APS has co-sponsored since 2003, with the help of funding from the National Science Foundation. The YPF's scientific sessions will focus upon two of the major physics sub-disciplines addressed at the March Meeting: condensed matter physics and materials physics. Through special topical and technical sessions, the forum will provide graduate students from the United States and China with:

- plenary physics sessions with US & Chinese senior scientists
- research presentations by participating US and Chinese students during parallel and poster sessions
- networking and social events with leaders in condensed matter physics, materials physics, and VIP's from APS and CPS
- career-development discussions on publishing in peer-reviewed journals and on careers outside of academia

Much like the CAM conferences, senior physicists will present their research in condensed matter physics and materials physics, followed by parallel sessions with the graduate students themselves presenting to each other.

Perhaps most exciting, a poster-session/networking-reception will allow students to discuss their research with not only their international peers, but also with leaders in condensed matter physics and materials physics, and with dignitaries from APS and CPS. During this session, graduate students can discuss their work and connect with potential partners or mentors in a smaller, more intimate setting than the much larger March Meeting. Dignitaries from APS and CPS will award an "Outstanding Poster" prize. All graduate students will be expected to participate in a scientific session, either through presenting their research during a parallel session, or presenting a poster during the poster-session/networking-event.

Newly elected APS 2015 Vice President Laura Greene will provide a session on "Publishing in Peer-Reviewed Journals," a session that she has given to international audiences of young scientists around the globe. In addition to the scientific presentations and poster session, two panel discussions focused upon professional development and career-building will be tailored to both US and Chinese graduate student interests. These include: "Careers Outside of Academia in the U.S. and China," and "Life as a Graduate Student in the U.S. and China."

The plenary and parallel scientific sessions will provide the YPF participants with an expanded view of physics beyond their own classrooms, laboratories, and nation. The panel discussions and networking opportunities will broaden their perspectives on career opportunities outside of academia, and will allow deeper insights into each country's scientific culture and approaches toward scientific research and international partnerships.

Likewise, the relationships formed at this conference have the potential to last throughout the participants' professional lives. As the YPF participants are likely to continue attending the annual APS March Meeting, or other international conferences in condensed matter physics and materials physics, they can maintain connections

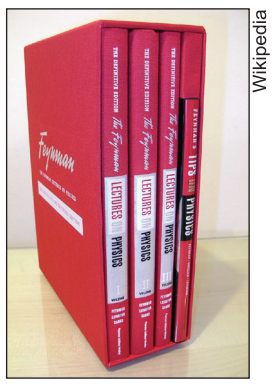
FORUM continued on page 6

Feynman Lectures Now Freely Available Online

By Michael Lucibella

The California Institute of Technology recently completed a years-long effort to upload the entire set of Richard Feynman's classic *Lectures on Physics* for the public to access for free. It is the first time the popular physics texts are available online for free in their entirety.

"I became aware of the many eager young minds who could benefit from reading [this set of books], who had heard of it and wanted to read it, but who had no access for economic or other reasons," said Michael Gottlieb, a software consultant who spearheaded the digitalization project, mostly as a volunteer. "At the same time I was becoming aware of the growing popularity of horrid scanned copies of old editions…that were circulating on file-sharing and torrent websites. A free-to-read high-quality online edition was my proposed solution to both problems."



Wikipedia

The website reproduces the three volumes, including all the equations and diagrams. The first volume, *Mainly Mechanics, Radiation and Heat*, was first uploaded in September 2013. The third and final volume, *Quantum Mechanics*, was uploaded at the end of August 2014.

Richard Feynman, along with Robert Leighton, Victor Neher and Matthew Sands, first developed the lectures in the late 1950s at Caltech. They wanted a way to introduce undergraduate students to "modern" physics topics, like relativity, atoms, nuclei, and the fundamentals of quantum mechanics. It was an offshoot of a broader movement after Sputnik to modernize the physics curriculum in universities.

Feynman presented each lecture only once during a two-year introductory course from 1961 through 1963. His standing-room-only lectures were full of undergraduates as well as graduate students and professors who snuck in. All but one lecture was audio-recorded, and all of his blackboards were photographed.

The following year, *The Feynman Lectures on Physics* was first published. They have been a huge success in the physics community. Ultimately more than 1.5 million English copies have been sold, and the three books have been translated into more than a dozen languages. "Students and professional physicists have found them very useful and inspiring over the 50 years since they were first published," said John Preskill, the Richard P. Feynman Professor of Theoretical Physics at Caltech and a contributor to the project.

Though inspirational to students and influential as to how modern courses have been structured, the lectures themselves are not often used as course materials.

"For close to two decades [*The Feynman Lectures on Physics*] was used as the primary textbook in Caltech's two-year introductory physics course, but I know of only a few other universities that adopted it," Gottleib said. "It's not an easy book to teach from, due to the advanced treatment of the material, Feynman's idiosyncratic approach, and the fact that the book did not include exercises." Often they're recommended as supplementary reading after basic concepts have been presented. "They do have a sort of a unique perspective.…They're not necessarily the best resources for students learning college level physics for the first time, but they're very insightful."

He added also that in the next few years he hoped to incorporate the audio recordings and photographs into a bigger, interactive package for people to purchase. "Eventually we want to publish a version of *The Feynman Lectures* that includes multimedia content," Preskill said.

The lectures can be found at www.feynmanlectures.caltech.edu

PhysTEC Sites Successfully Sustain Teacher Education Programs

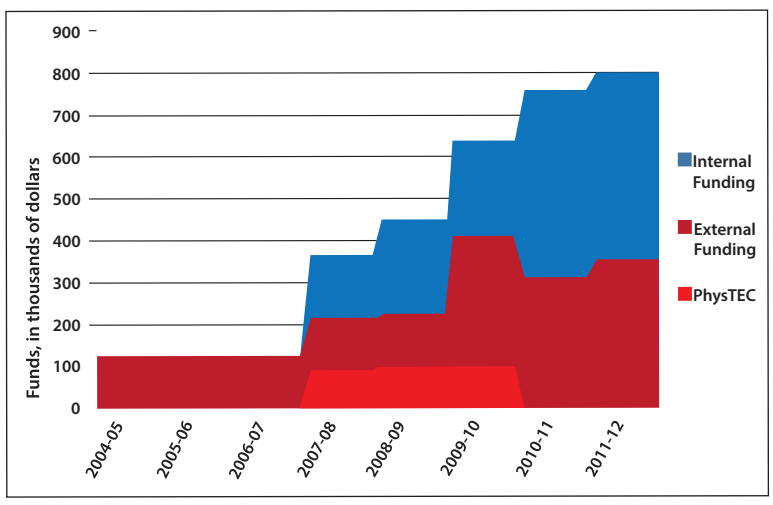
The flagship APS education program, the Physics Teacher Education Coalition (PhysTEC), recently received a strong vote of confidence in its methods. PhysTEC has supported over 30 institutions to develop model programs that increase the production of well prepared high school physics teachers. Physics is the number one shortage area in terms of qualified K-12 teacher candidates, according to the American Association for Employment in Education, and fewer than half of all high school physics classes are taught by a teacher with a physics degree. A study on the sustainability of eight PhysTEC programs found that nearly all maintained their progress over the long term, and many in fact continued to expand teacher production after project funding ended.

Rachel Scherr, Seattle Pacific University, conducted the study to measure the extent to which programs have been sustained after PhysTEC funding ended, and to identify features that ensure sustainable physics teacher education programs. "The programs have so much in common but also such diverse strengths," said Scherr. "For example, every sustained program has a champion, but each champion has unique expertise and a strong personality that shapes his or her program."

The results of the study strongly suggest that PhysTEC awards help initiate long-term support for physics teacher education at institutions that have received project funding. Nearly all of the studied sites sustained increases in the production of physics teachers as well as in funding for physics teacher education after PhysTEC project funding ended. Scherr said that about half of the programs in the study are "thriving," in that after the funded project ended, they actually further increased teacher production. To make this happen, these programs raised a remarkable amount of money on their own. As an example, the figure shows a dramatic increase in funding for physics teacher education activities at Florida International University, which is a "thriving" program.

The study identified two factors that characterize sustainable university-based programs designed to increase the production of highly qualified physics teachers. Specifically, one or more faculty members who choose to champion physics teacher education, in combination with institutional motivation and commitment, can ensure that such initiatives remain viable.

Scherr defines a champion as someone who secures funding and personnel benefiting physics teacher education and negotiates with the institution for changes beneficial to physics teacher education. All eight sites Scherr studied have at least one champion who is a member of the physics faculty,



Source: ***Sustaining Programs in Physics Teacher Education,*** **American Physical Society**

Funding of physics teacher education at Florida International University has increased from an annual average of $120K before PhysTEC funding to an annual average of $800k, substantially more than the amount of the award.

and about half have a champion with a partial appointment in the college or school of education. "In our experience with over 30 sites," said PhysTEC project director Monica Plisch, "we have found that a champion in the physics department is essential to increasing the number of physics teachers."

Institutional commitment to physics teacher education is evident through funding for physics teacher education programs and personnel, alignment of the institu-

PHYSTEC continued on page 7

Washington Dispatch

Updates from the APS Office of Public Affairs

POLICY UPDATE

Continued Gridlock In Washington D.C.

Congress has ceased work on spending bills for fiscal year 2015 and is now focused on a short term fix to keep the government open. On September 10, the House introduced a Continuing Resolution (CR) to fund the government through December 11, 2014, and then quickly delayed voting. The two key considerations causing the delay were whether or not to include Export-Import Bank authorization and whether the CR should last until March 1, 2015. The March date is favored by conservatives who expect the Senate to be Republican-controlled after the election and therefore wish to avoid giving the current Democrat-controlled Senate any opportunity during the lame-duck session. If the current House CR does come up for a vote, it would cut funding for non-defense discretionary spending by 0.06 percent.

All other legislation is likely dead, including an America COMPETES re-authorization that passed the House in separate smaller bills and was referred to committee in the Senate. The House passed the "Student Success Act" to replace "No Child Left Behind." But the Senate is not expected to consider the bill, having decided to focus on its own, very different version of an NCLB replacement. Even bills that seem to have strong agreement from both sides of the aisle, such as the Higher Education Act that Sen. Elizabeth Warren (D-MA) described as a "love fest," are also very unlikely to move.

WASHINGTON OFFICE ACTIVITIES

ISSUE: MEDIA UPDATE

The *Seattle Times* published an op-ed by Rachel Scherr, a senior research scientist at Seattle Pacific University, on September 15. The piece stresses the importance of boosting the number of women and minorities in STEM careers, as well the need for increasing science funding to keep the U.S. globally competitive.

Roll Call, a leading Capitol Hill newspaper, published the latest op-ed by APS Director of Public Affairs Michael S. Lubell on September 16. The piece focuses on using the "science of the future" to address challenges that include developing energy efficient automobiles.

ISSUE: POPA

The APS Panel on Public Affairs (POPA) continues its review of the APS 2007 Statement on Climate Change. Information about the process can be found at http://www.aps.org/policy/statements/climate-review.cfm

The APS Council's evaluation of the (POPA-approved) proposed APS Statement on the Status of Women in Physics is in progress; both the statement and Council commentary will be reviewed next by the APS Executive Board.

The POPA Physics & the Public Subcommittee will present a proposal for modification of APS Statement 06.3–Career Options for Physicists–at the next POPA meeting. The Subcommittee will also present a formal proposal to conduct a survey on incentives to increase the number of well-qualified students deciding to enter teaching in key STEM shortage areas.

The POPA Energy & Environment Subcommittee is investigating potential new activities associated with the 2011 POPA Report on Energy Critical Elements.

For a template for study proposals can be found online, along with a suggestion box for future POPA studies, see http://www.aps.org/policy/reports/popa-reports/suggestions/index.cfm

FOCUS ON ADVOCACY

Rachel E. Scherr is a senior research scientist at Seattle Pacific University working on physics education research. Rachel became interested in advocacy as the only girl in her high school physics class, and then as an editor of a feminist newspaper in college. Recently Rachel worked with the APS Office of Public Affairs and authored an Op-Ed piece in the *Seattle Times*. The Op-Ed discusses the need for physics to close the gender gap, the need for robust science funding, and the role that Congress has to play in rectifying the current lack. [link to op-ed: bit.ly/1oPEKXx]

The APS Office of Public Affairs is here to help you make a difference. To get your story across to local media and members of Congress, contact Tyler Glembo at glembo@aps.org.

Profiles In Versatility

Making A Career of Putting Numbers on Nature

By Gabriel Popkin

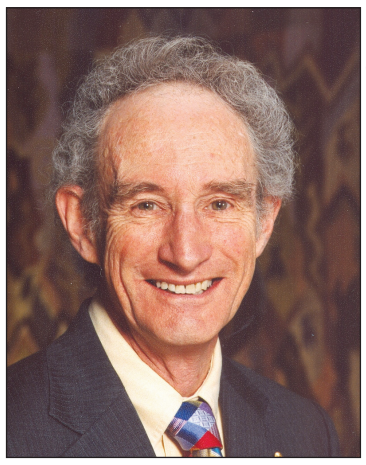
In 1969, a young theoretical physicist named Robert May decided he'd try a little ecology. "It all happened very accidentally," he insists. May, who was working at the University of Sydney in Australia, had joined a group that was supposed to promote social responsibility in science–it was the '60s, after all–but he realized he didn't know what he was supposed to be socially responsible about. So he picked up one of the era's major environmental science textbooks to study up on things like how to keep ecosystems from collapsing. According to the book, most ecologists believed that a more diverse ecosystem would be more stable than a less diverse one, meaning the populations of the species in the more diverse ecosystem would vary less from year to year. But the author of the book noted that based on his own experience, he found this hard to believe.

May too found it hard to believe. So he went home and began tinkering with the Lotka-Volterra equations, a famous ecological model developed in the 1920s (by two physicists) to describe how two interacting animal populations–predators and prey–will change over time. May found that adding species to the model–increasing the diversity–caused the population swings to increase, not decrease. The next day he went to the head of his university's biology department and told him, "Here's this basic principle that seems to be a bit of nonsense."

The department head replied that he didn't think math had anything to do with ecology, but nevertheless invited May to give a seminar. Encouraged, May went on to work out a more general mathematical ecosystem model, showing that strong interactions between species can decrease the overall stability of a food web. The work expanded on a theorem developed by Nobel Prize-winning quantum physicist Eugene Wigner; May notes with pride that the rule is now known as the "May-Wigner theorem."

May eventually published a 1972 *Nature* paper showing that no simple relationship exists between complexity and stability in nature. With the work, May overturned "one of the really pervasive urban legends" in the field, says Stephen Carpenter, an ecologist at the University of Wisconsin-Madison. "I think he gets a fair amount of credit for bringing a clarity of thinking into that whole branch of ecology."

"I discovered I'd wandered into an area which, by virtue of the stage it was at, was possibly more suited to my skills," May reflects, "which were more the skills of the golden age of physics in the 1930s, when there were all sorts of elegant, simple things to do." Using his physicist's eye for underlying patterns in complex phenomena, May has pursued a one-of-a-kind career studying everything from biodiversity and fisheries management to infectious diseases and banking systems. His success has led to posts advising top government and financial officials in the U.S. and Britain, as well as a knighthood. (In 2001, May became, to the delight and, perhaps, envy of his science colleagues, Robert, Lord May of Oxford.)



Royal Society

Robert May

May began his career in the 1950s in superconductivity theory. His PhD work at Sydney involved a major calculation on Australia's first mainframe computer, which, he says, "left me with abiding desire to deal with computers through the medium of graduate students." Although he had some early successes in physics—he calls a result on the behavior of elementary particles in two dimensions "the most elegant thing I did"–May began to realize he was a pencil-and-paper theorist living in an increasingly computerized age, and found himself gravitating toward ecology and its mathematically simpler problems.

The turning point in May's career came in 1971, while on a fellowship supposedly to study physics at the Institute for Advanced Study in Princeton. On a recommendation from a colleague, May went over to the university to meet Robert MacArthur, possibly the world's most famous theoretical ecologist at the time. MacArthur's career mission had long been to put ecology, still largely an observational science, on a more solid quantitative footing, but his ambitions sometimes exceeded his mathematical grasp. As soon as they began talking, May started to see solutions to the famous ecologist's problems, but the meeting was cut short when a colleague called MacArthur away.

The two men met again a short time later, and MacArthur confessed he had arranged to be interrupted in case May was wasting his time. MacArthur then told May he was dying of cancer, and offered the Australian his job. May was flattered but declined, protesting that he wasn't ready to move halfway around the world; MacArthur died the next year, his life's work incomplete. But May continued mulling the offer, and his wife eventually convinced him to call the Princeton department chair and ask if the job was still available. The position was still open, and May accepted. "That couldn't happen even at Princeton today," he marvels. "I didn't even ask about salary."

At Princeton, May's ecology career began in earnest. His 1973 book *Stability and Complexity in Model Ecosystems* quickly established him as his generation's most prominent theoretical ecologist. He scored another coup a few years later, with a study of a mathematical model in population biology, the "logistic map." The map predicts how populations of insects and other species with distinct generations change from year to year. Surprisingly, May found that if a population's growth rate–the number of offspring per individual per year–was larger than around 3, its predicted final value never stabilized. Instead the value began flipping between two numbers. When May made the growth rate even larger, the final population began flipping between four numbers, then eight, and so on. He called this pattern "period doubling." At high enough growth rates even the period doubling broke down, and any apparent relationship between the population's values in successive years vanished.

May presented his results at the University of Maryland, College Park, and admitted he didn't understand his model's behavior at high growth rates. James Yorke, a mathematician at Maryland, then jumped up from the crowd and said, according to May, "'I know what happens there but I didn't know about this period doubling stuff.'" The two researchers fleshed out the details and showed that from a simple, deterministic model they could get results that were almost impossibly complicated.

Yorke named the concept "chaos," and the field exploded. May published his analysis in a 1976 *Nature* article entitled "Simple mathematical models with very complicated dynamics." The paper has received over 5,000 citations, many from disciplines far beyond ecology. Once again May had challenged the notion of an orderly balance in nature, and introduced instead the disturbing idea that even seemingly simple natural systems could behave unpredictably, fluctuate wildly, and crash without warning.

But chaos did come with a "grace note," May says. A graduate student of his, George Sugihara, later showed that unlike completely random events, chaotic phenomena can be predicted a few time steps into the future. On the strength of that work, Sugihara was hired by financial giant Deutsche Bank to model stock futures, and earned a salary unheard of in academic circles. He later returned to academia, and he and May, along with others, are now using their insights to provide mathematical tools for

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ELEMENTS continued from page 1

of the APS Panel on Public Affairs and lead author of the report. (See http://www.aps.org/policy/reports/popa-reports/energy-critical.cfm)

The report made several recommendations to the federal government. The authors urged federal agencies to collect and distribute information on energy-critical elements across the life-cycle supply chain, create a research and development effort focused on energy-critical elements and possible substitutes, and improve rates of post-consumer collection of products containing energy critical elements.

Several bills have been brought forward in Congress to address these recommendations on a federal level, but thus far none have passed. The most recent, H.R. 1022 authored by Rep. Eric Swalwell (D-Calif.), failed on the floor of the House at the end of July. Ironically, it failed even though it garnered more than a hundred more yays than nays (with yays from both sides of the aisle). The bill was voted down because it was considered under a procedure that suspends the normal rules of the House, so it required a two-thirds majority to pass.

The bill came under fire from conservative groups who criticized the proposed government programs as market interference. "It was kind of brought about by the Heritage Foundation putting out some info and letting members know that they didn't support the bill," APS policy analyst Mark Elsesser said. "They viewed the bill as the government stepping in where private businesses could have done it themselves."

The press release from the Heritage Foundation stated that "… rather than create an expensive new government program, Congress should deregulate the market for rare earth elements and energy critical elements," and urged Congress to reject the bill. "Fortunately there have been other activities that have helped to further some of the recommendations in the report," Jaffe said.

Since the report was published in 2011, the Department of Energy established the Critical Materials Institute energy innovation hub at the Ames Laboratory at Iowa State University. The Institute researches new ways to expand and diversify production of these elements and develops new ways to reduce waste and identify potential substitutes. Other researchers around the country, including Jaffe at MIT, have been devoting more attention to finding substitutes for these elements.

In addition, the budget at the U.S. Geologic Survey's Mineral Resource Program has stabilized, ending a several-year decline in funding. The program tracks the supply lines and sources of a wide range of materials, including the so-called energy critical elements.

"We collect information on a variety of minerals and commodities that are used for a variety of different things," said Lawrence Meinert, the program's coordinator.

"We look at the whole range of elements of the periodic table in terms of tracking them."

Much of the data collection that the APS report recommended would be an expansion of what the program already does, and Meinert said that the report was helpful in highlighting improvements to the program. He added that the proposed legislation would have allowed the program to further ramp up its data collection and analysis. "The report did a very good and accurate job of assessing the situation and identifying where the USGS and other agencies can contribute," Meinert said.

APS has also started working more at the local level to improve the recycling recommendations of the report. Recycling is a promising method to recover rare earth elements, because they're usually found in higher concentrations in recycled consumer electronics than in natural ores. "Because we've seen some stalls in Congress," Elsesser said, "our office has started taking a state approach."

For example, Elsesser has been working with the Michigan legislature on preparing a bill that would offer incentives and other requirements to promote more electronics recycling in the state. "We're looking at hopefully introducing a bill in the state and having it focus on cell phone recycling," Elsesser said. "We're looking for sponsors of that legislation going forward." He said the aim is to get the cell phone recycling rate in Michigan above the state's goal of thirty percent, and he hopes to have some kind of legislation introduced in the fall, election permitting.

Though efforts to shore up the supply chains of these elements have started moving forward since the publication of the APS report, Jaffe said that the lack of federal legislation is an obstacle. "I think that it's baby steps," Jaffe said. "We're living in an age when a lot of these energy and materials issues are of critical importance and these steps are in general not ones that are going to have a significant impact."

He added that given the current political climate, he was not optimistic that Congress could pass a bill that did much more than ensure the stewardship of information about these materials. Though it seems that federal funding for significantly more research into these issues is unlikely in the near future, having scientists discuss potential supply problems and developing alternatives individually could start to change the attitudes of lawmakers over the long run.

"I think that kind of grassroots activity could raise consciousness and develop real security with respect to these elements," Jaffe said.

DOE continued from page 1

member of CHORUS. "I honestly don't see any major shortcomings of the policy."

Response from open access activists has been mixed. "The idea that articles are made accessible is one thing, and I think the DOE's plan does this. But making sure that the articles are usable by the public is another thing, and we don't think the DOE's plan does that," said Heather Joseph, director of the Scholarly Publishing and Academic Resources Coalition (SPARC), an organization advocating for more open access. She added that they would have preferred to see options for bulk downloading, text analysis, and rights to access manuscripts from institution's servers.

The access plan requires researchers to make the articles available at the end of the embargo period, and the OSTP would prefer the version of record, but publishers are not told how to help authors comply. "There are some places in [the plan] where it seems to be to be slightly ambiguous," Serene said. "I think those ambiguities will get sorted out in the days and months to come."

The version of record is the published version of the article that is posted on the publisher's web site. The author's accepted manuscript has changes made from the peer review process, but not the final copyediting and conversion into the XML code used by publishers for serving and archiving the article. "The differences are minimal," Serene said. "If you look at what the actual content of the paper is once it's been through the referee process, the content is essentially the same." Gene Sprouse, Editor in Chief of the APS journals adds that "APS has always allowed authors to post the version of record on their or their institution's website, and in many cases the author's final manuscript is already available on the arXiv preprint server."

The text of the DOE plan reads, "Under this proposal, the best version of the article is the [Version of Record] hosted by the publisher. In cases where this is not publicly accessible, the Department will provide access to accepted manuscripts in publicly accessible repositories."

Hitson said that DOE ideally would like to point the public to the versions of record, but if that version isn't made available by publishers, the author's manuscript would be an acceptable substitute. "It's economical and more or less ticks off all the points in the OSTP memo," Hitson said.

The plan also calls for the creation of a large "dark archive" of manuscripts maintained by the DOE's OSTI, which would be published if a publisher refuses to post a version on its own website. Papers stored on the archive will ordinarily not be accessible to the public, unless that's the only free version available. CHORUS is working with partners to create an archive of publisher content, which would become available if publishers fail to keep the articles publicly available.

Joseph said that she and her organization were hoping for the formation of a centralized archive like this, but one that would be open to the public. "They're collecting the papers simply to preserve, not to utilize," Joseph said. "It's almost like they came right up to the edge and then said 'Well, we collected them but we're going to keep them dark.'"

Each federal agency is free to develop its own policy for open access, but in leading the way, DOE's system may serve as a model for others.

MAY continued from page 5

managers of fisheries and other natural ecosystems.

May's research has ranged widely in ecology and biology, among other things helping to revise upward biologists' estimate of the number of species on Earth. He has also touched on issues of more direct human concern. A few years after HIV was discovered, May and a colleague simulated how it would spread in Africa. May's team's model was deliberately simple, focusing on a few key factors like infection rates between sexual partners. The World Health Organization developed a much more complicated model with far more detailed demographic data, and predicted the disease would spread more slowly. May's group was criticized for its gloomy prediction, May said in a 2012 BBC interview, but, he added, "sadly, we were right."

After his 15 years at Princeton, May and his wife decided to try living in England, so May took a joint position at Oxford and Imperial College London. May's career took another surprise turn in 1995, when he was tapped to be chief scientific advisor to then-prime minister John Major. The British government had been embarrassed by recent science-related blunders, including an incident in which a scientific panel concluded that the rogue protein that causes mad cow disease could never jump to humans (which it was later shown to do, with devastating effect). The government needed a credibility boost, and the brilliant and sometimes blunt May was a good person to provide it. As scientific advisor, May developed protocols for how scientists should and should not advise politicians; his philosophy is that "the role of the scientist is not to tell people what to do, but to tell them what the facts are."

May returned to university life in 2005, after five years in government followed by a five-year stint as president of the Royal Society. Much of his recent work has focused on economics. In 2006, before anyone outside financial circles was talking about subprime loans, then-Federal Reserve Bank of New York president Timothy Geithner and colleagues at the National Academy of Sciences had started worrying about whether the enormous risks that banks were taking with their money could put the entire financial system at risk. Thinking that knowledge of ecosystems and food webs might yield insights into the interconnected banking world, the economists tapped Sugihara, who brought in May, and the two, along with prominent Princeton theoretical ecologist Simon Levin, wrote a paper in *Nature* called "Ecology for Bankers." May says that while he and his colleagues weren't able to prevent the 2008 financial crisis, they did confirm some important intuitions–for instance, that big banks needed to hold onto a larger fraction of their capital, rather than put nearly all their money into play, as they had before the crisis. More recently May and Andy Haldane, the Bank of England's chief economist, published a paper, also in *Nature*, advising governments on how to avoid future financial collapses. Harkening back to May's work in the 1970s on ecosystem stability, the two called for increasing the stability of the banking system by limiting its overall interconnectedness.

At a birthday gathering several years ago, May reflected to colleagues and former students that no one today could enter ecology the way he did, simply striking up collaborations and immediately seeing ways to advance the field. "It is much more quantitative now than it was when he was entering in the early 70s," says Anthony Ives, a University of Wisconsin-Madison ecologist and former May graduate student. "And to a large extent Bob is responsible for that." For his part, May is quick to credit Ives, Sugihara and his many other protégés for continuing to expand the scope of theoretical ecology. "I've been very lucky in some of the graduate students I've had," May says.

While he made his mark in other fields, May credits his physics background for launching and sustaining his unique and diverse career. "I've hopped around a lot," he admits. "I have a short attention span; I like doing new things."

Fortunately, he adds, "If you have a good background in theoretical physics you can do anything."

FORUM continued from page 4

and continue sharing their research over the years. Consequently, the YPF has the potential to lead to many fruitful interdisciplinary and/or international networks and collaborations throughout the participants' careers.

Through this combination of scientific, career development, and networking opportunities, the U.S.-China Young Physicists Forum will allow students to connect with peers and network with eminent scientists in condensed matter physics and materials physics from the United States and China. Moreover, it will foster an appreciation for international scientific collaboration among young physics researchers, and promote long-term connections among graduate students from the two countries. These early insights will prepare both U.S. and Chinese physics students for future scientific leadership and international scientific partnerships.

More information regarding application submission, registration, and the program will be available at www.aps.org/international. In the meantime, I ask APS members to share news of the U.S.-China Young Physicists Forum with their colleagues in condensed matter physics and materials physics, and to please encourage graduate students in condensed matter and in materials physics to participate. Please feel free to contact me at Flatten@aps.org with any additional questions.

The author is Director of International Affairs for the American Physical Society.

ANNOUNCEMENTS

APS Congressional Science Fellowship 2015-2016

All application materials must be submitted online by close of business on January 15, 2015 (5:00 PM EST).

The American Physical Society is accepting applications for the **Congressional Science Fellowship Program**. Fellows serve one year on the staff of a senator, representative or congressional committee. They are afforded an opportunity to learn the legislative process and explore science policy issues from the lawmakers' perspective. In turn, Fellows have the opportunity to lend scientific and technical expertise to public policy issues.

Qualifications include a PhD or equivalent in physics or a closely related field, a strong interest in science and technology policy and, ideally, some experience in applying scientific knowledge toward the solution of societal problems. Fellows are required to be members of the APS.

Term of Appointment is one year, beginning in September of 2015 with participation in a two-week orientation sponsored by AAAS. Fellows have considerable choice in congressional assignments.

A Stipend is offered in addition to allowances for relocation, in-service travel, and health insurance premiums.

Application should consist of a letter of intent of no more than two pages, a two-page resume with one additional page for publications, and three letters of reference.

APS physics

http://www.aps.org/policy/fellowships/congressional.cfm

Reviews of Modern Physics

Beam by design: Laser manipulation of electrons in modern accelerators

Erik Hemsing, Gennady Stupakov, Dao Xiang, and Alexander Zholents

Lasers can be used to modify both the overall and internal structure of electron beams. This paper reviews the use of lasers for creating beams tailored to a number of different purposes, including synchrotron light sources and free electron lasers. In addition, beams can be conditioned, heated, and diagnosed with lasers.

http://dx.doi.org/10.1103/RevModPhys.86.897

http://journals.aps.org/rmp

Physics Teacher Education Coalition

PhysTEC 2015 Conference

The nation's largest meeting dedicated to physics teacher education

February 5-7, 2015

Seattle, Washington

Featuring a pre-conference Learning Assistant Workshop

Building Thriving Programs

APS physics http://www.phystec.org/conferences/2015 AAPT

Held in conjunction with

Building a Thriving Undergraduate Physics Program workshop

- Develop strategies for increasing enrollment of physics majors
- Send teams of 2-4 faculty members
- Participants will analyze their departmental situation and decide how to take actions that will help them sustainably achieve their goals.

February 6-8, 2015
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dinates somewhat with APS headquarters when getting started, but the goal is for the groups to become self-sustaining, involving local physicists and students to run them. "We're trying to encourage groups not to design a very rigid, talk-heavy program," Bailey said, adding that she hoped the different regions would meet about once every six weeks.

At the inaugural meeting of the Washington, DC area chapter on September 17, about thirty people from a range of backgrounds showed up to meet and mingle. "For all of us, networking is a big thing," said Erika Jones, a PhD candidate at George Mason University in Virginia. "It's a great opportunity to meet folks and get information."

Greg Harry, a physics professor at American University in DC, brought a number of students from his school to the event. "It's important for students to get a sense of the breadth of physics," Harry said. "Especially at a place like American where there's not that big of a faculty."

The program came out of the recent APS strategic plan recommendation to reach out more to students and especially to industrial physicists. "That is part of the ongoing mission of APS, to strengthen our relationship with that community of physicists," Bailey said.

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which direction is north.

Scientists often scoff at reports of the face of a famous person appearing in a piece of toast or a water stain. However Kang Lee of the University of Toronto wanted to see if there was a reason that these supposed manifestations were so widespread.

"We are looking at the phenomenon in perceptual psychology called face pareidolia, seeing nonexistent faces in everyday objects," Lee said. "The question we had was if that was a brain anomaly or was that the normal perceptual process?"

He had his subjects look at a series of images with random blotches on them. For half of his subjects, he told them there was a face embedded in the image, while for the other half he never mentioned anything about a face. Of the people to when he suggested the idea of a face, 100 percent of them identified faces on at least one of the images shown to them.

After scanning his subjects with an FMRI machine, he found that because recognizing faces is so important to human interaction, there is a section of the brain dedicated to just that. In addition, this brain machinery is so responsive and suggestible that it leads to a lot of false positives.

"That means that our beliefs, our expectations are very, very strong. It actually can influence strongly our perception of the world because we tend to believe what we see is what is real out there." Lee said. "But sometimes what we see is really what is up there in our head because the frontal area of the brain is regulating the visual cortex, which is in the back part of the brain."

Other winners included:

- Peter Jonason from University of Western Sydney and his team "for amassing evidence that people who habitually stay up late are, on average, more self-admiring, more manipulative, and more psychopathic than people who habitually arise early in the morning."
- Jaroslav Flegr of Charles University in Prague and his team "for investigating whether it is mentally hazardous for a human being to own a cat."
- Marina de Tommaso of the University of Bari in Italy and her team "for measuring the relative pain people suffer while looking at an ugly painting, rather than a pretty painting, while being shot [in the hand] by a powerful laser beam."
- Eigil Reimers of the University of Oslo in Norway and his team "for testing how reindeer react to seeing humans who are disguised as polar bears."

PHYSTEC continued from page 4

tional mission with physics teacher education, and establishment of infrastructure supporting physics teacher education. Institutions that sustained increases in physics teacher production over the long term were those that provided significant support to their champions. At various sites, this support has included tenure and salary increases, appointment of champions to influential administrative positions, and a mandate to dedicate substantial effort to the program. Many institutions also continued funding for expert high school physics teachers designated Teachers in Residence, who recruit undergraduates, teach content courses, and mentor future physics teachers.

The PhysTEC project is led by APS, in partnership with the American Association of Physics Teachers. Since 2001, the project has funded more than 30 institutions to transform their physics teacher education programs into national models. Collectively, these sites have more than doubled the production of graduates who are well prepared to teach high school physics. The PhysTEC coalition has over 300 member institutions committed to the mission of improving the education of future physics teachers. PhysTEC receives support from the National Science Foundation and the APS 21st Century Campaign. The full report can be downloaded at: http://www.phystec.org/sustainability.

This article was prepared by the PhysTec project staff.

The Back Page

The Aikido of Assessment: Redirect Rather than Fight

By Charles Henderson

As faculty members and chairs, many of us are under pressure to become more involved in course and program assessment. This trend in higher education can seem like an unwelcome burden on our time that does not contribute to our own intellectual advancement or our department's well-being. But, as you can learn from any good martial arts movie, often the best way to defend against an unwanted advance is not to try and directly stop it, but to redirect your opponent's momentum and energy to your advantage. If we treat assessment as busy work then that is what it becomes, and everyone's time is wasted. Instead, that same time and energy can be used to work towards something that is meaningful for us, our students, and our departments.

Know your opponent

Successful redirection of assessment pressures requires that we understand their origins. Much of the current emphasis on assessment is channeled through the regional accreditation process. Rather than have a government body, such as a ministry of education, that certifies the quality of higher education institutions, higher education institutions in the United States are accredited by one of six nonprofit regional accreditors. Accreditation is not legally required, but is necessary for participating in federal financial aid programs (such as Pell Grants).

Over the years, accreditation standards have shifted from a focus on inputs and resources (e.g., student-to-faculty ratio), which are easy to document at the institution level with little input from faculty, to a focus on documenting student learning outcomes, to the current focus on continuous improvement. Both of these new foci depend on faculty and department engagement. The rigor of the accreditation process has also increased significantly as a result of the increased political pressures on higher education institutions to demonstrate their value, both to individual students as well as to the national economy.

A key component of the accreditation process is a self-study carried out by the institution. A self-study includes comprehensive documentation of educational processes and measures of student outcomes. A common way for institutions to prepare the accreditation self-study is through ongoing program review. This is where faculty typically are recruited (or obliged) to participate.

Analyze the Situation

One big problem with the program review process is that the data used for program review are completely different than the data used to make personnel decisions, such as tenure and promotion. In fact, as I show in Figure 1, there are four different assessment processes operating at once. The arrows indicate how information should flow among these processes, but in reality they operate independently. Ideally, instructors would collect course-level data for the purpose of course improvement. These data would be summarized for personnel decisions (with an emphasis on instructor performance and development) and program improvement (with an emphasis on student performance and development). The information from multiple courses that departments use for program improvement would be summarized for program review. Finally, the bi-directional arrow between course and program improvement indicates that individual courses may need to be adjusted based on program-level data.

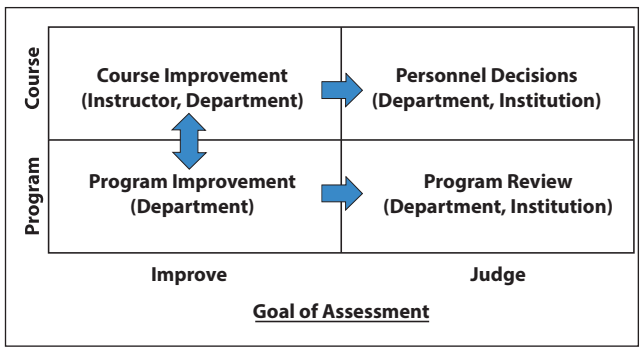

Figure 1. Ideal relationships among the four core assessment processes. The four assessment processes should inform one-another, but typically do not.

We can see the problems and possible solutions in play at the course level. In a recent interview study, Melissa Dancy, Chandra Turpen, and I interviewed 72 physics faculty at 4- and 2- year institutions [1]. We asked them what data sources they use for course improvement and what data sources their institution uses to judge their teaching performance. Unfortunately, as the results show in figure 2, faculty and institutions use almost completely different sources of data. The situation is actually even worse than the figure suggests. Of those instructors who say that they use student evaluations of teaching, most indicated that they really value only the written student comments, while the institution values only the numerical ratings.

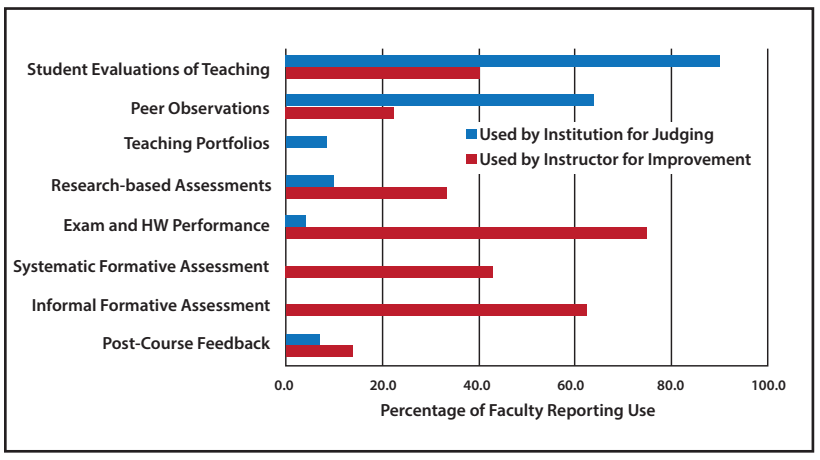

Figure 2. Data used for course-level assessment. Instructors use almost completely different data sources for course improvement than institutions use for judging teaching performance.

This difference between instructors valuing written student comments and institutions valuing numbers is indicative of most mismatches between the four assessment processes. The problem, of course, is that an instructor cares about and can make use of very detailed contextual information. Administrators, even department chairs, are not familiar with the context of each class and need quantitative summaries of big-picture issues. A big part of an administrator's job is to compare faculty. Using average ratings on a few key items (e.g., overall course quality, overall instructor quality) is a very easy way to do this.

This same mismatch occurs at the program level. Program review criteria are based on broad student outcomes that are relevant to many disciplines, such as critical thinking, quantitative reasoning, and written communication. These are difficult to measure. Lacking explicit guidance, most instructors and departments do the easiest thing they can: Use a test they have given as evidence that students had to think critically, solve a quantitative problem, and/or express themselves in writing. This kind of documentation feels like busy work for everyone involved, does not result in high quality program review data, and does little to support program improvement.

Redirect

The situation doesn't have to be like this. One way to improve assessment is to develop metrics that are quantifiable, but of interest to both faculty and administrators. For example, it might help to ask students how much they think they learned, rather than how good they think the instructor is. Even better would be for educators to use research-based assessment tools that have been developed by physics education researchers over the last few decades. The most user-friendly of these are carefully developed and validated multiple-choice conceptual tests, such as 30-item Force Concept Inventory (FCI). These tests have been very useful for individual faculty to understand the level of student learning in their courses. Administrators do not usually ask for these scores because similar tests do not exist in many disciplines. However, my experience has been that a summary score of class performance that puts the scores in context by comparing them to other similar classes elsewhere is seen favorably by administrators. PhysPort (https://www.physport.org/), a site developed by the American Association of Physics Teachers to help physics faculty find and use resources based on physics education research, is in the process of developing online assessment resources to help faculty do this more effectively.

Individual instructors can aggregate assessment data as discussed above. But real progress in assessment comes when groups of faculty work together on course and program improvement. For example, the physics department at the University of Colorado Boulder, has written about their program improvement process [2]. One of the starting points was the upper-level E&M course. The first step was to identify course goals. This differs from typical faculty discussions, which focus on topics (e.g., magnetostatics, electromagnetic waves). Discussions at this level rarely focus on what students should know or be able to do. When assessment folks talk about course goals, they usually emphasize starting from detailed measurable outcomes for each topic. In my experience, this approach is also not very useful.

In contrast, Boulder focused on course goals by asking the core questions "What is Junior E&M I about? How is it different from the introductory E&M course?" This framed the discussion in a way that was easy for instructors to understand and value. A total of 13 instructors met 7 times to set course goals based on these questions. They were supported by a postdoc who helped to keep things on track. The final set of specific goals for Junior E&M I was associated with eight broad learning goals (e.g., math/physics connection). Using these broad goals, each of the course topics could then be operationalized into a small number of topic-specific learning goals (e.g., "students should be able to write down, and explain in words and pictures, the full set of Maxwell's Equations"). These broad goals also provided the scaffolding for development of goals for other upper-level courses. (See the web site for more details: http://www.colorado.edu/sei/departments/physics_learning.htm).

The Boulder faculty then developed a diagnostic test to assess student progress towards the goals [3]. This test was open-ended, but could be scored relatively easily. Faculty felt that the questions were meaningful and, thus, valued the results. Like the FCI, test results could be summarized for comparison of outcomes for the course taught in different ways as well as for reporting on student learning as part of program review. Further, the 8 broad goals facilitated discussion among faculty about upper-level instruction, promoted program development, and enabled the department to track student progress through its program.

Similar department-level improvements were achieved by the physics department at University of California, Merced. They developed a set of five broad program learning objectives (e.g., mathematical expertise) that are assessed for each student throughout the undergraduate physics program. In keeping with Figure 1, as much of the data as possible is collected within individual courses (e.g., as part of a final exam) and summarized for program improvement, then summarized more for program review. Scoring tools (i.e., rubrics) guide this process of summarizing student performance on each objective, based on predetermined criteria.

Start from where you are

It is neither necessary nor advisable to immediately conduct a comprehensive overhaul of your assessment processes. Instead, I suggest that you eliminate wasted work by aligning some data collection that you are already doing to serve the multiple assessment processes shown in Figure 1. Accomplish the easy alignments (e.g., more use of standardized measures of content understanding, such as the FCI) and then tackle the harder areas in which tools are less well developed. Physics has been a leader in the development of innovative teaching strategies. We now have the opportunity to be leaders in working with the assessment movement to redirecting currently wasted energy towards goals that we all value–improving education for students in our courses and programs.

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