APS NEWS

A PUBLICATION OF THE AMERICAN PHYSICAL SOCIETY • WWW.APS.ORG/PUBLICATIONS/APSNEWS

May 2010
Volume 19, No. 5
www.aps.org/publications/apsnews

The Futurama of Physics
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Who Created this Drawing?

One of the iconic physicists of the 20th century was an enthusiastic artist, often making drawings or paintings of live models. To find out who created the drawing, please turn to page 5.

Council Passes Addendum to Climate Change Statement

In a process that began more than a year ago, APS Council has passed an addendum to the 2007 climate change statement. The vote on the addendum at the April 18 Council meeting was 31 in favor, 2 opposed, and one abstention. This document, which runs more than 800 words, is now an official appendage to the 157-word statement, and appears as such in the "Policy and Advocacy" section of the APS website.

The addendum was crafted as a commentary on the 2007 statement by a subcommittee of the Panel on Public Affairs (POPA). The final wording of the Commentary involved input not only from the subcommittee, but also from POPA itself and from the broad APS membership. Prior to consideration by Council, the Commentary had also been given unanimous approval by the APS Executive Board.

The subcommittee was chaired by Duncan Moore of the University of Rochester. Other members were John Browne, James Drake, and Frances Houle. Moore had been Chair of POPA in 2009.

The reason for the addendum is stated in its first paragraph: "There is a substantial body of peer reviewed scientific research to support the technical aspects of the 2007 APS statement. The purpose of the following commentary is to provide clarification and additional details."

Among other things, the Commentary addresses the use of the word "incontrovertible" in the original statement: "The evidence for global temperature rise over the last century is compelling. However, the word 'incontrovertible' in the first sentence of the second paragraph of the 2007 APS statement is rarely used in science because by its very nature science questions prevailing ideas. The observational data indicate a global surface warming of 0.74 °C (+/- 0.18 °C) since the late 19th century. (Source: http://www.ncdc.noaa.gov/oa/climate/globalwarming.html)."

The last paragraph of the addendum contains a suggestion for further involvement by the physics community: "With regard to the last sentence of the APS statement, the role of physicists is not just '... to support policies and actions...' but also to participate actively in the research itself. Physicists can contribute in significant ways to understanding the physical processes underlying climate and to developing technological options for addressing and mitigating climate change." The full text of the addendum, and of the 2007 statement, is available on the APS website at www.aps.org/policy.

Last fall, an ad hoc commit-

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Council OKs Constitutional Amendment, and Approves Expansion at Ridge

In a busy meeting on April 18, APS Council did more than just approve the addendum to the climate change statement (see story above). Among other highlights of the meeting, they approved an amendment to the APS Constitution that would, if adopted, create 4 International Councilors. They also approved an expansion and renovation of the APS editorial office building in Ridge, New York, that would add more than 50% to the current space.

Last year, the APS Committee on International Scientific Affairs (CISA) recommended the creation of International Councillors, noting that 21% of APS membership resides outside the US (this rises to about 25% if one looks at the non-student component of membership). APS Director of International Affairs Amy Flatten developed this idea in a Back Page in the January *APS News*. The matter was referred to the APS Constitution and Bylaws Committee, chaired by Jeff Urbach of Georgetown. They recommended eliminating the current International Councilor, who serves a 2-year term, and replacing 4 of the 8 General Councilors with International Councilors, who would be required to come from outside the US. These new International Councilors would serve 4-year terms; each year, the APS membership would elect one International Councilor and one General Councilor, instead of the 2 General Councilors that they now elect. The APS Nominating Committee would be responsible for recruiting candidates for International Councilor, paying due attention to geographic diversity.

Urbach said that this arrangement is preferable to simply instructing the nominating committee to include international candidates among those running for General Councilor, because people tend to vote for candidates they are familiar with, thereby giving the domestic nominees an *a priori* advantage that would preclude the election of an appropriate number of international representatives.

Now that Council has passed this amendment, the text will be printed in a forthcoming issue of *APS News*, and will appear on the ballot for the Society election this summer. If approved by two-thirds of those voting, the amendment will become part of the APS Constitution.

The Ridge expansion is motivated by the inexorable rise in the number of manuscripts submitted to APS journals, which is now running in excess of 3% per year. The current space is inadequate to house the personnel needed to process the manuscripts and manage the editorial process. Because the facility is located in the Long Island pine barrens, the footprint of the building cannot be arbitrarily extended. Consequently, the plan is to add 18,000 square feet by building a second storey. Careful scheduling will allow this construction to take place while work goes on in the building, without need for temporary relocation to another site.

In addition to the expansion, APS President Curtis Callan remarked that it is also important to renovate and redesign the entire space. He pointed out that the nature of scholarly publishing is changing rapidly, and that APS has to be on the leading edge of these developments. This requires a staff with an increased level of sophistication, which calls for an improved working environment that is not predicated on the old paper-based model of journal publication.

A project management firm and an architectural firm have been engaged, and, in the wake of Council approval, bids for construction are set to go out in June. If all goes as anticipated, construction will start in the late summer of 2010 and will be completed sometime in 2011.

Video Contest Reaches Out with Lasers

To help celebrate the laser's fiftieth anniversary, APS's outreach department is holding a video contest with a $1,000 grand prize for the winning video. The contest, run through the APS outreach website PhysicsCentral.com, is aimed at a wide variety of people who are interested in physics and science.

"We really want to make sure we're engaging the public and not just informing them," said Becky Thompson, APS's head of public outreach. "With a video contest we can get a whole range of people to participate."

This year's video contest is laser-themed in conjunction with LaserFest, the yearlong celebration of the fiftieth anniversary of the invention of the laser. Modeled after previous years' successful Nanobowl and ToyBox Physics contests, the LaserFest video contest invites contestants to create videos that use lasers in some way to highlight a physics concept. The idea is not necessarily to demonstrate how a laser works or show off the physics of lasers, but just to incorporate lasers and physics together into the video. The contest organizers have intentionally left directions about the content of the videos open-ended to foster as much creativity in submissions as possible.

"One of the neat things about the video contest is that we leave it vague," Thompson said. "I don't know exactly what I'm expecting, and I kind of like that."

Last year's ToyBox Physics contest invited participants to create a video that shows some concept of physics with toys. Demonstrating physics using football was the theme in 2008, the first year the contest was held. Past winners can still be found on the Physics Central website and YouTube.

The organizers aim to have each video be about two minutes in length and somehow use lasers to demonstrate a physics concept. The contest is open to anyone who wants to participate. Previous contestants have ranged from elemen-

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Where's the Fire?

Photo by Nick Romanenko, Rutgers University

No, this isn't a bizarre new version of Roller Derby using fire extinguishers. It's a demonstration by Rutgers professor Mark Croft of Newton's Third Law for a large and appreciative audience. For more on physics demos, please see page 6.

Members in the Media

"This is a great step they've made… But there are a lot more steps to get to what you and most people imagine when you think of cloaking devices."

***David Schurig**, North Carolina State University, on a meta-material made by a team of German physicists that can cloak objects in a wide range of wavelengths,* MSNBC.com*, March 18, 2010.*

"No practical scenarios of an attack on the real power grid can be derived from such work."

***Reka Albert**, Penn State, on an article in a Chinese science journal about the vulnerability of the US power grid,* The New York Times*, March 20, 2010.*

"As you might imagine, waiting 20 years is a pretty nasty chore,"

***Roy Weinstein**, University of Houston, after receiving a patent for superconducting magnets he first applied for in 1990,* The Houston Chronicle*, March 25, 2010.*

"You fund for a very short period of time–two years, three years -maximum–in hopes of opening up something big. So we are saying, swing for the fences."

***Steven Chu**, Department of Energy, on funding energy research,* Newsweek*, March 26, 2010.*

"He came in saying he was going to make decisions based on science. In this case, I think it was a political debt to Harry Reid."

***Thomas Cochran**, Natural Resources Defense Council, on President Obama's decision not to use Yucca Mountain to store nuclear waste,* The Seattle Times*, March 28, 2010.*

"This is the end of the beginning…The real fun now will be making the physics measurements."

***Robert Cousins**, UCLA, on the LHC's record setting 7 TeV collisions,* The Los Angeles Times*, March 30, 2010.*

"These magnetic fields could not have formed recently and would have to have formed in the primordial universe."

***Ruth Durrer**, University of Geneva, on galactic magnetic fields,* U.S. News and World Report*, April 2, 2010.*

"When you observe something in one state, one theory is it split the universe into two parts."

***Andrew Cleland**, UC Santa Barbara,* FoxNews.com*, April 5 2010.*

"I think they have an excellent convincing case for the first observation of element 117."

***Walter D. Loveland**, Oregon State University,* The New York Times*, April 6, 2010.*

"These pigeons know each other. They know which is the smartest. The fastest bird will even follow the slower one who knows the way home the best."

***Tamás Vicsek**, Eötvös Loránd University, on how flocks of pigeons are able to efficiently navigate,* U.S. News and World Report*, April 8, 2010.*

"We can go to regions we couldn't reach or go to previously explored regions and study them for extended periods that are impossible with conventional planes."

***David Fahey**, NOAA Aeronomy Lab, on the scientific uses for NASA's remote controlled Global Hawk,* CNN.com*, April 9, 2010.*

"On average, these weapons are 30 years old. One of our weapons just had its 40th birthday."

***Bruce Goodwin**, Lawrence Livermore National Labs, on the current condition of the U.S. nuclear arsenal,* UPI*, April 11, 2010.*

"In my opinion, NIF has nothing significant to do with the safety or reliability of the [nuclear] stockpile."

***Arjun Makhijani**, the Institute for Energy and Environmental Research,* The Philadelphia Inquirer*, April 12, 2010.*

CONTEST continued from page 1

tary school students to national laboratories. To enter, contestants must post their videos to YouTube with the word "LaserFest" somewhere in the title, and send an email with "LaserFest Video" in the subject line to physicscentral@aps.org. The grand prize winner, chosen by a panel of APS staff involved in public outreach and engagement, will receive a trophy made from laser toys and $1,000. Visitors to the Physics-Central website will be able to vote for the people's choice award winner starting on May 24th. The winners of both awards will be announced on May 31st.

The deadline for submissions is May 16th, the actual date that marks the fiftieth anniversary of the first successful demonstration of a laser.

This Month in Physics History

May 16, 1960: Maiman Builds First Working Laser

Lasers are ubiquitous in 21st century society, with applications in telecommunications, DVD players, checkout scanners, cutting and welding, eye surgery, tattoo removal, dentistry, and medicine, to name just a few of the markets that make up this multi-billion-dollar industry. But it all started with one lone physicist, Theodore Maiman, who defied the doubts of skeptical colleagues to build the first working laser in 1960. That achievement earned him the moniker, "father of the electro-optics industry."

Born in Los Angeles in 1927, Maiman spent his formative years in Denver. His father was an electrical engineer and an inventor, who wanted his son to be a doctor. Instead, the young Theodore parlayed his gift for mathematics–and early job experience as a radio and appliance repairman–into degrees in engineering physics from the University of Colorado. In 1955, he completed his PhD in physics at Stanford University, under his advisor, Willis E. Lamb, who won the Nobel Prize in Physics that same year. He soon found work with Hughes Aircraft Company, and it was there that Maiman got caught up in the race to build the first working laser.

Theodore Maiman contemplates a cube-shaped ruby crystal.

The theoretical underpinnings of the laser had been around for many years. Albert Einstein first broached the possibility of stimulated emission in a 1917 paper, although wasn't until the 1940s and 1950s that physicists found a novel use for the concept. In 1953, Charles Townes patented a device he called a maser, for "microwave amplification by stimulated emission of radiation." But the technique was limited to the microwave region of the electromagnetic spectrum. Townes thought it might be possible to gain even more information by developing a device that produced light at much shorter wavelengths, extending the maser concept to the optical range. The best way to do this, he thought, would be to use molecules to generate the desired frequencies through stimulated emission.

With his colleague (later his brother-in-law) Arthur Schawlow, Townes wrote a paper detailing the concept, "Infrared and Optical Masers," and published it in the December 1958 issue of the *Physical Review*, although they had yet to build a working prototype. They received a patent for their design two years later. That paper caused a flurry of research by other scientists vying to make this theoretical device a reality. Other major companies doing research in this area–many boasting hefty federal grants–included Bell Labs, RCA, Lincoln Lab, IBM, Westinghouse, and Siemens.

Against those steep odds, Maiman won the race in the same year Townes and Schawlow received their first patent for the "optical maser." He brought both his physics and engineering training to bear on the problem. Ironically, his supervisors at Hughes initially weren't interested in having him follow that line of research–he had been hired to work on government aerospace contracts–but Maiman insisted, so he was grudgingly given a meager budget of $50,000 over nine months, and he set to work.

Other scientists had dismissed ruby as a lasing medium and were focusing on gases in their experiments. Maiman discovered errors in those calculations, and found that artificial rubies (which had fewer impurities) worked very well. Thanks to the input of his assistant, Charles Asawa, he also used pulses of light to excite the atoms in the ruby lasing medium, instead of a movie projector lamp used in earlier experiments.

On May 16, 1960, Maiman succeeded in producing a short burst of coherent light from his humble device –not a continuous concentrated beam of light, and far less powerful than many lasers today, but nonetheless, it was a working laser. More importantly, it was very easy to build. "It looked like a high school [science] project," his widow, Kathleen, said recently. "It is so simple. But [so much] physics and thought went into it."

He published his discovery in *Nature*. Townes later called Maiman's paper "the most important per word of any of the wonderful papers" that the journal had published in its 100+ years. But at first, the relevance of the accomplishment wasn't clear. "A laser is a solution seeking a problem," Maiman once observed, and while he believed in the device's potential, Hughes was less interested in developing applications.

A frustrated Maiman left Hughes and founded his own company in 1961, Korad, devoted entirely to the development and manufacture of lasers, and in 1968 he left that position to found another company, Maiman Associates. Ultimately he held patents not just for his first laser, but also related to masers, laser displays, optical scanning, and laser modulation.

The question of patent rights has proven to be a fairly litigious one, most notably in the case of Gordon Gould, a graduate student under Townes at Columbia University in the late 1950s. He later sued to earn patent rights based on his research notebook, which contained an entry dated and notarized in November 1957, describing his own design for a laser. Gould fought for decades, and in 1973 the U.S. Court of Customs and Patent Appeals ruled that the original patent awarded to Schawlow and Townes was too general, and did not supply enough information to create certain key components of a working laser. Gould was finally granted patent rights.

Other types of lasers emerged over the years, such as the dye laser, the helium-neon laser, the semiconductor laser, the carbon-dioxide laser, the ion laser, the metal-vapor laser, the excimer laser, and the free-electron laser. Maiman's humble device literally changed the world. He received several honorary degrees, induction into the National Inventors Hall of Fame, membership in the National Academies of Science and Engineering, and won the APS Oliver E. Buckley Prize in 1966. But the one honor that eluded him was the Nobel Prize: twice nominated, Maiman never won.

Maiman died from systemic mastocytosis on May 5, 2007. As for that first working laser, it is stored in a safe deposit box in a bank in downtown Vancouver, BC. The white box (wrapped in bubble wrap and Styrofoam) has a label scrawled on top in bright red ink: "Maiman's laser."

APS NEWS

Series II, Vol. 19, No. 5
May 2010

Coden: ANWSEN ISSN: 1058-8132

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

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

Subscriptions: APS News is an on-membership publication delivered by Periodical Mail. Members residing abroad may receive airfreight delivery for a fee of $15. Nonmembers: Subscription rates are available at http://librarians.aps.org/institutional.html.

Subscription orders, renewals and address changes should be addressed as follows: For APS Members–Membership Department, American Physical Society, One Physics Ellipse, College Park, MD 20740-3844, membership@aps.org.
For Nonmembers–Circulation and Fulfillment Division, American Institute of Physics, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502. Allow at least 6 weeks advance notice. For address changes, please send both the old and new addresses, and, if possible, include a mailing label from a recent issue. Requests from subscribers for missing issues will be honored without charge only if received within 6 months of the issue's actual date of publication. Periodical Postage Paid at College Park, MD and at additional mailing offices. Postmaster: Send address changes to APS News, Membership Department, American Physical Society, One Physics Ellipse, College Park, MD 20740-3844.

Education Corner

A column on educational programs and publications

Gordon Conference on Physics Research and Education

The sixth in a series of Gordon Research Conferences exploring the connections between physics research and education will be held June 6–11, 2010 at Mount Holyoke College in South Hadley, Massachusetts. This conference will focus on experimental research and laboratories in physics education and will feature sessions on undergraduate research, upper-level labs, and experiments, simulations and modeling, among other topics. **The application deadline is May 16**, and partial support for attendees may be available. For more information, go to www.grc.org/programs.aspx?year=2010&program=physedu.

APS Releases Educational Posters

The APS Education and Diversity Department has released two posters focusing on physics education. "The Top 10 Reasons Why You Should Study Physics" was co-designed with the American Association of Physics Teachers to recruit high school and undergraduate students into physics classes. "Gravitational Waves" was co-designed with the Laser Interferometry Gravitational-Wave Observatory (LIGO) and presents cutting-edge physics research at the high school or undergraduate level. Both posters can be downloaded or ordered from www.aps.org/programs/education/teachers.

Teacher Recruiting Video Released

The APS/American Association of Physics Teachers-led PhysTEC project recently produced a five-minute video designed to inspire physics majors to pursue a career in teaching. The video features four young physics teachers who talk about what excites them about their jobs, as well as extensive footage from these teachers' classrooms. It is available on DVD as well as online at www.PhysTEC.org/video and on YouTube at www.youtube.com/user/physicsed.

Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (STEM)

The National Science Foundation's Course, Curriculum, and Laboratory Improvement (CCLI) program has been renamed Transforming Undergraduate Education in STEM (TUES). According to NSF, "the title of the program was changed in order to emphasize the special interest in projects that have the potential to transform undergraduate STEM education. The additional review criteria have been modified to emphasize the desire for projects that (1) propose materials, processes, or models that have the potential to enhance student learning and to be adapted easily by other sites and (2) involve a significant effort to facilitate adaptation at other sites." **Proposals are due May 26**. For more information, go to www.nsf.gov and search on "TUES".

Correction

The April Education Corner gave the impression that LaserFest kits are available to all teachers. In fact, the kits are available only to physicists providing professional development for high school teachers.

March Meeting Prize and Award Recipients

Photo by Keith Aden

At the March Meeting in Portland, President Curtis Callan presided over the ceremonial session at which APS Prizes and Awards were presented. Seated, in the picture, are (l to r): Marcia C. B. Barbosa, Patricia Thiel, Robert A. Frosch, Shlomo Havlin, and Russell McCormmach. Standing in the middle row are (l to r): Michael Rubinstein, Yueh-Lin Loo, Paul Steinhardt, Daniel Friedan, David Campbell, Lester Andrews, Michael Aizenman, Kathryn Greenberg (front), Felix Campelo Aubarell (rear), Bilin Zhuang, Jeffrey R. Moffitt, and Kenneth Kamrin. Standing in the back row are (l to r): Curtis Callan, Enrique Galvez, Eugene Ivanov, Sang-Wook Cheong, Nicola A. Spaldin, Ramamoorthy Ramesh, Alessandra Lanzara, Dov Levine, Duncan Steel and Stephen Shenker.

Researchers Pursue Advances in Electronics, Photonics

Physicists at the March Meeting reported on their work looking for ways to keep the exponential growth in computing power from tapering off by researching possible new materials and techniques.

While computing power has exponentially increased over the last several decades, many in the field have worried that it could saturate at some point. Moore's Law predicts that the number of transistors that fit on a computer chip, and its corresponding processing power, will double every 18 to 24 months. Though not a law of nature, it has been generally accurate over the last forty years. However as transistors have shrunk, many are worried about hitting a point where the transistors can't scale down any further and will start to become less efficient.

Graphene, thin sheets of hexagonally arranged carbon atoms, has garnered a lot of attention for its remarkable electrical properties. Some physicists say that it could be the material that in the future will replace silicon as the semiconducting basis of transistors.

"Over the past few years researchers have been looking into different materials…and graphene is considered one of the most promising," said Helen Xiangyu Chen of Stanford University.

At the meeting, Chen announced that her team has made a significant leap forward in developing a workable graphene transistor. They have been able to successfully integrate graphene interconnects into commonly used complementary metal-oxide semiconductor (CMOS) technology and achieve processing speeds as fast as a gigahertz.

Also at the meeting, Phaedon Avouris of the IBM Research Center announced that his team has taken an important step towards overcoming a major impediment researchers have encountered in graphene-based transistors. In order to function, semiconductors need a band gap where current completely stops flowing when in the "off" position. Creating a graphene transistor with the necessary band gap has

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The Futurama of Physics with David X. Cohen

By Alaina G. Levine

In the episode "Bender's Big Score" of *Futurama*, the animated television comedy, the character Professor Farnsworth contemplates paradox-free time travel.

"I believe this 'paradoxicality' equation to be unsolvable," he says, pointing to the equation, $E=9.87\sin(2B)-7.53\cos(B)-1.5\sin(B)$, written on a blackboard. "Ergo, time travel is impossible. But I can't quite prove it."

Thanks to some help from a "razzle dazzle" band of basketball-playing mathematicians, the Harlem Globetrotters, who "use variation of parameters and expand the Wronskian", the claim is disproven in a rare instance of televised mathematics... with the caveat that the very fabric of causality may rupture.

Whether a doomsday scenario is possible in the Universe of *Futurama* is of great interest to David X. Cohen, the show's Executive Producer and head writer, and a former writer and producer for *The Simpsons*. Cohen has a bachelor's degree in physics from Harvard and a master's degree in computer science from UC Berkeley, and is not afraid to use them.

With an omnipresent devotion to physics, and many writing colleagues on the show with backgrounds in applied math, electrical engineering, computer science, and chemistry themselves, Cohen is always looking for places in stories where he can insert "an in-joke" relating to science and technology. He is extremely proud of the fact that *Futurama* is one of the "few shows that can put in a joke for a physics graduate student," he says. "And with an animated show, you have much more opportunity to do those kinds of things. In a live action show, it's kind of hard to put in a floating holographic equation."

His veiled mathematical homages are usually in the background, and are done mostly "to amuse ourselves," he says. One of his favorite clandestine operations was an allusion to Fermat's Last Theorem in an episode of *The Simpsons* entitled "Homer^3". In the name of entertainment, he wrote a computer program to search for very near misses of the theorem, and found some so close that they could not be invalidated by a standard 8-digit calculator.

"But I felt I could do better," Cohen says with conviction, and in another episode, he penned another equation which improved the answer by one decimal place. Although it was repetitive, he just felt the need to do it. "I felt competitive with myself," he admits.

Cohen gets such a kick out of imbedding television episodes with scientific citations that after his shows air, he sometimes trolls the internet to read fan comments about his contributions.

Despite his passion for burying physics treasure in a trove of episodes, Cohen, along with Matt Groening (creator of *The Simpsons*, and Executive Producer along with Cohen of *Futurama*), made the conscious decision early on that "we would make sure that the story and the humor would take the first position and science would take the second position. As much respect as we have for science, we have to make the show entertaining." This requires Cohen to bend natural laws, but "we try to come up with an explanation that will amuse scientists, even if it is bogus," he says.

For example, since the show's universe requires travel faster than the speed of light, "we stuck something in one episode where we stated that the characters weren't actually traveling faster than light, but that scientists had in fact managed to increase the speed of light," Cohen explains. "We like to at least acknowledge it when we know we're wrong."

But fans don't seem to mind. Because *Futurama* is a comedy and not a drama like *Star Trek*, "we are given much more leeway" to alter the rules of space and time, says Cohen. "We show a healthy respect for science, so I think it's okay if we don't always get it

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Letters

Is "Seminal" Sexist?

A listserv for college educators that I belong to recently had a post recommending a "seminal article.". A response gently suggested that we try and avoid sexist and sexual words such as "seminal" and use alternatives such as groundbreaking, cutting edge, leading edge, and foundational.

This aroused much controversy in this usually decorous forum, with levels of passion usually reached among academics only for the topic of grade inflation. One side argued that the word seminal was innocuous, the issue trivial, and the reaction a symptom of political correctness run amok. The other side said that since many did find the word distasteful and alternatives were available, why not retire it except for use in its narrow, technical sense?

Soon after that episode, I received my March 2010 issue of *APS News* with its list of prize and award winners. I went through the citations and found the following words used to describe the achievements: seminal (6), pioneering (4), leadership (4), contribution (3), groundbreaking (2), development (2), elucidation (2), original (1), brilliant (1), revolutionary (1), insightful (1).

While seminal was the winner, it seems like we have good alternatives. At the risk of provoking a fresh round of protests in this venue, perhaps we could suggest to prize committees that they use these alternatives whenever possible.

Mano Singham
Cleveland, OH

What to Do When the Oil Runs Out

Everything Frits de Wette says in his letter "The Sun is a Wild Card" [*APS News*, January, 2010] is valid and sensible, but heating due to anthropogenic activities is nevertheless possible, even likely if you look at the combustion of about one-half of Earth's stored oil in about fifty years. Should there be an anthropogenic threat, dealing with it will get more difficult year-by-year.

The best arguments against a solar cause are the steepness of the increases and the physical changes in the planet. Tree records do not show such past steepness.

This is an extremely complex question, and we may not have good answers for a decade or more. Further, we may not be chasing the right question. If the increase is solar as per de Wette's letter, are we going to sit back and watch our agriculture severely damaged, our environment altered, and do nothing?

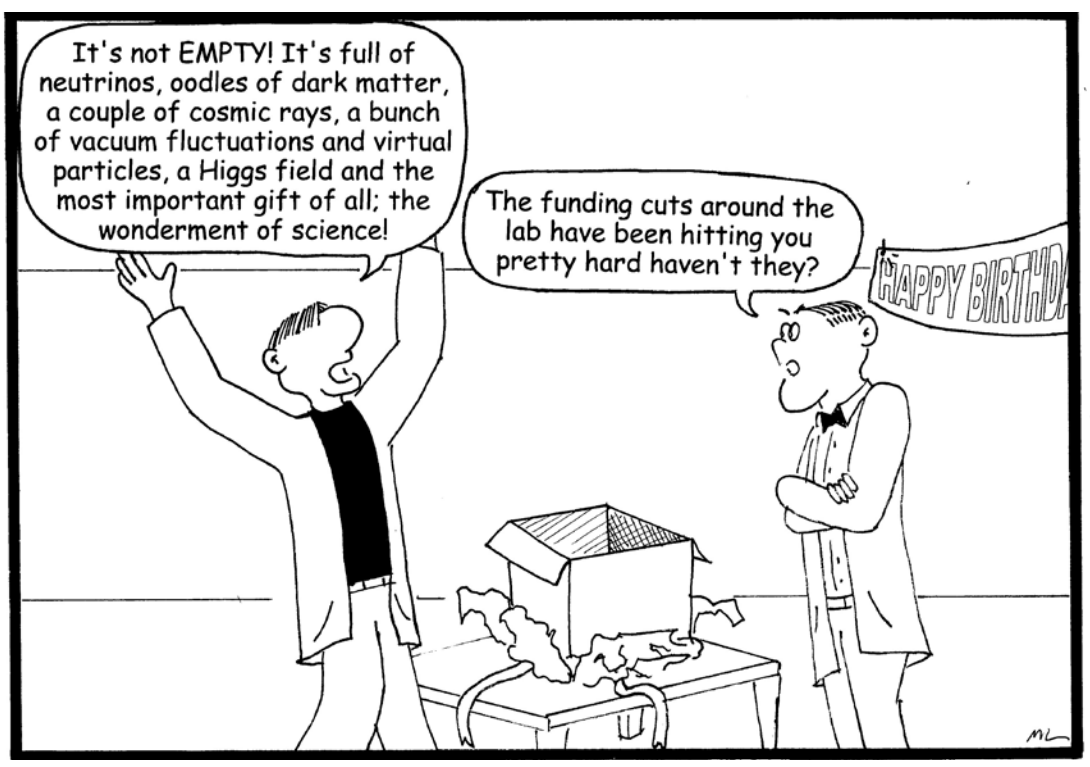
The proposed solutions are to increase efficiencies and to find new renewable, non-solar trapping, energy sources (or if not renewable, more plentiful.) Since we have used approximately 50% of the stored oil in less than 100 years, and since our usage is ever increasing, a day of reckoning comes, when the soda straw will suck air. Recovery techniques get better every year, and there is still some oil to be found, but this only has to do with the date of the day of reckoning–not its certain arrival.

When the oil runs out, we are going to need nuclear. Wind, water, thermal, and solar, even coal (with caveats) are all good, but no way we power Earth with them. Using the US as a standard, most of Earth is extremely underpowered right now. Our nuclear reactors take forever to build and approve, create too much radioactive waste, are not safe enough, and do not breed new fuel. We need a new design. We have about a decade or two to get a new reactor design done, tested, and approved and another decade to build reactors. This has to do with post-oil power, not with global warming, but the design of all new energy must address global warming.

Let's get on with solving the problems.

Richard A Karlin
Pittsburgh, PA

By Michael Lucibella



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Laser Pioneer Turns 90

In March, on a bright and sunny day in Tucson, Arizona, 18 eminent laser pioneers and optical physicists came together to celebrate the 90th birthday of Nobel Laureate Nicolaas Bloembergen. Sponsored by the University of Arizona College of Optical Sciences where he holds a faculty appointment, the Nicolaas Bloembergen Nobel Laureate Scientific Symposium featured talks by fellow laureates Roy J. Glauber, John L. Hall, and Charles H. Townes. The scientists gathered to congratulate and express gratitude to "Nico" for not only his contributions to science, and in particular the laser, but to their own careers as well. Most of the speakers at the conference were "one degree" away from Nico in some way, either as his former student or colleague, and were referred to with affection by Marlan Scully as the "Nicolettes." Nico, who served as President of the APS in 1991 and published more than 300 papers, has been a trailblazer in nonlinear optics. A highlight of the meeting was when all of the attendees sang Happy Birthday to the physicist, followed by the cutting of an enormous cake. Many pictures of the event can be found at http://www.optics.arizona.edu/.

Photo by Margy Green, University of Arizona
Seated (l to r): Nicolaas Bloembergen, Charles Townes. Standing (l to r): Roy Glauber, John Hall.

Lasers Are Creative Tools for Education, Outreach

Demonstrating the importance of lasers to the public is one of the goals of LaserFest, the 50th anniversary celebration of the invention of the laser. At the March Meeting's "LaserFest: Laser Education and Outreach" session, physics teachers showed off how they use lasers as outreach and education activities.

"A key audience for LaserFest is kids," said APS's head of public outreach Becky Thompson, who organized the session, "We wanted to highlight both what APS was doing for laser education and give meeting attendees a chance to learn about successful outreach in general."

Lasers have been a big part of undergraduate research labs for years. Chad Orzel, a professor at Union College, described at the meeting how he often uses laser experiments to show his students their importance to scientific measurements.

"The most impressive applications in science and physics are in precision measurement," Orzel said at his talk, "The world's best measurements mostly involve lasers."

During lab sessions, Orzel has his students conduct experiments designed to explore the same fundamental premises that are used in current cutting edge research. His freshman students measure the speed of light by timing how long it takes to reflect back from the far side of the room, akin to measuring the distance from Earth to the moon with laser range finders and retro reflectors. His more advanced students build their own interferometers that are essentially simpler versions of LIGO, and take the laser spectrum of rubidium using the same principles that atomic clocks operate on.

"It's something that can get the basic idea of lasers as important tools for precision measurements across to students," Orzel said.

This idea of learning by doing is also central to the teaching philosophy at Stony Brook's Laser Teaching Center. Completed in 1999, the center has an assortment of lab stations and equipment geared towards teaching the physics of optics to graduate, undergraduate, and even high school students.

"We teach optics," said Harold Metcalf, a professor at the university and one of the founders of the center, "You can see light. It's extremely important for the students to see what's going on without a lot of equipment in the way."

Converted from an empty hall beneath the offices of the Department of Physics and Astronomy in the Physics building, the center offers students a chance to work on hands-on optics projects. The high school students who attend are usually part of the lab's summer program and use the lab to work on science fair projects. Many students have been finalists and semi-finalists in national competitions. Undergraduates often use the lab to do extra credit work and other research, while graduate students participate in an "Optics Rotation" course.

The University of Oregon's SPICE summer program is a science summer camp with a special emphasis on optics, aimed at encouraging middle school girls to participate more in the sciences. The Science Program to Inspire Creativity and Excellence (SPICE, formerly the Optical Science Discovery Camp) is a weeklong day camp that combines optics education with summer camp fun.

"You get to set stuff on fire with a Fresnel lens," said Miriam Deutsch, one of the directors of the camp, "The whole point of camp is to set stuff on fire."

Photo courtesy of John Noe
James Scholtz, then undergraduate at Stony Brook University, adjusts a laser diode on his project at the Laser Teaching Center.

More importantly, she said, the camp is working to help to close the gender gap in the physical sciences. Research has shown that exposing girls to college level science concepts as early as middle school greatly improves the likelihood they'll stay in the sciences. Though no male applicant has ever been turned away from the SPICE program, the organizers primarily recruit girls in middle school to participate.

Paul Guèye at Hampton University is also working to bring more underrepresented groups into the physical sciences. Working with both the National Society of Black Physicists and National Society of Hispanic Physicists, Guèye has brought the science ambassador program to hundreds of elementary school students in dozens of predominantly minority and underprivileged classrooms across the country.

"The most important thing is fun. You don't want to do something boring," Guèye said.

These science ambassadors travel with physics demonstrations to classrooms in areas with limited resources, in order to show students the fun of physics experiments. Since its inception, the class has expanded from reaching 25 students in 2005 to over 400 in 2009. Guèye said that they hope to continue to expand the program using funding from LaserFest on the Road grants to incorporate more

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Washington Dispatch

A bimonthly update from the APS Office of Public Affairs

ISSUE: Budget and Authorization Environment

Another Continuing Resolution Likely this year

Following the bruising fight over healthcare, and public anxiety over the still lagging economy, the Democratic majority in Congress will have to overcome significant hurdles to complete a FY 2011 Budget Resolution and the attendant appropriations bills. According to "The Hill", a newspaper that follows Congressional developments, "House Democrats are facing a much tighter vote on the budget resolution in 2010 because of big deficit projections and the looming mid-term election. As a result, centrist Democrats will have a harder time voting for the resolution." The bottom line: It is likely that there will be Continuing Resolutions again this year to keep government agencies running once the fiscal year ends.

America COMPETES Reauthorization

The tight fiscal environment will also have an impact on reauthorization of the America COMPETES Act. Staff for the House Science Committee, earlier this year, forecast that reauthorization of the bill would be bipartisan and somewhat easy to accomplish. However, the mood has since changed. During a March 25th markup of the DOE Office of Science section of the bill, Republicans offered seven amendments in an attempt to cut back authorization levels over concerns about spending. Included among the amendments was one offered by the bill's original co-sponsor, Congresswoman Judy Biggert, to cut the overall authorization. Ultimately she withdrew the amendment after Committee Chairman Bart Gordon pledged to work with her to lower some of the authorization levels prior to consideration by the full Committee. The National Science Foundation (NSF) portion of COMPETES will be marked up on April 14th, and the full House Science Committee is expected to mark up the full reauthorization bill by the end of April.

With regard to the Energy and Water appropriations bill, which funds the DOE Office of Science, funding levels for FY11 could be particularly difficult. Because a number of water projects would not be funded in the President's budget, Congress is likely to strip money from DOE/SC to make up the shortfall.

Be sure to check the APS Washington Office's Blog, *Physics Frontline* (http://physicsfrontline.aps.org/), for the latest news on the FY11 Budget.

ISSUE: POPA Activities

The Energy Critical Elements Study group, which is examining the scarcity of critical elements for new energy technologies, held its first meeting in late April at MIT. Featured keynote speakers included Anthony Mariano, rare earths consultant; David Eaglesham of First Solar, Inc.; James Lancaster of the National Research Council; Cyrus Wadia of UC Berkeley; Scott Sibley of the U.S. Geological Survey; and Jung-Chan Bae of the Korea Institute of Industrial Technology (KITECH).

The Electric Grid Study group, which is examining the technical challenges and priorities for increasing the amount of renewable electricity on the grid, is in the final stages of drafting its report, which will be presented to POPA for approval in June.

A POPA subcommittee, comprising Duncan Moore, John Browne, Frances Houle, and James Drake, continued its work on the 2007 APS Statement on Climate Change. In February, the subcommittee –with APS Associate Director of Public Affairs Francis Slakey and POPA Chair Rob Socolow serving as resources–had prepared and circulated an Addendum to the Statement in response to a November APS Council motion. In March, the subcommittee reviewed and considered more than 1,700 comments sent by APS members, and updated the proposed Addendum. In April, POPA unanimously approved the updated Addendum and sent it to the APS Executive Board and Council for final action. See story on page 1 for further details.

If you have suggestions for a POPA study, please visit http://www.aps.org/policy/reports/popa-reports/suggestions/index.cfm and send in your ideas.

ISSUE: Media Update

USA Today, Global Security Newswire, *Science Magazine,* and the *Physics Today* blog were among the many media and online news organizations that published stories on the release of the APS report, "*Technical Steps to Support Nuclear Downsizing*."

The April edition of the APS newsletter, *Capitol Hill Quarterly*, features an op-ed by Congressman Frank Wolf (10th-VA) on investing in basic research to keep America strong.

Log on to the APS Public Affairs Web site (http://www.aps.org/public_affairs) for more information.

Feynman Drew More Than Diagrams

Photo courtesy of Curtis Callan

The drawing on page 1 was done in 1985 by celebrated Caltech physicist Richard Feynman. It is one of several that are now at Princeton in the possession of APS President Curtis Callan. In the photo, Callan (left) enlists the help of colleague Igor Klebanov to display a few of the others. The works were acquired by Princeton, where Feynman had been a graduate student, in the mid-eighties, and were kept in the office of the late Sam Treiman, from whom Callan received them. In the opinion of experts, Feynman was at least as good at drawing as Rembrandt was at physics.

INTERNATIONAL News

...from the APS Office of International Affairs

Indo-US Student Visitation Program: Graduate Students Building Collaborations

By Danielle Lieske and Sunita Srivastava

In 2008, the APS and the Indo-US Science and Technology Forum (IUSSTF) issued its first call for proposals for a new program to sponsor the exchange of physicists and physics graduate students between India and the United States. The Professorship Awards in Physics permit professors from India and the United States to deliver short courses or a lecture series in the other country. The Physics Student Visitation Program provides both scientific training as well as cultural experiences while graduate students pursue a breadth of opportunities such as attending a summer institute or conducting research in a host professor's lab. The first round of proposals yielded two especially interesting applications–in order to build an ongoing collaboration between their laboratories, two professors applied to "exchange" their graduate students between Stanford and the Indian Institute of Science. Each new to the other's country, the two students have given an account of their studies and impressions of their host country.

Danielle Lieske: From Palo Alto to Bangalore

In the fall of 2008 I received an email from Gerry Fuller, my PhD advisor, with the text "would you be interested in visiting India" and attached information about the India-US Physics Student Visitation Program (co-sponsored by APS and the Indo-US Science and Technology Forum). Gerry had just returned from a visit to the Indian Institute of Science (IISc) in Bangalore. During his visit, he met Jaydeep Basu and they realized that each lab specializes in characterizing interfacial phenomena from a different perspective. After some discussion, they agreed that it would be mutually beneficial for each of them to send a student on a two-to-three week visitation to the other's lab.

As many graduate students would be, I was very excited at the prospect of visiting another lab, particularly one in India. I began to work on the application immediately. A few months later we heard that both Sunita (Professor Basu's PhD student) and I were awarded the grant, and we began to plan our trips.

Danielle Lieske (left) and Sunita Srivastava

Several of my friends have visited India and I have heard stories, both good and bad. As Professor Basu mentioned on the first day of my visit, Americans often react to India in one of two ways: they either love and embrace the experience or find India to be overwhelming. Knowing this, I was a little apprehensive about my trip, but also excited.

Sunita visited Stanford first. The

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tee, appointed by then-President Cherry Murray and chaired by Daniel Kleppner of MIT, recommended that the 2007 statement be returned to POPA to address issues of "clarity and tone." Council adopted the recommendations of the Kleppner committee, and asked POPA to appoint a subcommittee to accomplish this goal, and also both to consult outside experts and to solicit input from the entire APS membership. The Moore subcommittee conducted a series of teleconferences with a number of climate scientists in January. By late January, they had a draft commentary which they presented to POPA. With some modifications, POPA approved the Commentary on February 5. This was then brought to the APS Executive Board, which approved it at its meeting on February 12.

There followed a period in which the logistical and technical details of requesting input from the APS membership were worked out. On February 23, a message from APS President Curtis Callan went out to all 46,034 APS members who could be reached by email; each message contained a unique URL that enabled the member to access the text of the statement and proposed Commentary, and, if desired, to provide input. The system was designed so that each member could comment only once during the 3-week period that the site was open.

Of those who received the email, 5805 viewed the material, and 1767 submitted comments by the March 19 deadline. Each of the 1767 messages was read by at least one member of the Moore subcommittee. The subcommittee members categorized each comment as either favorable to the addendum, or unfavorable, or neutral. They found that 55% of the comments were in the favorable category, and 26% were unfavorable. As several Council members pointed out during the discussion on April 18, it is probable that these percentages are not representative of the APS membership as a whole.

In addition, the subcommittee collected those comments that they deemed potentially useful in modifying the addendum, and used them to produce a revised version. This version, which contained substantial differences from the original, was presented to POPA and approved by that body on April 2. It was this version that was forwarded to the APS Board and Council, and approved by the latter on April 18.

This entire sequence of events began at the Council meeting last spring, when Councilor Robert Austin introduced a motion to replace the 2007 climate change statement. Austin's motion was tabled, and Murray appointed the Kleppner committee to advise her on how to proceed. In the run-up to the Council meeting in the fall of 2009, Council members were bombarded with email messages from the APS membership, expressing their opinions of the 2007 statement and the Austin motion. Council then adopted the recommendations of the Kleppner committee, which led to the formation of the Moore subcommittee and the subsequent developments culminating in the approval of the addendum.

The Dawn of the Demo: Demonstrations Are Changing Physics Outreach and Education

By Calla Cofield

The science auditorium at Rutgers University only seats 330, but over 400 people sat on the floor and squeezed into the aisles for two hours, just to see Dave Maiullo perform. He's not a movie star and he doesn't play guitar, but Maiullo does know how to put on a show. And he's just one of a growing number of people who are packing in crowds and engaging students with the power of physics demos.

The word "demo" was once just a short way of saying "demonstration," but in physics outreach and education, it's taken on a new meaning. A "demo," according to Maiullo, is a system or a physical set-up where one parameter can be easily adjusted, and all others remain the same. The demo leader adjusts that parameter, playing with high and low and in between, in order to illustrate some physics concept.

"There's a lot of teaching that goes on if demos are done correctly," he said. "You don't want to hide any of the physics, but you can jazz it up in lots of different ways and make something that's eye-catching. That creates a memory trigger, and those are great for educating."

Take, for example, a demo that Maiullo did in a video for *The New York Times online*. The set-up is a glass beaker placed next to a speaker that lets out one steady note with an adjustable frequency. Maiullo tunes the frequency of the sound waves until they reach the resonant frequency of the glass, and in a startling burst, the beaker shatters.

But that's one of the more mild demos that Maiullo has in his arsenal. There's the smoke ring cannon built out of a garbage can, or the liquid nitrogen trapped in a plastic bottle that explodes and lifts a garbage can ten feet in the air. One of Maiullo's specialty demos is sandwiching himself between two beds of nails, having someone walk on the top one, and then having someone smash a brick that's placed on top of him. There's smoke, fire, flashy lights and explosions. There's one demo known simply as "the glowing pickle" that involves two electrodes and usually leaves behind an odd smell. "Are some of the things we do bigger and flashier than they need to be? Probably," states Maiullo. "Is it more of a memory trigger if it's bigger and badder? Definitely."

Photo by Nick Romanenko, Rutgers University

Dave Maiullo (center) blasts the audience with his smoke-ring cannon.

Maiullo is officially the Physics Support Specialist at Rutgers, and one of a growing number of "professional demo people." He spends part of his day refilling chalk and adjusting projectors for the Rutgers physics and astronomy professors, and the rest of his time designing, building, and setting up demos. His popularity among the general public has soared thanks to public demo shows that Rutgers now puts

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so far proven difficult, but Avouris said that they are getting close. He and his team built a transistor out of two layers of graphene where only 1 percent of current flows in the off position. Though it's still not quite a large enough band gap to be used in digital electronics, it is about twenty times more effective than single layers of graphene.

Just as important as the transistors that do the computing is the wiring that connects to each transistor. The surging field of topological insulators shows a lot of promise for physicists working to solve the fundamental problem of energy dissipation in integrated circuits.

Shoucheng Zhang of Stanford University said that while the engineering of transistors has improved, the fundamental materials for the connecting circuit haven't changed much. Electrical wiring on small scales loses a lot of energy as heat when flowing electrons collide.

"We're facing a situation where fundamental new ways of thinking are required," Zhang said, "The engineering [of circuits] has been progressing, but the fundamentals have not changed."

Physicists say that topological insulators do much to reduce lost energy. Using the quantum Hall effect, flowing electrons organize along the surface of a specially prepared layered semi-conducting material. When they do, the charges all flow in a single direction, preventing charges from colliding with each other and cutting out nearly all resistance, much like a superconducting material.

At the meeting, physicists announced that for the first time they have been able to synthesize a material from mercury telluride with these properties that don't require powerful magnetic fields or ultra cold temperatures. Also from Stanford, Yi Cui presented a material, derived from bismuth selenide, made into tiny nano-ribbons that could, with more development, function as wires between transistors.

The problem of overloading wires has led some researchers to think that the days of electronics are numbered. Many see photonics as the next step in computer processing, where data is sent and received using photons rather than electrons.

"The wiring within machines is becoming a bigger problem than the logic…It's a basic scaling problem–once you've filled the space with wiring, you can't send any more information," said David Miller of Stanford University, "The energy benefit of optics is something we're only beginning to start to see."

At the meeting, researchers offered an overview on the current state of the field. Recent research suggests that silicon and germanium each are a promising medium to send photonic computing signals. More development is needed to improve the optic cables and to shrink transmitters and receivers before silicon photonics replaces electronic computer chips. However physicists developing these new computer systems say that photonics would take up less space and require significantly less energy than traditional electronics.

"The last century I consider to be the century of electronics. This century I consider to be the one of photonics," said David Lockwood of the National Research Council in Canada.

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work went smoothly and we were able to complete all the experiments on her list. We got along very well and had many good discussions on both scientific and personal subjects. She showed me how to cook paneer and I took her to Santa Cruz and Yosemite National Park.

A month later, after traveling for 24 hours, navigating the H1N1 health check point, clearing Indian customs, and walking the gauntlet of aggressive drivers at the airport, I arrived in Bangalore. Already a bit overwhelmed, I was excited to see Sunita waiting for me outside the airport. The next day she, along with her brother, sister, and best friend took me out into the city.

To say that India is an assault on the senses is absolutely true. There are people everywhere and each of them are dressed in beautiful, bright colors from head to toe. The food is spicy and the noise of traffic and smells of exhaust are inescapable (at least in Bangalore). But what I had not heard about India and was constantly impressed by is that Indians are unbelievably generous and welcoming. The tiniest personal connection to somebody gained me enormous amounts of help and welcoming. During my visit, Sunita was an amazing host. She took me with her to go sari shopping, went with me to visit a Hindu temple, took me to see a Bollywood movie, and for several other adventures. But not only did she accompany me on all these trips off campus, but her labmates and brother and sister came along as well. All of them were very conscious of me; they carefully shepherded me through traffic, made sure my food was cooked with American (i.e., no) spice, etc. And it was this personal connection to the country and the culture that made my trip so amazing.

On a professional note, I was thoroughly impressed with the level of science and the facilities present at IISc. Although IISc is a much smaller university than Stanford, they have access to most major pieces of equipment that I could think of (within my field, anyway). Professor Basu's group also had a wonderful atmosphere. Not only did the students continuously engage in discussions about their research, but they were all clearly good friends, an attitude that was extended to me the first day I arrived. My experiments went smoothly thanks to the assistance of several students in the group, and I collected enough data for a publication.

Although I had entered this adventure with some trepidation, the overall experience was incredible. I can see that alone and without the guidance of a local, India would be a difficult and sometimes frustrating place to navigate. But as it was, my trip was wonderful, mostly thanks to the generosity of Sunita and her friends. In addition to getting acquainted with a small piece of India, what I most appreciated about this experience was the reciprocity. Getting to host Sunita and show her my home in California, then traveling to see her home in Bangalore created a much stronger bond between us than if only one of us had traveled. It was an experience that I will always cherish.

Sunita Srivastava: Indian Institute of Science to Stanford

I came to know about the Indo –US student visitation program, when Prof. Gerry visited our lab after giving a very interesting talk on interfacial rheology in the Physics Department of the Indian Institute of Science. At this time I was working on the very difficult and challenging experiment of understanding the rheology of polymer monolayers under mechanical strain. We (I and Prof. Basu) were amazed with the results that I had gotten and were in the process of understanding the physics of the obtained data. There was no scientist better than Prof. Gerry to discuss them with, and for that reason Prof. Basu had invited him to visit the lab. I explained all the results to him and he was interested in them. We realized that further interfacial stress rheometer (ISR) measurements would be useful to have better insight into the physics. During this conversation Prof. Gerry came to know about the advanced facilities at IISc, which he thought were required for the work of some of his graduate students. This is how the seed of collaboration was sown between the two labs. After discussions with Prof. Gerry, Prof. Basu suggested that I find out the details of the visitation program. I was really excited about the potential opportunity and in the excitement it did not take me much time to find the details and place the application.

It was the month of December and I was enjoying official holidays at home when I got an email from Michele Irwin that my application had been accepted. Nothing more could make my holidays than this news. After my leave, when I was back at IISc, I began scheduling the trip and experimental plans. This was my first very involved interaction with an international group and I had a very good and satisfying experience for the full process.

I visited Stanford first. Danielle was there at the airport to pick me up in her car. She was very careful to first take me to the Indian grocery store so that I was comfortable with my food. She took me to Prof. Gerry's home and showed me around the house. First instant I was surprised to realize the type of hospitality I received from Mary (wife of Prof. Gerry). She took care to offer me all the food (fruits, drinks etc.) in her kitchen during my stay. Being from India, where I am always with my friends, the company of Mary and Prof. Gerry in their home made me feel less lonely. They took me for a Hollywood movie and dinner outside. My discussions over the dinner table with Mary continued for hours, we discussed wide areas like politics, culture, society, etc. of two of the biggest nations in the world. Prof. Gerry took great care in both my academic and personal issues. He lent me his four gear bike to ride, which was again a very exciting experience. He gave me lots of time to discuss my ISR results in spite of his many engagements at his home and in the office.

All of my travel was full of learning new experiences. The most important thing that I cherish now is I got to meet a person like Danielle. Now she is not just a professional collaborator of mine but also a very good friend. I spent lots of quality time with her discussing several issues and sharing opinions. She took me to visit Yositemite National Park, The Mystery Spot, and Santa Cruz Beach along with her husband Chad, uncle and aunt. The two most wonderful experiences were the volleyball match at Stanford University and the visit to the park. I also enjoyed cooking Indian food at Danielle's home and getting introduced to her sweet pets.

From the professional side this trip was again very productive for me. I got to learn the advanced technique of interfacial rheology and interact with a few group members in Prof. Gerry's Lab and others. I did several experiments and am now in the process of writing a manuscript for publication.

Altogether the exchange program helped to build up a strong collaborative bond between both the labs. We got to know the working culture and scientific environments more closely, which would not have been possible without actually being able travel to the place and sharing the experience. It was an experience which both of us, I and Danielle, will always appreciate and make an effort to carry forward in our scientific careers.

FUTURAMA continued from page 3

right... the science-minded fans have learned to throw in the towel sometimes."

Cohen knew from an early age he wanted to be a scientist–he was directly influenced by both of his parents being biologists. "It became a matter of which science I would go into," he recalls. He had always gravitated towards math and physics and computers, and contemplates that his choice to pursue physics in college was perhaps "a pathetic form of rebellion against my parents."

However, when it did come time as an undergraduate at Harvard for him to choose whether to major in physics or comp science, he selected the former because "physics was more of a fundamental thing to study, with a degree of eternal truth to it that I felt computer science did not necessarily have," Cohen posits. "I wanted a real, solid underpinning for whatever I decided to do later on… Physics seemed more unchanging to me, more eternally useful, and I felt like I would have more options afterwards by majoring in physics."

But he was also always driven to humor, and wrote comedic essays and served as the President of the *Harvard Lampoon*. By the time he graduated from college, a plethora of his peers were jetting to Hollywood to launch careers in comedy writing. "Prior to that I never knew anyone who had done that and never thought of that as a career," he says. He still went to graduate school, because, he recalls saying to himself, "if I don't go now, I will forget everything I've learned. I have to keep up the momentum."

But while a grad student, he continued writing. "I reached the point in graduate school where I had gotten a master's degree and was at a dead end on what I had been working on as research, and I would have had to start on something new," Cohen says. "It was a good time to think about what I was doing next. The comedy writing won out at that point and I gave it a try."

Cohen took a leave of absence from Berkeley and "hung around my cheap, rent-controlled apartment" where he wrote sample scripts for various TV programs. By chance and "pure luck", one of his scripts found its way into the hands of Mike Judge, the creator of animated shows such as *Beavis and Butthead* and *King of the Hill*, who at the time was looking for "cheap writers." Before he knew it, Cohen was hired to write some early episodes of *Beavis and Butthead*, and in 1993, he joined the staff of *The Simpsons*, where he remained until 1998, when he and Groening launched *Futurama*.

As Executive Producer, Cohen considers his most important responsibility to be that of head writer, and is involved with every script from its conception through its infancy and as it flowers into adulthood as a finished product ready to be animated. It takes more than eight months to produce one episode of *Futurama*, from the moment a script is finalized to the time it is fully animated and ready to air.

Despite the fact that he incorporates many scientific references into his shows, he ironically is still unsure whether his decision to study physics was exactly the right one for his career path. Spoken like a true scientist, he admits that he cannot make a final deduction because he "was not able to perform the experiment successfully by majoring in every subject." But physics definitely helped him–"I feel like I was forced to work very hard, and to think hard and logically, and to try to understand the process behind the correct answer… and those things all come in handy no matter what you do."

New episodes of *Futurama* are expected to be aired this year. In an *APS News* exclusive, Cohen reveals for the first time that in the 10th episode of the upcoming season, tentatively entitled "The Prisoner of Benda," a theorem based on group theory was specifically written (and proven!) by staffer/PhD mathematician Ken Keeler to explain a plot twist. Cohen can't help but chuckle at the irony: his television-writing rule is that entertainment trumps science, but in this special case, a mathematical theorem was penned for the sake of entertainment.

Does the physicist-turned-comedy icon have any regrets? "What I do is ultimately not similar to physics or computer science," Cohen admits. "I would like to have lived two lives, to be a scientist in one... So of course I have regrets. Science is more important than what we do, although I do get a lot of satisfaction out of my work."

"One thing I worry about is that when we purposely present inaccurate science in *Futurama* in the name of entertainment, that viewers may hold it against us," he concedes. "We do have genuine respect for science, and we're trying, when we can, to raise the level of discussion of science on television. If we fail sometimes, I hope people still appreciate the frequent attempts to bring real science into the show. I apologize in advance for any failures in the future, because I'm sure there will be many more, hopefully entertaining, failures."

"Comedy writing is not closely related to physics," Cohen concludes. And yet he does confess that the research arm of science in general has correlations to comedy writing, in that their creative processes have similarities. "On a day to day basis, I'm not using a lot of diagrams and solving differential equations. But sometimes in writing, as in scientific research, you rely on your gut instinct and your experience to tell you that yes, I am setting off on a road that is worthwhile."

Alaina G. Levine is a science writer and President of Quantum Success Solutions, a leadership and professional development consulting enterprise. She can be contacted through www.alainalevine.com.

ANNOUNCEMENTS

ERRATUM

In the March Prize and Award insert, the affiliation of the recipient of the Prize to a Faculty Member for Research in an Undergraduate Institution, Enrique Galvez, was incorrectly listed. He is a professor at Colgate University, not Harvey Mudd College.

ERRATUM

In the April *APS News* story about Iranian Physicist Farhad Ardalan's visa problems, there is an unfortunate error in the sentence "In 1993 he and his wife received green cards to stay in the US where he resided until her death in 2003." His wife did not die in 2003 and is indeed still alive. Ardalan left the US after the death of his friend and colleague Freydoon Mansouri of the University of Cincinnati.

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optics into their demonstrations.

One of the attendees at the session was Sean O'Malley of Rutgers University. He received a LaserFest on the Road grant to develop a suitcase of laser demonstrations he could take from school to school in the vein of an old fashioned traveling salesman.

"I'm selling to them the wonder of lasers," O'Malley said.

One of the most attention-grabbing demonstrations he plans on including in his kit is a YAG laser used to remove tattoos from a piece of mounted pig skin. Other demonstrations he is working on that show off the applications of lasers are a scaled-up mockup of a CD/DVD player and a laser used to grow thin films by means of pulsed layer deposition.

"I'd like them to be inspired," O'Malley said, "Kids in general are naturally curious. It doesn't matter what their ethnicity is or their background is; they're curious."

DEMO continued from page 6

on every year. In an effort to thin out the packed crowd, they added a third performance this year, but that only encouraged even more people to come.

Rutgers isn't the only university doing demo shows, and it's not just friends of academia who are interested in seeing them. At a public demo show in a bar in Brooklyn, a hip-looking crowd of New Yorkers watched Maiullo smash items he dipped in liquid nitrogen. This was the third physics demo show that was put on in the city this year, and some of the venues have turned away more people than they can seat. *The New York Times* reported back in 1997 that one bar tried to mix the physics demos with music performances, but the audience ignored the bands.

"YouTube and shows like *MythBusters* have really increased public interest in physics demos," said Maiullo. "I think a lot of people of my age or even older than me, and I'm just about 50, remember Mr. Wizard. He was on public television doing different physics or chemistry demonstrations. And for a long time, that was all the access people had."

That was also the only resource that demo people like Maiullo had, up until twenty-five years ago when the American Association of Physics Teachers (AAPT) put together an auxiliary group who were doing demos, and called it the Physics Instructional Resource Association, PIRA. About ten years after its initial formation, the dawn of the Internet allowed the group to set up a website where they indexed physics demos and organized them by the concept they illustrate, and created online discussion areas where people could share ideas and ask questions. With the debut of the website, the group immediately saw a boom in physics demo shows around the country, and Maiullo says it was then that demos began to change from a hobby into a profession.

Associate Executive Officer of AAPT Bo Hammer praises PIRA for playing an important part in making demos that are accessible to physics teachers. Demos are becoming an ever more popular and important tool in inquiry-based teaching, the method of teaching by asking questions rather than lecturing. Hammer says the workshops offered by PIRA at the AAPT semiannual meetings are the primary way that teachers can learn about demos and how to do them in their classrooms.

"Demos lift the physics out of the textbook and make it much more real," says Hammer. "And then the next step is to actually let students manipulate the demo or the device themselves. Then they start to get an intuitive sense of how things work."

Hammer also serves on the APS Committee for Informing the Public (CIP), which serves physicists who want to do outreach with the general public. He says some physicists are just eager to connect with the public, and to share their excitement about the work they do. For others, outreach has become a requirement they must fulfill for their jobs or their funding agencies. The broader outreach criterion of the National Science Foundation, for example, now requires its major grant recipients to not only do research, but find a way to connect that research to society.

The CIP works with the APS Outreach Department, headed up by Becky Thompson. The goal of both the committee and the department is to provide APS members with the resources and infrastructure they need to do a public outreach project.

"A lot of APS members want to get out there and engage the public about the things they're so excited about," Thompson said. "And a lot of times that comes back to doing demos. The goal of outreach is to get people interested in physics, and of course an easy way to do that is with things that are flashy and go 'bang!'"

Thompson illustrates another impact of the growing demo culture: encouraging physicists who want to enter the field of informal education, which refers to jobs like Maiullo's as opposed to teaching in a traditional classroom setting. Thompson started doing demo shows at local schools while she was working on her PhD, and got hooked.

"The revelation came when I realized I could do this as a career," Thompson said. "I didn't want to do formal education at all, but this was exactly what I wanted to be doing. And I don't think people realize how many jobs there are for PhD's in informal education, especially in museums."

Teachers and physicists interested in doing demo shows or other outreach projects are encouraged to contact the APS Outreach department. Thompson and the APS Outreach department compiled an Outreach Guide (www.aps.org/programs/outreach/guide/) with sections such as "So You Want to Do a Physics Demo," which can assist in setting up teachers, educators or professors with demos depending on the resources they have available. But the guide also includes tips about setting up public lectures, science cafes (which Thompson says are currently "in vogue"), open houses, and working with museums. Maiullo published a book in 2009 titled "*A Demo a Day: A Year of Physics Demonstrations*," outlining physics demos that can be done in a classroom.

The Back Page

Training Physics Professionals for the Nonacademic Workforce

By Eleanor L. Babco, M. Nancy Vincent, and Donald N. Langenberg

Physicists can do almost anything if they put their minds to it. Most physicists would probably agree with that claim, but when it comes to the academic preparation of young physicists, they focus almost entirely on traditional PhD programs aimed at training them for research careers in physics. That is changing. In this article we introduce the reader to some young physicists who are alumni of a new type of graduate program, the Professional Science Master's (PSM) degree program.

"To effectively apply innovative science towards technology in a business setting one should not only be proficient in the science…, but also in skills required to excel in a business environment," says Wilfred Kittler, a Magnetic Resonance Applications Engineer at Magritek Ltd. Mr. Kittler is a graduate of the PSM program in Nanoscale Physics at Rice University, and one of a growing number of science students interested in training for a career outside of academia.

PSM programs are cropping up across the country as students seek careers in science in the business, government, or nonprofit sectors, and employers want hires who are productive from day one. These new and innovative programs combine an internship and rigorous study in a science or mathematics discipline with highly valued workplace skills such as communication, management, regulatory affairs, and entrepreneurship. After only a dozen years in existence, there are nearly 170 PSM programs underway at 86 institutions, including 16 in physics in fields such as engineering physics, health physics, nanoscience, medical physics, and applied physics, (see Table 1)[1].

A hallmark of PSM programs is the involvement of employers who provide insight on the skill sets and academic preparation they would like to see in new hires, and provide guidance to ensure that PSM programs are responsive to the changing demands of the 21st century workforce. At the institutional level, employers may serve on PSM program advisory boards, as adjunct professors, as mentors, and provide feedback on curriculum development. At the student level, employers may offer internships or sponsor team projects giving students an opportunity to interact with potential employers in "real world" settings outside of the lab. The internship is often a springboard to full time employment.

Typically, individuals who are interested in pursuing a PSM degree are looking for an alternative career path in science and mathematics, not a stepping stone to a PhD. PSM programs attract students who: (1) want careers in the business, government, or nonprofit sectors; (2) find the two-year full-time-equivalent time-to-degree appealing; (3) thrive in team oriented environments; (4) find work in managerial or other professional level positions desirable; (5) value the flexibility afforded in such programs; and (6) seek to gain a competitive edge in the job market. PSM programs tend to attract more women and U.S. citizens than do research-based master's programs in the natural sciences.[2]

Wilfred Kittler

Richard Norris

William Griffin

Danielle and Jake Philipson

Chris Fennig

So how are graduates of these pioneering degree programs faring with their PSM degrees? After completing his undergraduate degree, Richard Norris wanted to get a master's degree but was uncertain about a PhD. He felt that "academic careers in physics are respectable and rewarding, although do not fit everyone's personality." Mr. Norris found that the PSM in Engineering Physics: Instrumentation and Automation at Appalachian State University was just what he wanted–a degree that would "blend together all of the engineering physics traits I enjoyed with some accounting, strategic human resource management, and entrepreneur classes." He is currently an Energy Systems Analyst with Brite Engineering Consultants, Inc. and found that this degree has enabled him to "talk to accountants, manage people, help the company evaluate its position and vision, and perform engineering physics tasks." Additionally, he noted that, "Traditionally, there has been a large gap in the effective communication/ understanding between different fields, for example engineers and accountants or electrical circuit designers and chief officers." The PSM provided the skills needed to bridge this gap.

William Griffin was an undergraduate student nearing the end of his studies in physics and discovered the PSM was the perfect fit, since he didn't want a career in academia. He said the PSM in applied physics at the University of Northern Iowa provided an opportunity to "hone the scientific skills I had learned as an undergraduate into tools that I could easily employ outside of academia. PSM programs "develop the practical skills that employers are looking for while preparing you to succeed in your career," he added. Mr. Griffin is currently employed as a test engineer for DISTek Integration Inc., with his primary responsibility being to create test systems for clients.

The flexibility of the PSM is illustrated by the husband and wife team of Jake and Danielle Philipson, and provides an example of how the PSM can fulfill both professional and personal goals. As working professionals, they understood the need to augment their skills as industry continued to demand more of their employees. At the same time, the online PSM program in Health Physics at the Illinois Institute of Technology (IIT) provided the professional skills they required to be dynamic and innovative in industry, but on their own time. They feel the PSM has given them a "competitive edge not only in our repertoire of skills but in our personal confidence." Mr. Philipson is Section Manager of Radiation Protection and Senior Health Physicist for Ontario Power Generations Nuclear Waste Management Division. Ms. Philipson is Lead Auditor at Bruce Power Nuclear Site, where her duties consist of auditing and program assessment in environmental monitoring, radiation protection programming, and at Bruce Power's licensed dosimetry service.

Chris Fennig is a physicist turned entrepreneur thanks to the PSM Program in Physics Entrepreneurship at Case Western Reserve University. He is convinced "the PSM approach is the key to developing the next generation of entrepreneurial leaders." Currently responsible for ODIN technologies' Self-Inventorying SMART Container product line, his team won the Outstanding Achievement in RFID Technology award in 2009. Mr. Fennig launched a RFID consulting firm during the second year of his PSM program and is now running a multi-million dollar product development initiative inside the high-tech venture he helped create. He credits much of his success to the interdisciplinary nature of the PSM program stating, "My belief in the power of combining technical expertise with business acumen has only been reinforced through on-the-job experience." He feels that he could not have "received this level of professional experience so quickly without the PSM as a growth accelerator."

These are just a sampling of the success stories that PSM graduates have achieved. This exciting innovative degree is also catching the attention of federal policymakers. The 2009 American Recovery and Reinvestment Act stimulus bill appropriated $15 million to the National Science Foundation for PSM program development, with the accompanying Senate report lauding the role of the PSM in creating a strong science and engineering workforce essential to maintaining the Nation's competitive edge. This recognition by the U.S. Congress of the value of professional science education at the master's level adds credence to the idea that a new type of science professional is needed to respond to the needs of continued technological innovation and economic growth. Additionally, the National Research Council of the National Academies produced a 2008 report, *Science Professionals: Master's Education for a Competitive World*, which was in agreement with this sentiment and strongly endorsed the PSM, encouraging even broader support and concluding that these programs provide a powerful contribution to our nation's competitiveness.

Professional Science Master's programs produce highly skilled science-trained professionals who are essential to our nation's advancement. They possess the capacity to translate the knowledge from scientific discoveries into products and services. Some PSM graduates will emerge as leaders in industry, government, and nonprofit organizations and help our nation meet the global challenges of the 21st century.

For further information about the PSM, go to www.sciencemasters.com or www.npsma.org.

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M. Nancy Vincent, Program Manager, Best Practices, Council of Graduate Schools

Donald N. Langenberg, Chancellor Emeritus, University System of Maryland, and a former President of the APS

Table 1

Professional Science Master's Programs in the Physical Sciences	
Appalachian State University	Engineering Physics: Instrumentation and Automation
Arizona State University	Nanoscience
Case Western Reserve University	Physics for Entrepreneurship
Illinois Institute of Technology	Health Physics
New York University	Physics
Oregon State University	Applied Physics
Rice University	Nanoscale Physics
San Diego State University	Medical Physics
Southern Illinois University-Carbondale	Advanced Energy and Fuels Management
Stony Brook University	Instrumentation (Business Track)
Towson University	Applied Physics
University of Arizona	Medical Physics
University of Houston-Clear Lake	Physics, Technical Management Sub-plan
University of Northern Iowa	Applied Physics
University of South Carolina	Modeling for Corporate Applications
University of Utah	Science Instrumentation

[1] Council of Graduate Schools, available at www.sciencemasters.com.

[2] National Professional Science Master's Association, PSM Degree Program Enrollee & Graduate Report, 2009, available at http://npsma.org/assetlibrary/eg_data_report_final.pdf.