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APS physics

Still Time to Vote in APS Election
See Page 6

New Topical Group on Climate Actively Seeks Members

At its meeting on April 29, APS Council voted to establish the new Topical Group on the Physics of Climate. The group's organizers hope to reach out to the physics community to draw in a wide swath of expertise to address climate issues. The group is now actively recruiting members, and the organizers hope to set up a website and newsletter soon and begin organizing sessions at meetings.

According to the group's founding documents, its purview encompasses all research related to the advancement and diffusion of the physics of climate. This includes the measuring and modeling of climate processes as well as what physical effects climate change might have on the planet.

"The group is going to focus on the science of climate and climate change as opposed to the politics or policies, which its charter says specifically not to do," said organizing committee member Brad Marston of Brown University. "It's a very rich and complex area of science."

Organizing committee members emphasized the need to keep the focus on unbiased science rather than politics and partisanship. Council member Robert Austin of Princeton has pushed hard to get the group established, and to keep ideology from dictating the direction of the group's work.

"You'll get an unbiased viewpoint," Austin said, "where you can find clearly written articles that bring the physics out in a major way."

Understanding climate change is rooted in understanding the physics behind it. Many of the biggest questions facing climatologists have to do with understanding the physical principles of atmospheric thermodynamics, radiant solar energy, the fluid dynamics of oceans and the like.

"There are a number of ways that physicists can contribute to a better understanding of climate and climate change," Marston said. "Theorists can contribute by bringing in ideas from statistical physics…computational physicists can bring in expertise, for example, for developing new

GROUP continued on page 4

New APS Online Journal Issues Call for Papers

APS is now accepting physics papers for its new online, open access peer-reviewed journal, *Physical Review X*. Its editors have issued a general announcement to all physicists and institutions, calling for submissions.

"*PRX* is a new journal from the APS. It's looking to publish excellent, high quality papers in all areas of physics and related topics," said Dan Kulp, editorial director at APS.

The first issue of *PRX* is expected to be published online in September of this year, with new papers added as they work their way through the peer-review process. A table of contents listing the accepted articles will be emailed out quarterly at first, then more frequently as more papers are accepted to the journal.

In some ways *PRX* is modeled after APS's flagship publication, *Physical Review Letters*. "It also covers all of physics," said Jorge Pullin, who is the Founding Editor of *PRX*, and Hearne Chair of Theoretical Physics and Professor at Louisiana State Uni-

JOURNAL continued on page 7

Assessment Casts Doubt on Utility of Direct Air Capture of CO_2

APS Panel on Public Affairs (POPA) recently released an assessment that casts doubt on the feasibility of removing carbon dioxide from the atmosphere.

The study, titled "Direct Air Capture of CO_2 with Chemicals: A Technology Assessment" found that using current technology, extracting carbon dioxide from the atmosphere would be significantly more difficult and expensive than reducing carbon emissions.

Direct air capture, or DAC, refers to technologies where air is circulated over a chemical, or a collection of chemicals, that absorbs carbon dioxide and prepares it for sequestration. Some experts claim that constructing large air capture facilities might be used to combat climate change by removing excess carbon dioxide from Earth's atmosphere.

"We believed it was a timely issue with a lot of technical aspects to it and it deserved a closer look from physicists," said Francis Slakey, APS associate director of public affairs.

The assessment put forth by POPA said that because of the tremendous engineering and tech-

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Physics Contributes to New Medical Imaging Technique

By Calla Cofield

Stanford University physics graduate student Nicole Ackerman spent the first three years of her graduate career studying neutrinos. Now she's working in the radiation oncology department, investigating the use of Cherenkov radiation in medical imaging.

"I'm still simulating particles interacting with matter," said Ackerman. "They are just in mice now instead of in a detector."

At the 2011 APS April Meeting in Anaheim, California, Ackerman delivered a general session talk and spoke to reporters about her work.

One of the biggest goals of modern cancer research is to develop better imaging techniques. Imaging is key to early diagnosis, effective treatment, and finding cancer cells that have metastasized. Many medical imaging techniques rely on nuclear and particle physics principles, and yet, says Ackerman, many of the biologists working with those techniques don't understand the physics behind them.

In positron emission tomography, or PET, positron-emitting radioactive isotopes are attached to molecules designed to bind to specific types of cancer cells. When the isotopes decay, they produce gamma rays that signal the presence and location of those cancer cells.

In 2009, scientists in Cambridge, Massachusetts published a proof of concept paper demonstrating that radioactive isotopes used in medical imaging will cause water-dense tissue to emit optical Cherenkov radiation. In materials the speed of light is lower than in a vacuum, and high energy particles may emit Cherenkov radiation when they travel faster than the photons. Radioiso-

IMAGING continued on page 6

Five Funded Sites Join APS Teacher Education Project

By Gabriel Popkin

The Physics Teacher Education Coalition (PhysTEC) project recently announced it would provide funding for five universities to develop their physics teacher education programs. The new awardees are Boston University; California State University, San Marcos; State University of New York at Geneseo (SUNY Geneseo); Virginia Polytechnic Institute and State University (Virginia Tech); and Wright State University in Dayton, Ohio.

The winning institutions were selected during a two-stage review process that began with a pool of 70 applicants. Proposals were evaluated on a number of criteria, including sites' ability to develop their programs into national models, the strength of departmental and institutional support for teacher preparation efforts, and the experience and commitment shown by the proposing teams. The review panel included representatives of APS and the American Association of Physics Teachers (AAPT), which jointly lead the project, as well as external reviewers.

The new awardees will begin major project activities in Fall 2011 and will receive funding for three years. They will join the eighteen institutions that have already received awards from the project since it began in 2001. According to data collected by the project, most of these institutions have made significant gains in the number of high school physics teachers graduating from their programs. PhysTEC sites are expected to increase teacher recruiting efforts; hire master teachers to work within physics departments; develop early teaching experiences; revamp content and pedagogy courses; im-

SITES continued on page 6

April Meeting Prize and Award Recipients

Photo by Kevin Roznowski

At the ceremonial session at the APS April Meeting in Anaheim, the pictured individuals received prizes and awards from APS President Barry Barish. They are, seated (l to r): Douglas Bryman, Laurence Littenberg, M. Granger Morgan, Huichao Song, Lawrence Badar, Jonathan Jarvis, Noemie Benczer Koller. Standing, middle row (l to r): Miguel Jose Yacaman, Chris Quigg (slightly to the rear), Kenneth Lane (slightly to the front), Estia Eichten, Ian Hinchliffe, Richard F. Casten, John F. Ahearne, Silvan S. Schweber, George Amann, James Nelson, Robert Beck Clark. Standing, back row (l to r): Michael Romalis, James M. Stone, A. J. Stewart Smith, Ezra Ted Newman, Christopher J. Pethick, Janet Seger, Matthew Luzum, Jan Mader, Karen Jo Matsler. More information about these recipients is available on the web pages for the individual prizes and awards at www.aps.org/programs/honors .

Members in the Media

"We will not discover dark matter today…We will be doing this again and again."

***Elena Aprile,** Columbia University, after an initial null result from the XENON Dark Matter Project in Gran Sasso, Italy,* The New York Times*, April 13, 2011.*

"We're very, very close… We can't say for sure how long it is going to take to get there. My best guess is four years, maybe five."

***Edward Stone**, Caltech, on the Voyager 1 spacecraft approaching the edge of the solar system,* The Ottawa Citizen*, April 21, 2011*

"It is actually quite illegitimate and unscientific to talk publicly about internal collaboration material before it is approved… So this 'result' is not a result until the collaboration officially releases it."

***Sheldon Stone**, Syracuse University, on the leaked memo hinting at the detection of the Higgs boson,* MSNBC.com*, April 22, 2011.*

"Don't worry, Higgs boson! I would never spread scurrilous rumors about you. Unlike some people."

***Sean Carroll**, Caltech, on the leaked memo hinting at the detection of the Higgs boson,* MSNBC.com*, April 22, 2011.*

"We've got 3,000 physicists spread across the world. Everyone's working away, trying to find something new. Every day, there's bound to be someone around the world who thinks they've got something… There's nothing anybody in the collaboration can or should be saying about this particular rumour."

***Robert Orr**, University of Toronto, on the leaked memo hinting at the detection of the Higgs boson,* The Globe and Mail*, April 24, 2011.*

"She didn't just happen on this, she's been pushing hard on the data sets and pushing to understand the simulations for quite a while."

***Robert Roser**, Fermilab, on a leaked memo by Sau Lan Wu's team at CERN which hints at a possible detection of the Higgs boson,* FoxNews.com*, April 25, 2011.*

''Our society squanders vast sums on trivia and entertainment, yet cannot find some small change to address the burning issue of whether we are alone in the universe.''

***Paul Davies**, Arizona State University, on the shuttering of SETI's new telescope array because of budget constraints,* The Sydney Morning Herald*, April 28, 2011.*

"I think the AMS will be a great uplift for American particle physics."

***Ulrich Becker**, Massachusetts Institute of Technology, on the launch of the Alpha Magnetic Spectrometer on board the Space Shuttle Endeavour,* Washington Post*, Apri1 28, 2011.*

"In the last 30 years, [physicists] were trying to make our theories more complicated by introducing more particles, more dimensions… We decided to go the other way and make theories less complicated in the high energy realm. At high energy [in the early universe], we are changing the background on which the standard model of particle physics is formulated. In 1-D, the problem greatly simplifies."

***Dejan Stojkovic**, University of Buffalo,* MSNBC.com*, April 28, 2011.*

"What we are learning by comparing the new materials with the older ones is that these quasi-localized spins and the interactions among them are crucial for superconductivity, and that's a lesson that can be potentially applied to tell experimentalists what is good for raising the transition temperature in new families of compounds."

***Jian-Xin Zhu**, Los Alamos National Laboratory,* U.S. News and World Report*, May 5, 2011.*

MEMBERS continued on page 7

CORRECTION

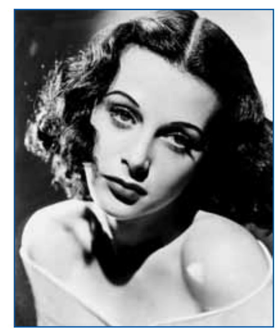
In the May Members in the Media column, *APS News* incorrectly identified the author of a quote from the LA Times. The identification should have been: "Mark Kruse, Duke University, a member of the team at Fermilab that detected the unexpected anomaly in the Tevatron's data." *APS News* regrets the error.

This Month in Physics History

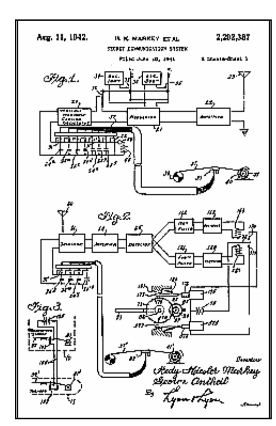
June 1941: Hedy Lamarr and George Antheil submit patent for radio frequency hopping

Fans of classic film know the name Hedy Lamarr for her memorable performances in *Algiers*, *H.M. Pulham Esq*., and *Ziegfeld Girl*, among others. But the actress also made a small contribution to wartime technology with her co-invention of an early form of spread spectrum communication technology, in which a noise-like signal is transmitted on a much-larger bandwidth than the frequency of the original information. It is a staple today in modern wireless communications.

Born in November 1914 as Hedwig Eva Maria Kiesler in Vienna, Austria, Lamarr studied ballet and piano as a child and attending a famed acting school in Berlin headed by director Max Reinhardt. She dropped out of school to be Reinhardt's production assistant and had bit parts in two films before starring in a Czech film called Ecstasy–shocking for the era because Lamarr appeared nude on screen.



Hedy Lamarr



Lamarr leveraged her beauty and notoriety into marriage just before she turned 20, to a man 30 years her senior: Friedrich Mandl, an arms merchant based in Vienna who sold munitions and manufactured military aircraft. Mandl forbade her to continue acting. Instead, Lamarr presided over her husband's lavish parties, attended by Hitler and Mussolini among others, and was often present at his business meetings. As a result, despite her lack of formal education, Lamarr acquired a great deal of knowledge about military technology, most notably guided torpedoes and the vulnerability of radio-controlled weapons to jamming and interference.

Disillusioned with married life– especially her husband's controlling behavior and dealings with Nazi industrialists–Lamarr disguised herself as one of her maids and escaped to Paris in 1937, where she obtained a divorce from Mandl. (She would marry five more times before giving up on the institution.) After she met Louis B. Mayer in London, he signed her to MGM as Hedy Lamarr. In a town filled with stunning women, Lamarr stood out. Actor George Sanders once said that she was "so beautiful that everybody would stop talking when she came into a room."

But Lamarr was more than just a pretty face: she had a natural mathematical ability and lifelong love of tinkering with ideas for inventions. One of those ideas bore fruit when she met her Hollywood neighbor, *avant garde* composer George Antheil, in the summer of 1940.

Born in New Jersey to Prussian emigrants, Antheil studied music in Philadelphia and toured Europe as a concert pianist, before turning his hand to composing. His signature piece was called "Ballet Mécanique," a complicated score originally written for Fernand Léger's 1924 abstract film of the same name. It called for mechanically synchronizing sixteen player pianos, as well as xylophones and percussion. He returned to the US in 1933 to compose for film, and also became a syndicated advice columnist and author of a book about romance and endocrinology.

Legend has it that Lamarr approached him for endocrinological advice, but the two soon began chatting about weapons, particularly radio-controlled torpedoes and how to protect them from jamming or interference. She realized that "we're talking and changing frequencies" all the time, and that a constantly changing frequency is much harder to jam.

This became the basis for their design for a torpedo guidance system. Lamarr contributed the idea of frequency hopping, while Antheil drew on his experience with "Ballet Mécanique" and the sixteen player pianos to devise a means of synchronizing the rapidly changing radio frequencies envisioned by Lamarr. Their joint invention used a mechanism similar to piano player rolls to synchronize the changes between the 88 frequencies–not coincidentally, this is also the standard number of piano keys–and called for a high-altitude observation plane to steer a radio-controlled torpedo from above. They submitted their patent on June 10, 1941, and the patent was granted on August 11, 1942. Lamarr was listed under "Hedy Kiesler Markey," her married name at the time.

It was not an entirely new concept. Nikola Tesla alluded to frequency hopping in 1900 and 1903 patents. A similar patent for a "secrecy communications system" was granted in 1920, with additional patents granted in 1939 and 1940 to two German engineers. And evidence came to light in the 1980s that during World War II, the US Army Signal Corps worked on a communication system that used the spread spectrum concept as well.

Lamarr and Antheil had less success convincing others their idea was feasible. The US Navy felt the clockwork mechanism was too bulky and unreliable to use with a torpedo. It wasn't until 1957 that engineers at Sylvania Electronic Systems Division adopted the concept, using the recently invented transistor for an electronic system.

Antheil died in 1959. As for Lamarr, she went on to make more than 20 more films, most famously Cecil B. de Mille's 1949 *Samson and Delilah*. Lamarr has a star on Hollywood's Walk of Fame in honor of her film career, but she took particular satisfaction in being awarded the Electronic Frontier Foundation Award in 1998, more than 50 years after she and Antheil received their patent.

Lamarr died on January 19, 2000, in her Florida home. She will likely always be remembered more for her spectacular beauty than for her technological contributions, which are usually treated as an intriguing footnote. "My face has been my misfortune," she once observed, describing it as "a mask I cannot remove. I must live with it. I curse it."

Further Reading

Shearer, Stephen. *Beautiful: The Life of Hedy Lamarr*. New York: St. Martins Press, 2010.

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Washington Dispatch

A bimonthly update from the APS Office of Public Affairs

ISSUE: Budget and Authorization Environment

Fiscal Year 2011 and Fiscal Year 2012
In the last edition of the Dispatch, we reported that Congress was working on a short-term Continuing Resolution (CR) to fund the government through April 8th. The CR (P.L. 112-6), which Congress passed in the middle of March, contained funding reductions acceptable to both political parties. With neither side willing to compromise further, the stage was set for a potential government shutdown over the final Fiscal Year 2011 budget. A last minute agreement between the White House and the House Republican leadership, struck on the night of April 8th, averted the shutdown and restored most of the draconian science cuts contained in the original House bill. The agreement (Public Law 112-10) settled federal spending for the remainder of Fiscal Year 2011. A summary of the science appropriations follows, with percentage increases or decreases shown relative to FY 2010.

- DOD 6.1: $1.95 B, +3.7%
- DOE Office of Science: $4.89 B, +1.2%*
- DOE EERE: $1.84 B, -5.6%*
- DOE ARPA-E: $0.18 B†
- NASA Science: $4.94 B, +10.0%.
- NIH: $30.75 B, -0.8%.
- NIST STRS: $0.578 B, +0.1%*
- NIST CRF: $0.070 B, -30.0%*
- NIST TIP: $0.045 B, -35.7%.
- NSF Total: $6.81 B, -0.9%.
- NSF R&RA: $5.52 B, -0.7%.
- NSF MREFC: $0.117 B, 0.0%.
- NSF EHR: $0.863, -1.1%.

* With FY 2010 earmarks removed
† No dedicated program funding in FY 2010

Although science escaped crippling reductions for the current fiscal year, major increases planned for future years are off the table, at least for now. In striking the FY 2011 compromise, the White House stated, "Even though we will no longer double the funding of key research and development agencies, you will still see strong investments in NIST, NSF and the Office of Science." What the Administration means by "strong investments" is unclear. Although the President's FY 2012 budget request treats science generously, it reflects funding plans that predate the FY 2011 accord. It is highly unlikely that final appropriations will in any way resemble the White House proposals. With fiscal conservatives holding the upper hand in the House, FY 2012 is shaping up as even more difficult than FY 2011.

Be sure to check the APS Washington Office's Blog, *Physics Frontline* (http://physicsfrontline.aps.org/), for the latest news on the FY12 Budgets.

ISSUE: POPA Reports

The Direct Air Capture Technology Assessment was approved at the April Executive Board Meeting and was publicly released in May. For a copy of the Assessment, please visit http://www.aps.org/policy/reports/popa-reports/loader.cfm?csModule=security/getfile&PageID=244407.

Representative Randy Hultgren (R-14th IL) introduced legislation in the U.S. House of Representatives in early May, written in response to the recommendations put forth in the POPA *Energy Critical Elements Report*.

At its next meeting, POPA will consider creating an educational component associated with the Direct Air Capture Technology Assessment. The POPA National Security Subcommittee will discuss a possible workshop related to nuclear weapons issues. The POPA Energy & Environment Subcommittee will ask members to consider a follow-on activity stemming from the Electric Grid Study dealing with integrating demand-side management on the electricity grid. Members will also consider a possible addition to the APS Guidelines for Professional Conduct.

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

ISSUE: Media Update

The *New York Times*, *UPI* and *TechnewsDaily* are among the many media organizations that recently published stories on the newly released POPA assessment, *Direct Air Capture of CO_2 with Chemicals*. The assessment, released May 10th, concluded that *Direct Air Capture* would play a very limited role in a coherent CO_2 mitigation strategy for many decades.

In other media news, *The Republic* in Lead, S.D., published a story on May 9th about the importance of funding DUSEL–the proposed deep underground science and engineering lab. The piece pointed out that if the US wants to remain competitive in a global economy, it must make scientific research a priority.

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

A Long and Distinguished Career

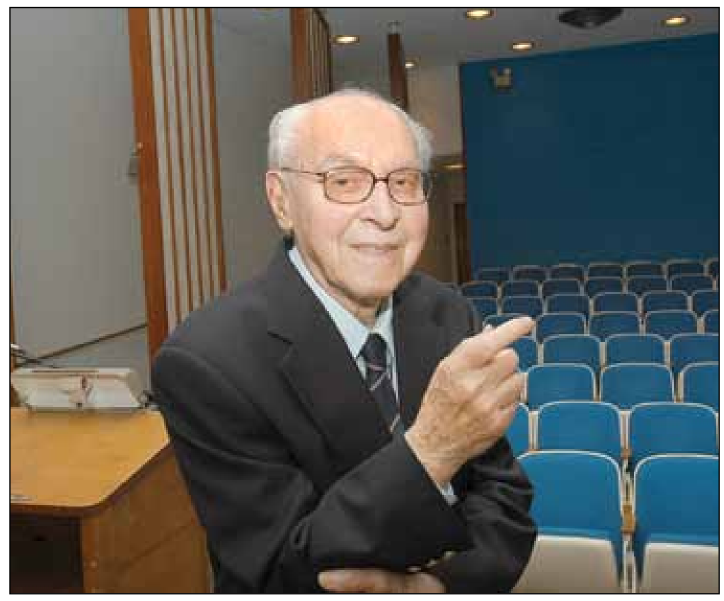


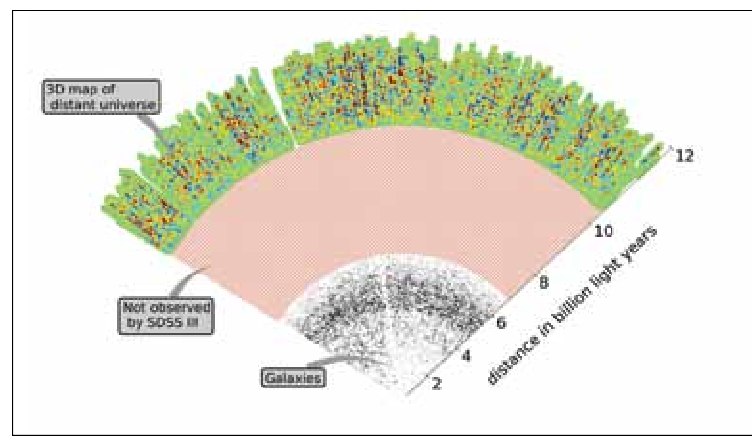
Photo courtesy of Alfred Scharff Goldhaber

Maurice Goldhaber, shown here in a photo from 2003, turned 100 years old this year on April 18, and died on May 11 as *APS News* was going to press. He served as APS President in 1982, one of many accomplishments over a long and distinguished career. He was Director of Brookhaven National Laboratory from 1961 to 1973, and received the National Medal of Science in 1983, as well as the APS Tom Bonner Prize in 1971 and many other awards. Goldhaber was also the senior member of an extensive family in physics. His late brother, Gerson, was professor of physics at Berkeley for many years, and his son, Alfred, is professor of physics at Stony Brook. Both Maurice's wife, Gertrude, and Gerson's first wife, Sulamith, were nuclear physicists, and Maurice's grandson, David Goldhaber-Gordon, is a professor at Stanford in condensed-matter physics.

Quasars Help Researchers See in 3-D

By Michael Lucibella

Researchers with the third Baryon Oscillation Spectroscopic Survey (BOSS) have released the first peek at the largest assembled three-dimensional map of the cosmos. As announced at the APS April Meeting in Anaheim, scientists combined the spectra of over 14,000 quasars to map the location of clouds of hydrogen in the distant universe. The map provides the most complete picture of galaxies forming in the distant past, and could shed light on the nature of dark energy.



The third Sloan Digital Sky Survey mapped the red shifts of both nearby galaxies and distant quasars to create the most complete three dimensional map of the universe.

"The new thing is that we use it to map the universe in three dimensions," said Anže Slosar of Brookhaven National Laboratory. "This is the first time we have dense enough regions of quasars…to combine them."

The team created the map using two different methods. The first is an established technique that looks at the redshifts to determine the recession velocities of galaxies.

To obtain information about the very early universe, right when galaxies were starting to form, the team used a second technique for measuring the spectral lines of quasars. As light passes through interstellar hydrogen, specific wavelengths of light get absorbed and leave a distinct spectral signature. As light travels through the vast intergalactic distances that separate Earth from the distant quasars, its missing spectral lines shift down to lower energies.

"It's like looking at the moon through clouds. You can see the shapes of the clouds by the moonlight that they block," Slosar said.

When the light from the quasar is broken into its constituent wavelengths, hydrogen absorption lines appear throughout the low energy wavelengths. Each line corresponds to a cloud of hydrogen between Earth and the original quasar. The researchers can determine how far away the cloud is by looking at how redshifted each spectral line is.

Each quasar offers essentially a one-dimensional map of the hydrogen in the universe. When data from the 14,000 quasars in the survey are combined, the shape of the distant universe begins to emerge. Slosar compared the quasar's light to ice cores taken in Antarctica and how many thin cross sections can combine to form a three dimensional picture. Up to now, galaxies have generally been used to map spectral lines, but quasars have proved ideal because of their luminosity.

The team took their data at the Sloan Telescope at Apache Point Observatory in New Mexico. The telescope they used offers a unique opportunity to map the night sky because of its wide field of view.

To measure the spectral lines, the team blocked out much of the night sky with flat aluminum plates the size of a coffee table. At precise points, corresponding to where in the sky they were looking, the team drilled small holes in the plates to let in the light of known quasars. They plugged in optical fibers into these holes, and ran the light through a diffraction grating to get the quasar's spectra. Each exposure involved about one thousand targets, and even with the telescope's wide field of view, thousands of exposures were used to assemble the map.

"We're mapping out a million and a half galaxies between us and out a couple billion light years," said David Schlegel of Berkeley National Labs and principal investigator on BOSS.

Slosar said that this preliminary result using data from the first year of BOSS's five-year run demonstrated a proof of concept, and the team plans to continue to study as many as 160,000 quasars to put together a more complete map of the universe.

Already the information is leading to insights about how matter first formed in the primordial universe. Matter like stars, galaxies and quasars first clumped together in areas of higher densities left over from when the universe was a mass of hot matter. Vibrations in the hot primordial soup of the cosmos created denser regions of matter that formed galaxies and quasars when they cooled. By looking at the patterns of where galaxies formed, BOSS's map can help researchers better understand the oscillations of matter only a few thousand years after the Big Bang.

There's a large gap in the survey's ability to map the distant, ancient universe. Nearby galaxies up to about seven billion light years away are easily observed using established methods to measure their red shifts. Starting a little bit more than ten billion light years away, BOSS is able to start taking the red-shifted data from distant quasars.

"This technology does not work [for] low red-shifts," Slosar said.

The researchers hope that the next generation survey, BigBOSS, can fill in some of the missing sections on the map. They hope to further study the expansion of the universe, especially around five to six billion years ago when it's believed the mysterious dark energy first started to manifest itself.

"The problem with BOSS is it doesn't map enough. It's only mapping out some fraction of the way across the universe and that happens to be less than one percent of the volume of the visible universe," Schlegel said. "We can learn more the more we map so the goal is really to map as much of that volume that we can, and that's what we're designing this BigBOSS project for."

Letters

Readers interested in submitting a letter to* APS News *should email letters@aps.org.

Peer Review Weeds Out Good Ideas

Having read in the April 2011 *APS News* the perceptive letter by Alexander Abashian and the reply by APS president Barry Barish, I strongly agree with Abashian that the most pressing issue facing the physics/astrophysics community is not "research funding" but "originality and excellence of ideas." More contact with members of Congress probably will produce "pork," "earmarks" and millions of dollars wasted. Barish argues "we certainly don't lack for good ideas." But the fact is that our peer review system weeds many of them out, unless the author is at a very top-level university. Europe suffers far less from this disease. Hence the LHC is rightly located at CERN.

Peer review does not serve us well today. Barish's claim was partially true in the early fifties when program managers had wide discretion, as was then true at ONR, but when I was a visiting NSF program director in the early eighties, the culture had degenerated so that managers were required to get many opinions and had to decide by counting which was greater, the yeses or noes.

Abashian is correct when he says approaching new members of Congress is counterproductive to getting the best research supported.

Howard David Greyber
San Jose, CA

Clinton Administration Also Responsible for SSC Termination

The Viewpoint in the May *APS News,* entitled "Another SSC Moment?", states that Congress terminated the Superconducting Supercollider (SSC). This was under President Bill Clinton's administration, which did not favor the SSC and which helped in its termination. The termination of the SSC ended the future of experimental high energy physics in the United States.

John Maloney
Olympia, WA

Old Bulls Don't Deserve Respect

Michael Lubell in his May "Inside the Beltway" column says that "Republican freshmen ... have shaken the foundations of Congressional decorum." He adds that "for as long as any of the old bulls can recall ... new members ... are supposed to be seen, not heard, and they are supposed to toe the line, not charge across it."

That, indeed, is really great news! Given the wretched nature of our political class, I am not keen on deference being shown to the "old bulls" (most of whom are old bulls because they represent non-competitive districts anyway). The last time the Republicans were in control of Congress they ran up, totally unnecessarily, massive deficits, and it was the old bulls who did it. Good on the new people; may they not find a home inside the Beltway and become like "old bulls" themselves.

Ken Bolland
Columbus, OH

Don't Show Physics in a Negative Light

With reference to the Profiles in Versatility column in the April *APS News*, entitled "Designing Games in Sin City Pays Off": Olaf Vancura got his physics training presumably helped by taxpayer's money through NSF, DOE or NASA grants. Now he uses his acquired skills and innate talents to help Joe the Plumber depart from his hard-earned money as fast as possible, while making himself and the casino owners rich as fast as possible. As he explains, "The key...is to design games that are fun for the players and keeps them playing, even when they are losing.."

Vancura is certainly entitled to have fun and make a living with his activity, in a free society where gambling is legal. But is it really something we want to advertise in half a page of *APS News*? I'd rather have my member's dues used by APS to publish articles that show physicists using their skills to benefit society–if it's game design, not the kind of games that can lead players to become addicted and lose their livelihood in the process. I don't believe this article sheds a positive light on the physics profession, and I believe it certainly won't encourage taxpayers to support increased government spending in training future scientists.

Jorge E. Hirsch
La Jolla, CA

Another Way to Produce Helium?

Regarding the interesting energy critical elements article (*APS News*, April 2011), another future source of both energy and helium may be their production by Low Energy Nuclear Reactions (LENR) in the Pd-D system. I reported the observation of helium production at the China Lake Navy laboratory in 1991 (see *J. Electroanal.Chem.*, Vol. 346, pp.99-117, 1993), and several other laboratories have reproduced this result.

One can also Google "Nickel Hydrogen Cold Fusion" and read up on Rossi's work focused on the production of commercial reactors. Although Rossi's nickel-hydrogen system differs from the palladium-deuterium system, it is apparently more reliable in producing large amounts of energy.

Melvin H. Miles
Ridgecrest, CA

Eakins Paints Rowland. Questions Abound.

The "This Month in Physics History" column in the April *APS News* on Henry Rowland comments that "Rowland's name became so strongly associated with diffraction gratings that one is featured in his official 1897 portrait by artist Thomas Eakins." There is a scientific curiosity in this impressive (~7x5 foot) painting, considered by many critics to be "the finest example of Eakins' later paintings" (Sidney D. Kirkpatrick, *The Revenge of Thomas Eakins,* Yale University Press, 2006, p. 431)

In the painting, done after about two weeks of sketching Rowland at his summer home on Mount Desert Island in Maine and a brief visit to Rowland's Johns Hopkins laboratory, Rowland is shown seated in front of his ruling engine and holding "a card [grating?] inscribed with the spectrum lines of solar light cast by his diffraction grating" (Kirkpatrick). The curiosity (I have seen the original painting) is that the sequence of colors in the spectrum is yellow-orange-red-green-blue-indigo-violet!

Questions abound. Did Eakins, who was supposedly committed to a "scientific" form of painting, know that this was an error? If so, did he consciously assume the prerogative of "artistic license"? Why? Did Rowland see the final painting (there is no evidence that he did)? If so, and presumably recognizing the error, did he ask Eakins to change it? and did Eakins refuse? I have not found that art historians are interested in answers to such questions.

Samuel Krimm
Ann Arbor, MI

Willa Cather Mentions Rowland

There's a nice literary reference to Rowland in Willa Cather's "The Professor's House."

After Tom's graduation, two courses were open to him. He was offered an instructorship, with a small salary, in the Physics department under Dr. Crane, and a graduate scholarship at Johns Hopkins University. St. Peter strongly urged him to accept the latter. One evening when the family were discussing Tom's prospects, the Professor summed up all the reasons why he ought to go to Baltimore and work in the laboratory made famous by Dr. Rowland. He assured him, moreover, that he would find the atmosphere of an old Southern city delightful.

I have long recommended this book for its insights into academic life, and for the memorable writing about the South-West.

I tried to find out if Cather knew Rowland, but without success.

Leonard Finegold
Philadelphia, PA

Rowland Grating Played Key Role in Quantum History

I read the article about Henry Rowland in the April *APS News* with great interest. To this I would like to add the following:

In 1903, Friedrich Paschen at the University of Tuebingen gained access to one of the best Rowland concave diffraction gratings for his research. Paschen had accepted the appointment as Ordinarius of Physics at Tuebingen in 1901. The diffraction grating had been given to him at the factory price for the concave mirror. Subsequently, the diffraction grating in Tuebingen became world famous because of the research results of Paschen and his students.

From 1912 until about 1930, Paschen's spectroscopy laboratory in Tuebingen obtained important results for the development of atomic and quantum physics: the Paschen series in the hydrogen spectrum, the Paschen-Back effect discovered in 1912 together with Ernst Back, ortho- and para-helium, the fine structure of He+, and the precision measurement of the Rydberg constant. Starting from the experimental data originating from the Rowland grating in Paschen's laboratory, Arnold Sommerfeld developed his quantum theory of the structure of atoms.

Rudolf Huebener
Tuebingen, Germany

GROUP continued from page 1

algorithms…experimental physicists can bring their expertise to perhaps develop new tools."

The group's charter identifies five main focus areas for the group. These include understanding climate as a complex dynamic system, the physics of climate influences, the sensitivity of climate, methods used to infer past climates and new techniques for gathering and analyzing climate data. It also highlighted specific disciplines in physics especially pertinent to understanding climate science, including fluid dynamics, modeling nonlinear systems, physics of complex systems, gas phase physics and chemistry, heat transfer, phase transitions, measurement science, computational physics, statistics and biophysics.

The group came about after two separate petitions began circulating last year to establish a topical group on climate. Ultimately the two efforts merged, and a single plan for a group was agreed upon at a meeting in December of last year.

zero gravity

By Michael Lucibella

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INTERNATIONAL News

...from the APS Office of International Affairs

Committee on International Freedom of Scientists Combats Rights Violations Worldwide

By Kyler Kuehn

The Committee on International Freedom of Scientists (CIFS) is one of the many Committees appointed by the APS President to carry out the mission of the APS. In the case of CIFS, that involves addressing situations where the human rights of scientists have potentially been violated, whether that violation is directly related to their scientific work or not. The most recent high-profile case that CIFS was involved in was that of Igor Sutyagin (see the August/September 2010 issue of *APS News*, available online), but CIFS was active for many years prior to that as well. In the past, CIFS members had supported a Chinese scientist sentenced to 11 years in prison for attempting to found the China Democratic Party. At that time, CIFS members were able to contact the scientist's family and attempt to visit him directly; the publicity CIFS brought to his situation in this manner is believed to have contributed to his improved treatment in prison and, eventually, his early release.

While these are two of the more recent "success stories," there are many additional cases that CIFS is currently dealing with that are not as prominent. For example, in 2009, CIFS, along with many other academic and professional societies, wrote to the Spanish Ministry of Housing to protest the exclusion of a number of Israeli students who were prevented from participating in an international competition held in Spain. Since that time, CIFS has also worked to encourage the Israeli government to lift the travel restrictions on other students who have been prevented from traveling outside of Israel/Palestine to continue their education. CIFS has also sought the removal of sanctions brought by the European Union against an Iranian scientist whom the EU claims is involved in illicit nuclear programs within Iran, but whom CIFS believes to be "blacklisted" erroneously. CIFS has also been monitoring the situation in Turkey that developed in 2009, in which a scientific publication removed articles and references to Darwin and evolution, and disciplined the editor in charge of that publication. The APS (along with many other scientific societies and prominent individual scientists) voiced their concern over this action; and though the publication has planned a future edition to focus on such topics, it is not clear as of *APS News* press time whether that edition has yet been published.

While most of the cases CIFS deals with are outside the US, it may surprise many APS members that CIFS is actively involved in cases within the US as well. One recent case involved the alleged improper transfer of sensitive information from a US scientist to a foreign national–in this case, a subordinate working on research with that scientist. While the APS International Affairs office has worked for many years to clarify the nature of exports and the regulations surrounding them, CIFS is also teaming with the APS Forum on Graduate Student Affairs (FGSA) to ensure that any student (especially foreign students) in potentially sensitive situations are aware of the restrictions that the US Government has placed upon their access to certain knowledge and technology. Furthermore, CIFS is partnering with FGSA on a number of other projects, including the publication of a document detailing graduate students' "rights and responsibilities" within the university environment. CIFS has also offered feedback to FGSA on a forthcoming survey regarding the climate of departments and universities with respect to gender and sexual diversity.

Additionally, CIFS works with several other larger human rights organizations, including Scholars at Risk and the AAAS Science and Human Rights Coalition. The former helps displaced scientists into new positions where their skills can be utilized, and the latter includes a working group on the welfare of scientists with whom CIFS has been cooperating.

All of this work is carried out by a small group who have volunteered to serve on CIFS. APS members can help CIFS by telling their colleagues about it so that those who may experience violations of their rights will know of this avenue for assistance. They can also report human rights violations to CIFS by contacting Michele Irwin, International Affairs Program Administrator, at mirwin@aps.org and can find information regarding joining the "Friends of CIFS" network on the CIFS page of the APS website. Finally, APS members can consider serving on the committee themselves–new positions on CIFS are filled every year by volunteers from within the APS.

Kyler Kuehn is a member of the Committee on International Freedom of Scientists. He is in the High Energy Physics Division at Argonne National Laboratory.

ASSESSMENT continued from page 1

nical obstacles "DAC is not currently an economically viable approach to mitigating climate change," and that "it is entirely possible that no DAC concept under discussion today or yet to be invented will actually succeed in practice." Carbon dioxide in ambient air is so sparse that the structures needed to make an appreciable difference would be so massive that their cost would be prohibitive. The assessment found that it is far more cost-effective to clean the exhaust of sources of carbon dioxide like power plants, factories and foundries.

"The report basically comes to the conclusion that because of the challenge of pulling such a dilute concentration of CO_2 out of the air, isolating it and sequestrating it…. direct capture from air is much more expensive," said co-chair Michael Desmond of BP. "You really should be going after all the big point sources first."

The air capture facilities would need to be immense. One estimate is that in order to remove the six million metric tons of carbon dioxide emitted by an average 1000 megawatt power plant, the DAC system would have to have ten meter tall towers for 30 kilometers. The committee estimated that with existing technology it would cost at least $600 per ton of carbon dioxide removed from the air, as compared to the roughly $80 per ton when removed from major carbon dioxide producers like power plants.

Committee chair Robert Socolow of Princeton said that the prices were meant to be a way of comparing the costs rather than an absolute dollar value. "The ratio is more important than the numbers," he said.

Desmond echoed this statement, and compared that to the cost per ton of completely decarbonizing transportation. He said that if all vehicles switched to electric and all fossil fuel power plants were replaced with renewable energy, the cost would be about $200 to $300 per ton. He added that the $600 was probably on the low end of estimates, as unexpected costs inevitably surface when a new technology is first implemented.

"You don't know what you don't know," Desmond said. "When you try to integrate things, costs almost without exception go up."

Air capture is difficult because carbon dioxide in air is very dilute, around 390 parts per million. The process needs a large surface area to absorb the carbon dioxide at an appreciable rate. Concentrations of carbon dioxide in smokestacks and exhaust flues are much greater, making it much more economical to deploy carbon capture technology there, rather than in ambient air.

The assessment did find that direct air capture technology has much in common with carbon capture inside of smoke-stacks and exhaust flues.

"It's got similar principles…. [it's] trying to pull CO_2 selectively out of a gas stream," Desmond said, "In most cases you should be able to apply that learning to the more difficult problem of direct air capture."

The assessment concluded that further research into direct air capture would likely be of the most benefit to carbon capture in smokestacks and exhaust flues, and advances there could be transferred to direct air capture as well.

Egg-streme Sport

Photo by Matthew Payne

On May 13, Six Flags America held its annual physics day, hosting hundreds of middle- and high-school students from around the Washington, DC area. APS was there too, together with its partners, the American Association of Physics Teachers (AAPT) and the American Institute of Physics' Society of Physics Students, to organize the event and provide fun physics experiences for the students, using the roller coasters and other rides at the park. New this year was an egg-drop contest, in which 35 teams vied to engineer the best device that would prevent an egg from breaking when dropped from an upper-storey window. In the photo, Melissa Lapps of AAPT gingerly displays one of the failed attempts, as some of the participants look on.

Neutrinos Can Monitor Changes in Reactor Fuel

Physicists working with the International Atomic Energy Agency (IAEA) have been developing a way for nuclear weapons inspectors to use neutrinos to monitor reactors remotely and in real time. With more development, it should be possible to detect if any of the reactor's spent fuel has been removed for possibly nefarious purposes.

Spent nuclear fuel has long been a major source of concern for anti-proliferation experts, who fear that the plutonium produced in reactions could be diverted for building weapons. This new system could augment the IAEA's inspection regime and help to better keep track of dangerous fissile material.

"Current safeguard systems are effective, but they require some cooperation and they also don't provide real time monitoring. We think we can improve this with antineutrino detectors," said Fangfei Shen of MIT, speaking at the APS April Meeting in Anaheim.

All fission reactions produce antineutrinos when the bonds holding the nuclei of uranium together are broken. When an isotope's nucleus splits, it releases antineutrinos with a distinct signature, which the team's detectors can monitor. Neutrinos make the perfect indicators because they can't be blocked or suppressed.

"Antineutrinos are very independent particles, they go through everything. You can't stop them. You can't fake them. What comes out of the reactor is what's there," Shen said.

As uranium-235 is used, some of it is converted to plutonium, the material of choice for most modern nuclear weapons. In order to retrieve this plutonium in most nuclear reactors, typically the reactor has to be shut down and the spent fuel rods removed for reprocessing while fresh uranium is added.

The detectors that the team has developed can register when a nuclear reactor has been shut down, and more importantly can detect if plutonium has been removed and replaced with fresh uranium. If the monitors detect an unexpected and sudden spike in the energy of the neutrinos, plutonium has been replaced with uranium.

"What we are providing for the IAEA is a means to determine analytically the amount of uranium and plutonium in a reactor core in a real-time environment," said Gregory Keefer of Lawrence Livermore National Laboratory.

The two prototypes developed by the team have shown promising results so far. The first, a one-ton water Cherenkov light detector, has been in place at the San Onofre Nuclear Generating Station in Southern California since July of last year. Located about 50 meters from one of its pressurized water reactors, the detector has been reading the neutrino signatures of what's happening inside the reactor in almost real time.

"In the first prototype, we've shown that we are capable of determining if the reactor has been turned off within five hours. We can determine over the time of one week what the absolute thermal power of the reactor is to three percent. During these refueling outages this was a chance for us to really determine what the amount of plutonium difference would be," Keefer said. "We're capable of saying with a 95% confidence level that during refueling there was a 70 kilogram removal of plutonium."

The team also installed a second, more advanced prototype at San Onofre in December. This one is a prototype segmented liquid scintillator, which can identify several kinds of events including

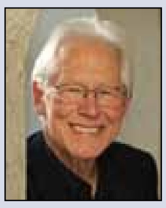
NEUTRINOS continued on page 7

Still Time to Participate in APS Election

The APS society-wide election is open this year from May 16 to June 30, so there is still time for members who have not yet done so to cast their ballots. Each member with an email address should have received a message containing the unique identifier that will enable him or her to proceed to the election website and vote. Others should have received their ballots in the mail. Below are the candidates running for the various society-wide offices. More information, including biographies and candidates' statements, can be found on the web at http://www.aps.org/about/governance/election/index.cfm .

Candidates for Vice President

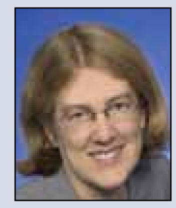
Malcolm Beasley
Stanford University



Pierre Hohenberg
New York University

Candidates for Chair-Elect, Nominating Committee

Sally Dawson,
Brookhaven National Laboratory

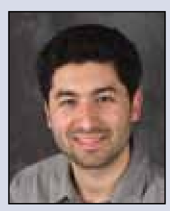


Robert Tribble,
Texas A & M University

Candidates for General Councillor

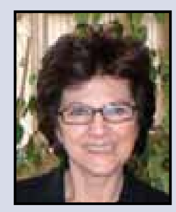
Ernesto E. Marinero
Hitachi San Jose Research Center/Purdue University

Keivan Guadalupe Stassun
Vanderbilt University



Candidates for International Councillor

Luisa Cifarelli
University of Bologna



Annick Suzor-Weiner
French Embassy, Washington, DC

SITES continued from page 1

prove advising and mentoring; and develop collaborative relationships between physics departments, education schools, and local school districts.

According to Theodore Hodapp, Director of Education and Diversity at APS and PhysTEC project director, this year's crop of new sites shows exceptional institutional commitment to making their programs sustainable. "We fund sites for three years, enough to get their programs off the ground," said Hodapp, "but we expect them to show us up front how they will sustain things in the future. We're confident that this year's sites will be able to keep their programs running after PhysTEC funding ends."

Hodapp also noted that the universities joining the project increase the geographic diversity of the project's sites. "We have found that most PhysTEC teachers tend to find jobs close to the universities they graduate from, so it is important that the project be represented in as many parts of the country as possible. We now have our first site in New England, our first in the Appalachian region, and our first in Ohio."

Beate Schmittmann, physics department chair and project leader at Virginia Tech, agrees that her department is poised to address regional needs for physics teachers. "We know that physics is significantly less available to students in smaller high schools, and most of the schools in our region are relatively small, with 300 seniors or fewer," said Schmittmann. "We felt that we would be able to impact both the rural parts of the Commonwealth of Virginia as well as the more urban areas where some of our alumni are teaching."

Monica Plisch, Assistant Director of Education at APS and PhysTEC project co-director, also noted that the new sites include several types of institutions that are underrepresented within the project. "SUNY Geneseo is a bachelor's degree-granting physics department, of which we have very few, despite the fact that they educate over 40% of physics majors in the country. And Cal State San Marcos is a Hispanic-Serving Institution, which is important as we work to increase the diversity of the physics teacher corps."

In addition to funding new sites, the project has made a one-time award to a team proposing a video project illustrating interactions between undergraduate peer instructors, called Learning Assistants, and students whom they work with. This project will be led jointly by researchers and faculty members from Seattle Pacific University and Florida International University, both universities that have received PhysTEC funding in the past. "This video project is a new concept for PhysTEC, and we feel it has potential to improve courses for future teachers around the country," said Plisch.

PhysTEC is funded by a five-year, $6.5-million grant awarded by the National Science Foundation in Fall 2009, as well as APS 21st Century Campaign.

IMAGING continued from page 1

topes have been used to treat cancer for over fifty years, and while some biologists and doctors had noted the optical glow before, no one, it seems, had thought to use it.

In a preclinical and research setting the technique offers some significant benefits over PET scans, including the fact that optical scans only take 3 minutes, where PET scans take 30, and optical scanners are less expensive and used more frequently by research staff.

In the future, Cherenkov light may offer imaging where there is currently none. There are presently no direct ways to image alpha and electron emitters in the body. Cherenkov radiation, however, can be used with positron, gamma, electron and alpha emitters, at short time intervals. Rather than delivering one dose of radioactive isotopes to image a tumor and a second to treat it, doctors could watch the treatment dose directly.

Because Cherenkov light is optical, it scatters quickly when traveling through tissue and would likely be used to image shallow tumors such as skin cancer or some breast cancers, or cancer of the esophagus, viewed via an endoscopy. A recent paper proposed using Cherenkov light immediately following tumor removal surgery, to see if any cancerous cells are left behind. Another group has proposed using a molecular component called a fluorophore that would lengthen the wavelength of the Cherenkov light at its source, and allow it to travel further through tissue to a detector.

Ackerman's work is focused on modeling the path of the Cherenkov photons as they travel through tissue. She uses a software program called Geant4, which was designed to model particle tracks in high-energy physics experiments. She says she isn't sure yet how exactly the models will be used, but she wants to understand the mechanisms behind the observations her group is making.

"I don't mind thinking about cross sections and spectra and path length, but the biomedical researchers don't want to," said Ackerman. "My goal is to find the places where the physics details are important and then take the equations and simulations and turn them into something useful for the other researchers in the field."

Early in her involvement with the oncology group, Ackerman was studying the Cherenkov radiation from actinium 235, one of the isotopes used by the group in tumor treatment because it releases an alpha particle. She realized that this alpha particle shouldn't be fast enough to generate Cherenkov light in tissue, and yet, there was clearly an optical signal when they injected actinium 235 into mice. She deduced that daughter isotopes of the Actinium actually release a beta particle responsible for the Cherenkov light, and that this is the case for all the alpha-decay isotopes used by the group. Researchers could still use the Cherenkov light to monitor alpha particles used for treatment, but they would have to consider the time delay between the release of the alpha particle and the release of the beta particle, and a difference in the location of the parent isotope and the source of the radiation. Ackerman is currently investigating another isotope that causes Cherenkov radiation, even though it doesn't appear to emit high enough energy particles to do so.

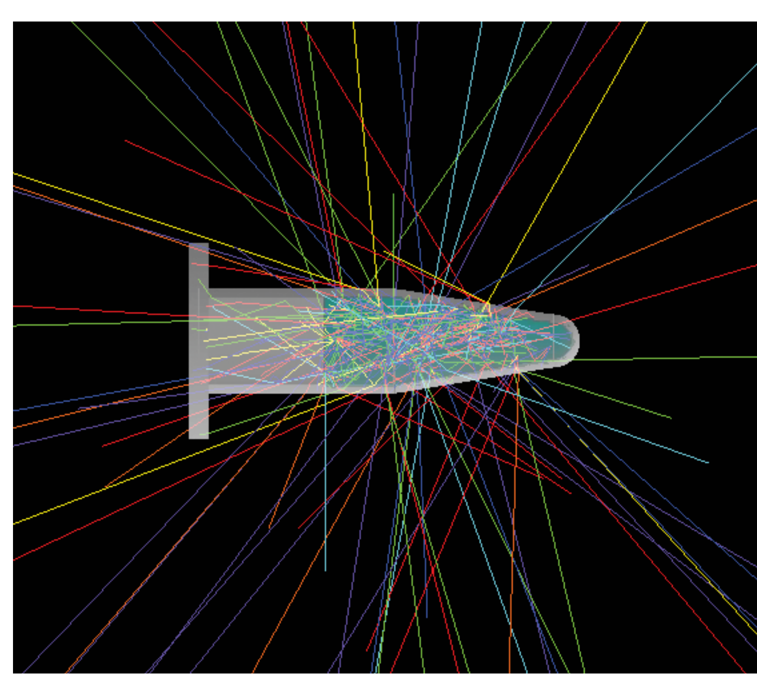


Image courtesy of Nicole Ackerman

Inside an Eppendorf tube, Cherenkov photons are released from the decay of fluorine 18 in water. The paths of the photons are reconstructed from data, and while the light is too faint for human eyes to see, the color of the photons in the image corresponds to their actual wavelength.

Ackerman says she never planned on switching to biological physics mostly because she had no idea what it entailed. While attending the Lindau Nobel Laureate conference in Germany last summer, she saw, for the first time, professional biology and chemistry lectures, and was fascinated by the range of applied physics topics presented there. Once she saw how her skills would be valuable in an area dominated by biologists, the decision to transition came easily.

Now Ackerman is putting her physics knowledge to work on various topics within the radiation oncology department. For her thesis project she will look at how radiation interacts with cells to kill them, while exploring ways to boost those interactions.

"I might not find a new particle or a new law of the universe, but that's okay," said Ackerman. "Instead I might be contributing to saving lives. I really feel like I can do some good here."

Japanese Physics Undergoes a Slow Recovery

By Michael Lucibella

The effects of March's devastating earthquake and tsunami in Japan have touched all aspects of society, including science. Research at labs near the earthquake epicenter has either been slowed or been halted altogether by damage to the labs themselves and by ongoing power shortages.

The J-PARC facility located in Tokai, about 250 miles away from the epicenter of the earthquake, is home to several research particle accelerators and beam lines. Although it abuts the shoreline, it suffered no damage from the tsunami because of seawalls designed to protect the facility from ocean swells up to eight meters high. The earthquake did damage some of the equipment; however it should all be reparable. Experiments at the lab have been suspended for the time being. At the Materials and Life Science Experimental Facility, five of the sixteen neutron beam lines have been knocked out of alignment and the lab's linear accelerator will have to be realigned as a section in the middle sank about four centimeters.

"All accelerator elements and experimental elements have undergone only minor damage, due to the strong underpin reinforcements used in the major buildings," said Shoji Nagamiya, director of J-PARC. "However, surrounding facilities such as power stations, electric power lines [and] water lines were severely damaged. Roads also suffered much damage."

At the Photon Factory at KEK, located in Tsukuba, no one was injured at the site, but the facility and equipment sustained significant damage. KEK's Linac was knocked out of alignment as much as ten centimeters in some places, its vacuum was breached and one of its focusing magnets fell. The buildings around the site have likewise shown signs of buckling and stress.

"We are still in the process of assessing the damages to the accelerators and apparatus," said Youhei Morita, head of the public relations office at KEK. "There are many broken vacuum beam pipes, some fallen magnets, misplaced alignments of the beam lines, broken klystrons [and] fallen electronics racks." Morita added also that though the experiments and buildings have been damaged, so far it looks like nothing is irreparable as they continue to assess the situation.

The medical accelerator at HIMAC in Chiba has limited operations because of power shortages. Research labs that have continued normal operations include the KamLAND and Super-Kamiokande neutrino detectors in the Gifu Prefecture, the Ring Cyclotron in Osaka, SPring-8 Synchrotron Radiation Facility and XFEL in Harima.

The main site of RIKEN is located just outside of Tokyo in Wako. A spokesperson for the institute said that the facility was largely unaffected by the earthquake, and research has been able to continue with only minimal disruption. The administrators of RIKEN invited scientists affected by the earthquake and tsunami to come to Wako and continue their research.

"We launched a program to provide support to doctoral students and researchers in the affected area who have not been able to attend university labs due to the disaster by inviting them to continue their research at RIKEN and offering experiment samples and materials," said Yasuaki Yutani, director of RIKEN's global relations office.

Other facilities around the world have pitched in to help Japanese scientists continue their research. The Spallation Neutron Source at Oak Ridge National Laboratory said that it is setting aside 10% of its beam time for Japanese researchers to continue their work.

A full recovery for Japanese science will take some time. Early estimates at J-PARC are that the facility won't be back up and running at its original capacity until December at least, provided that inspections don't reveal additional critical damage to the equipment. Similar estimates at KEK put it on track to restart sometime in autumn. Inspections and repairs have been slowed because of power and supply shortages as the region continues to recover from the disaster.

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versity.

The editors hope that *PRX* will include papers spanning the whole spectrum of physics research. In addition, because of its broad focus, it should attract a lot of interdisciplinary research that would have a more difficult time finding a home in the more specialized journals.

The new publication differs in several respects from other APS journals. The entire journal is open access, meaning that there are no fee or subscription costs to readers who want to access it. In addition, the journal is published under the terms of the Creative Commons Attribution 3.0 License, which allows anyone to freely reproduce any amount of the publication as long as the original work is properly cited. Because the journal is online only, there are no limits to lengths of the articles. The journal will be supported by a $1,500 per article processing charge, usually paid by the author or the author's institution.

The journal should offer physicists the chance to have their research widely read. The number of papers published in the first issues is expected to be relatively small, so each will have a great deal of visibility.

"This is an opportunity to come into the APS community," Kulp said. "What we're offering to [authors] is recognition. It is a *Phys Rev* journal, it's highly regarded, the journals are extremely well read… *PRX* is going to be as good as it can possibly be, but it's all contingent on what comes in our front door."

The decision to make *PRX* all open access and freely reproducible is part of an effort by APS to give authors more options about the redistribution rights of their work. Already APS has two specialized open access online journals, *Special Topics: Accelerators and Beams* as well as *Special Topics: Physics Education Research.* In addition, APS recently began offering authors the ability to purchase Creative Commons Attribution 3.0 Licenses for work published in the subscription-based *Physical Review* journals.

"Open access is going to be a big part of the future of publications," Pullin said.

The American Institute of Physics recently started the open access journal AIP Advances, and offers authors the option to buy open access rights in their other journals as well. Many major institutions, such as CERN, have requirements that research originating from them be published under some form of open access license.

Publishing online offers other benefits as well. Pullin said that down the line they hope to incorporate more multimedia into the publications, such as video, animated figures and word tagging.

Authors can find information about submitting their work to the journal at prx.aps.org.

MEMBERS in the Media continued from page 2

"We have to deal with our centralized power sources first… This is not an assignment for the next few decades."

***Robert Socolow**, Princeton, on the efficiency of removing carbon dioxide from air versus from centralized sources like power stations,* The New York Times, *May 9, 2011.*

"He's got the scientific chops."

***Robert Beichner**, North Carolina State University, on Nobelist Carl Wieman's study on effective teaching strategies,* The Associated Press, *May 13, 2011.*

"Physicists will never cease testing their basic theories, whether in order to confirm them better or in order to reveal new physics beyond those standard theories. In some realms the only place to do this, to carry out such experiments, is in space. This was the case with [Gravity Probe-B]."

***Clifford Will**, Washington University in St. Louis,* BBCNews.com, *May 14, 2011.*

ANNOUNCEMENTS

Reviews of Modern Physics

Recently Posted Reviews and Colloquia

Continuous-time Monte Carlo methods for quantum impurity models

Emanuel Gull, Andrew J. Millis, Alexander I. Lichtenstein, Alexey N. Rubtsov, Matthias Troyer, and Philipp Werner

Quantum impurity models were introduced to describe atoms or molecules embedded in a host material and are now understood to be a central concept in condensed matter physics with applications ranging from modeling the conductance and other properties of quantum dots to auxiliary problems whose solutions help reveal the physics of complex heavy fermion and oxide materials. This review describes a new family of numerically exact methods solving quantum impurity problems. The methods are based on continuous-time quantum Monte Carlo algorithms which are free from the time discretization errors which occur in standard quantum Monte Carlo approaches. They enable solutions of broader classes of models, over wider parameter regimes, than previously possible. A description of the new methods is given, along with a review of the systems to which the new methods have so far been applied, with a goal of enabling the readers to implement and use the algorithms described.

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neutrons and gamma rays. This feature comes into play because these neutrino detectors are located above ground, so they need to differentiate between normal background signals from cosmic rays, and neutrinos generated in the reactor. The team is still sifting through the data from this second detector, and should be finished with the analysis by the end of the year.

The IAEA also asked the team to develop a way to monitor another kind of reactor more difficult to keep tabs on: bulk process reactors. In order to remove the plutonium from pressurized water reactors like the ones at San Onofre, they have to be shut down, which is easily detected by a drop off in neutrino production. The fuel in bulk process reactors moves through it on a kind of conveyor belt. Fresh fuel goes in one end and spent fuel can come out the other, without ever shutting down. The team has developed another prototype detector, this one to be installed at the Point Lepreau Nuclear Generating Station in New Brunswick, Canada next year to start developing a profile of the neutrino flux in these reactors.

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The Back Page

Can we declare victory in the participation of women in science? Not yet.

By Marie-Claire Shanahan and Zahra Hazari

"When will we know when we can declare victory? For years I proceeded on the assumption that victory was equal participation of men and women in all branches of science and engineering. Today I'm not so sure. ... It's possible that we will come to understand that some fraction of the asymmetries in the distribution of women in the sciences, with women far more well represented in the life sciences and less so in the physical sciences, is the result of women seeking those fields in which they are able to make the greatest contribution *in their own judgment*. As scientists we have to be open to that possibility."

Shirley Tilghman *President of Princeton University, speaking at Queen's University*[1]

The question of gender representation in science is an incredibly difficult one. Women are underrepresented in science as a whole, especially in senior positions, but the disparity can be even more dramatic, or in other cases disappear, when we narrow the focus to particular fields.

Over the last half century, efforts to recruit and encourage women to pursue careers in science have been very successful, but they have not been evenly distributed. In 1966, for example, women earned only a quarter of the undergraduate biology degrees awarded in the United States. By 2007, however, women out numbered men, earning 60 percent of these same degrees. In physics, though, the numbers have barely budged, with the percentage of undergraduate degrees earned by women rising from 14% to only 21% over the same time period. The question, of course, is "why?"

Most recent studies, such as Hyde and Linn's 2006 review in *Science*, have shown very little difference in science-related abilities between genders, including in physics. These small discrepancies are not nearly enough to explain the large participation gaps. So what is keeping women out of physics? Is it as Dr. Tilghman suggests, that women just don't choose to put their efforts into physics because they feel they can make a greater contribution elsewhere? Or, maybe women are not interested because they don't see how physics fits with their desire to work with people? Looking into career aspirations of college students often shows that more young women than men desire careers that afford interpersonal opportunities such as helping others.

These might seem like comforting explanations – no discrimination, just choice–but they are also too simple.

What influences students' decisions to pursue physics?

As early as the eighth grade, the interest that students show in science is one of the best ways to predict whether they will go on to receive a bachelor's degree in science. Robert Tai, from the University of Virginia, has found that this link is even more important than their mathematics achievement.

Personal interest isn't, however, the only factor. Students' belief in their own abilities is extremely important. Students with high self-efficacy, confidence in their ability to succeed at particular tasks, tend to understand physics better and achieve better grades. This makes a lot of sense –if students don't believe they have the ability to master new ideas and problems, it is easy to see why they might not persevere. This relationship is true for both male and female students, but female students tend to believe in their abilities less, contributing to the difficulties they can encounter in physics.

Parents, teachers and peers also have strong influences on students' perceptions of their own abilities, affecting students' career and degree choices. In one study, Bleeker and Jacobs from Pennsylvania State University followed students from age 12 to age 24. They asked the students and their parents about the student's math and science interests, abilities and career aspirations. They found that the more mothers believed in their children's science and math abilities in grade 7, the more likely those students were to pursue careers in science at age 24. Peers can have a similar impact, supporting or eroding students' belief in their own abilities. In another study, Jacobs noted that even girls who were identified as talented in science were strongly influenced by the recognition and support they received from their peers. These social influences can be troubling because parents, teachers and even peers often have stereotypical views of interest and ability in science, views that tend to favor male students.

Together, studies like these illustrate how challenging it is to pinpoint a single cause for the underrepresentation of women in physics. There are elements of interest and self-confidence, but also difficult social pressures. With these challenges in mind, what is needed is not acquiescence but the continued search for solutions. We still need to know what can be done to support and encourage students, and girls in particular, to pursue careers and graduate studies in physics.

Zahra Hazari

Marie-Claire Shanahan

Looking for solutions in high school physics experiences

One such effort, the Persistence Research in Science and Engineering Project[2] (PRiSE) led by researchers at the Harvard-Smithsonian Center for Astrophysics, is trying to identify the impact of teaching environments and strategies on students' decisions to enrol and continue in physics in university. As part of the project, they have surveyed 3,800 American undergraduate students about their physics interests, confidence, and career plans along with their experiences in high school physics classes.

Together with colleagues Gerhard Sonnert and Philip Sadler, we used the survey data to create a measure of each student's "physics identity," the degree to which they perceive themselves to be the right type of person for physics.[3] Being the right type of person means, for example, having confidence in their ability to complete the right tasks (e.g., understand and solve difficult physics problems), having a strong interest in physics, having others recognize them as the right type of person, being successful in physics, and choosing to participate in physics-related activities. We found that our measure of identity was a very good way to predict students' desire to remain in physics and pursue it as a career.

Once we were confident that our measure of physics identity was a valid way of bringing together many of the social and personal factors that tend to influence career choice and persistence, we wanted to know what could be done to improve it. As physics educators, we were particularly interested in finding out which teaching strategies or classroom activities contribute to stronger and more positive physics identities, especially for female students.

To answer these questions, the PRiSE questionnaire asked students what they remembered about their high school physics experiences: what they did in class, how they were taught, and the types of resources they had available. In addition to strictly pedagogical questions about lab time versus lecture time, topics that were emphasized, and instructional strategies that their teachers used, we were also interested in whether students recalled their physics teachers taking time to address subjects that generally fall outside of the usual physics curriculum such as discussions of the benefits of and steps needed to pursue a career in physics, ethical considerations in science, and the underrepresentation of women.

Supporting women by recognizing underrepresentation

Looking at all of the students, male and female, there were several classroom factors that were related to stronger identities. From the perspective of generating student interest, it wasn't surprising that teachers who introduced current and cutting edge physics topics contributed to stronger identities. Frequent labs addressing students' beliefs about the world, opportunities for peer teaching, and encouraging student questions and comments were also related to stronger physics identities. Students with stronger identities also remembered receiving encouragement from their teachers to pursue physics and having discussions in class about the benefits of being a scientist.

But what about women in particular?

Usually, the strategies that come to mind for encouraging female students include providing positive female science role models, creating opportunities for collaborative group work, and discussing the lives of female scientists. We were very surprised, though, that none of these usual solutions had an effect on the physics identities of the students in our study. Female students who experienced them were no more likely than others to have strong or weak identities in physics.

Several of the positive classroom experiences described above, however, while having an equal impact on male and female students were less frequently reported by female students. For example, females were less likely to report a focus on conceptual understanding, that labs addressed their beliefs about the world, discussing relevant science topics, or discussing the benefits of being a scientist. Thus, sitting, on average, in the same types of physics classes, female students perceived less of a conceptual focus and less contextual relevance with their world than did their male counterparts, even though these associations were equally beneficial to the smaller number of females who did report them. This perhaps provides some support for previous findings, such as those of Heidi Carlone, suggesting that many female students are personally disengaged in introductory physics, often relying on rote learning strategies (e.g., memorization) over more meaningful strategies (e.g., understanding concepts, linking to other knowledge/experiences, connecting ideas, reasoning) that provide deeper connections to the conceptual material.

There was only one classroom experience that had a uniquely positive impact on female students: the explicit discussion of underrepresentation of women in science. This isn't just highlighting women scientists like Marie Curie but instead talking directly about the fact that there are few women in physics. Female students who had experienced these discussions in their high school physics classes had significantly stronger physics identities. Furthermore, these discussions had no impact on male students. In other words, for students who experienced explicit discussion of female underrepresentation in physics the potential physics career gap was decreased.

While addressing her audience at Queen's, Dr. Tilghman suggested we might reach a point where there are as many women in some areas of science as want to be there, with any remaining gender gaps the result of choices made by women themselves. Our analysis shows that we are not there yet; social influences are still very important for determining if students will pursue a career in physics. Students'opinions are far from fixed, and good science teachers can have an important effect on their students' physics identities. Teachers who, for example, do something as simple as meaningfully addressing the gender imbalance in physics, could be an avenue to helping encourage female students towards a physics career.

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Zahra Hazari is an assistant professor in the Department of Engineering & Science Education at Clemson University. Her research, supported by an NSF Career Award and GSE Award, focuses on reforming pedagogy in physics education using a physics identity theoretical lens in an effort to improve critical educational outcomes for underrepresented groups in physics.

Endnotes

1. Her talk was broadcast as part of an episode of the CBC Radio program Ideas: http://www.cbc.ca/ideas/episodes/2011/01/26/of-mice-and-men/
2. Funded by the National Science Foundation (NSF), PRiSE (http://www.cfa.harvard.edu/sed/projects/prise1.html) surveyed a nationally representative sample of college/university students enrolled in introductory English courses in the fall of 2007 about their interests and experiences in science. The survey can be viewed online at www.cfa.harvard.edu/sed/projects/PRiSE_survey_proof.pdf
3. This essay is based on findings published in our paper: Hazari, Z., Sadler, P. M., Sonnert, G., & Shanahan, M.-C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching*, **47**, 978–1003 (http://www.clemson.edu/ese/per/?page_id=19)

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