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 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 policy, 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’ve got 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 climate scientists 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, editor-in-chief 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 University.

April Meeting Prize and Award Recipients

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 Blumen, Laurence Littenberg, M. Granger Morgan, Hideaki Sato, Lawrence Bodnar, Jonathan Jarvis, Noemie Benziger Kolter, 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. Ashman, Silvia S. Schwedler, Georgia Armann, Jamie Nelson, Robert Back, Clarks, Standing, back row (l to r): Michele Romalski, James M. Stone, A. J. Stewart Smith, Ezra Ted Newman, Christopher J. Petrich, Janet Sager, Matthew Luzum, Jan Mader, Karen Jo Matlack. More information about these recipients is available on the web pages for the individual prizes and awards at www.aps.org/prizeawards. (Photo by Karen Rozenwasser)

Assessment Casts Doubt on Utility of Direct Air Capture of CO₂

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,” was released as part of POPA’s “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 absorb 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 the atmosphere.

“We believed it was a timely issue with a lot of technical aspects to it and it received 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 technical...”

ASSESSMENT continued on page 4

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. Radioisotopes are accepted to the...”

IMAGING continued on page 6

Five Funded Sites Join APS Teacher Education Project

By Gabriel Popkin

The Physics Teacher Education Coalition (PhyTEC) project recently announced it would provide funding for five universities to develop their physics teacher education programs. The new awardees are Boston University; California Institute and State University in Dayton, Ohio; California State University; 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.

PhyTEC 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...
Fams of classic film know the name Hedy Lamarr for her performances in Algol, 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 radar spreading 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 networks.

Born in November 1914 as Hedwig Eva Maria Kiesler in Vienna, Austria, Lamarr studied ballet and played the violin. After attending a famous class 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 Ectasy—shocking for the era because Lamarr appeared made on screen.

Dissuaded with married life—especially her husband’s controlling behavior and dealings with Nazi industrialists—Lamarr disguised herself as one of her maid’s and escaped to Paris in 1940, 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 Heddy Lamarr. In a town filled with stunning women, Lamarr stood out. Actor George Sanders once said that she “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 technology. She and Antheil invented a new ideas bore fruit when she met her Hollywood neighbor, avant garde composer George Antheil, in the summer of 1940.

A native of New Jersey to Russian 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 Leonid Léger’s 1924 abstract film of the same name. It called for mechanically synchronizing sixteen pianos, as well as xylophones and percussion. He returned to the US in 1935 to compose for film, and also became a syndicated adviser on television as the sudden disappearance of the background on which the stars were trying to make our music heard among the noise.

Antheil died in 1959. As for Lamarr, she went on to make more than 20 movies, including Cecil B. de Mille’s 1949 Samson and Delilah. Lamarr has a star on Hollywood’s Walk of Fame in honor of her achievements. She told the story of her invention with a great deal of knowledge about military technology, especially the vulnerability of radar-controlled weapons and jamming and interference.

“Tinkering is a lesson that can be potentially applied to experimentalists what is good for raising the transition temperature in new families of compounds.”

The United States government in 1992, with additional patents granted in 1939 and 1940 to two German engineers. As and, if possible, include a mailing label from a recent issue. But the actress also made a small contribution to wartime technology with her co-invention of an early radar spreading 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 networks.

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Quasars Help Researchers See in 3-D
By Michael Lucibella

Researchers with the third Baryon Oscillation Spectroscopic Survey (BOSS) have released the first 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 new thing is that we use it to map the universe in three dimensions,” said Andy 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 forming, the team used a second method 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 locations, 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 away,” 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 young, and may have predated the formation of 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 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] 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 is believed the mysterious dark energy first started to manifest itself.

The map of the universe from BigBOSS is it doesn’t map enough. It’s only mapping out a fraction of the way across the universe and that happens to be the one percent of the volume of the visible universe,” Schlegel said. “We can learn more about how the universe works, more about the goal is really to map as much as that volume that we can, and that’s what we’re designing this BigBOSS project for.”
Dear [Name],

I hope this letter finds you well. I am writing to you because I have a concern regarding [issue or topic]. I believe it is important that we address [issue or topic] in order to [state purpose or objective].

I have been following developments on [issue or topic] closely and feel that [state your position or concern]. I am concerned that [state your concern or the impact of the issue].

I would greatly appreciate your [action or input] in this matter. I believe that [state the potential benefits or importance of the issue].

Please let me know if you have any questions or if there is anything else I can provide. I look forward to hearing from you soon.

Sincerely,
[Your Name]
The Committee on International Freedom of Scientists (CIFS) is one of the many committees appointed by the American Physical Society (APS) to further the mission of the APS. In the case of CIFS, that involves addressing situations in which the rights of scientists have been violated, whether that violation is directly related to their scientific work, or a reaction to their holding views that are unpopular outside the scientific community. A 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 the 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. Such scientists were able to contact the scientist’s family and attempt to visit him directly; the publicity CIFS brought to his situation may have helped to provide him with his improved treatment, or even his 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 human rights organizations, 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 other universities to ban travel restrictions on other students who have been prevented from traveling outside of Israel/Palestine.

One of the possible reasons that CIFS has also been able to continue its work is that, both in order to remove the six billion tons of carbon dioxide emitted by an average 1000 megawatt power plant, the cost would be so massive that their cost would be “blacklisted” erroneously. CIFS has also been monitoring the situation in Turkey that developed in 2011 when such 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) rallied around the editor over the decision; and although the publication has planned a future edition to focus on such topics, it is not clear if the APS News press time whether that edition has yet been published.

While most of the cases CIFS deals with are outside the US, it appears that many APS members are also calling on the committee to address cases that CIFS is actively involved in cases within the US as well. One current 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 been in communication with the US Department of Commerce 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 made aware of the problems. 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 for students to “understand their rights and responsibilities” within the university environment. CIFS has also been helping to present a number of students who have been expelled for forwarding the communications data of classmates 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 worked.

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 those so that they may experience violations of their rights will have access to avenues of 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 contacts to the APS 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.

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

Neutrinos Can Monitor Changes in Reactor Fuel

Physicists working with the International Atomic Energy Agency (IAEA) have been developing a way for nuclear engineers to inspect reac- tors to use neutrons to monitor re- actors remotely and in real time. With more development, it should be possible to detect if any of the reactor’s spent fuel has been re- moved for possibly nefarious pur- poses. Spent nuclear fuel has long been a major source of concern for anti-proliferation experts, who fear that material that re- actions in core could be diverted for building weapons. This new sys- tem could augment the IAEA’s inspection regime and help to 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 an- tineutrino detectors,” said Fangfei Shen of MIT, speaking at the APS April Meeting in Anaheim.

All fusion reactions produce antineutrons when the neutrons that bind the nuclei of uranium to- gether are broken. When an iso- topes’s nucleus splits, it releases antineutrino detectors,” said Fangfei Shen of MIT, speaking at the APS April Meeting in Anaheim. All fusion reactions produce antineutrons when the neutrons that bind the nuclei of uranium to- gether are broken. When an iso- topes’s nucleus splits, it releases antineutrinos when the bonds are broken. When an iso- tope’s nucleus splits, it releases antineutrino detectors,” said Fangfei Shen of MIT, speaking at the APS April Meeting in Anaheim. All fusion reactions produce antineutrons when the neutrons that bind the nuclei of uranium to- gether are broken. When an iso-
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 promise, and our first in Ohio.”

In the future, Cherenkov light may offer imaging where there is currently none. There are present—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 developing 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 released a beta particle responsible for the Cherenkov light, and that 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 and 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 energy particles to do so.

Ackerman says she never planned on switching to biology 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 Lucchella

The effects of March’s dev- astating earthquake and tsunami in Japan have touched all aspects of the country’s scientific community. Research at labs near the earth- quake 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 earth- quake, is home to several research particles accelerators and beam lines that sit on the shoreline, it suffered no dam- age from the tsunami because of seawalls designed to protect the facility, but has slipped up to eight meters high. The earth- quake did damage some of the equipment; however it should all be back up and running by the time the lab have been suspended for the time being. At the Materials and Life Science Experimental Facil- ity at Ritsumeikan University, neutron beam lines have been knocked out of alignment and the lab’s linear accelerator has to be realigned as a section in the mid- dle sank about four centimeters. “All accelerator elements and experimental elements have undergone only minor damage, due to the strong underpin rein- forcements used in the major buildings,” said Dr. Yutaka Nagamya, director of J-PARC. “However, surrounding facilities such as power stations, electric power lines [and] water lines were se- verely damaged. Roads also suf- fered 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 cracks. “We are still in the process of assessing the damages to the accelerators and apparatus,” said Youhei Morita, head of public relations office at KEK. “There are many broken vacuum beam pipes, some fallen mag- nets, misplaced alignments of the beam lines, broken klystrons [and] fallen electronics racks.” Morita added also that though the experiments and building 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 op- erations because of power short- ages. Radiations of the lab’s three continued normal operations in- clude 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 in- stitution said that the facility was largely unaffected by the earth- quake, and research has been able to continue with only mini- mal disruptions. The administra- tors 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 stu- dents and researchers in the af- fected area who have not been able to attend university labs due to the disaster by inviting them to come to Wako and offering experiment samples and materials,” said Yasuaki Yu- tani, director of RIKEN’s global relations division.

Other facilities around the world have pitted 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 the Japanese physicists 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 they can avoid ad- ditional critical damage to the equipment. Similar estimates at KEK put it on track to restart sometime in autumn. Inspections and repairs have been slowed be- cause of power and supply short- ages as the region continues to recover from the disaster.
The Back Page

Can we declare victory in the participation of women in science? Not yet.
By Marie-Claire Shanahan and Zahra Hazari

what can be done to support and encourage students, and girls in particular, to pursue careers and graduate studies in physics.

Looking for solutions in high school physics experiences

One such effort, the Persistence Research in Science and Engineering Project (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 with along 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.

When the right type of person matters, 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 major.

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 influence 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 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 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 under-representation 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 identities. Interestingly, this was also remembered receiving encouragement from their teachers to pursue physics and having discussions in class about the benefit of being a scientist.

But what about women in particular?

Our findings are consistent with research for encouraging female students include providing positive female science role models, creating opportunities for collaborative group work, and discussing the lives of female scientists who may not be as well known. Usually, though, that none of these usual solutions had an effect on the physics identities of the students in our survey, female students who experienced them were no more likely to report strong or weak identities in physics.

Several of the positive classroom experiences described above have shown, however, while having an equal number of 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 female students 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., memorizing definitions and understanding concepts, linking to other knowledge/experiences, connecting ideas, reasoning) that provide deeper comprehension.

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 peak 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 pursue physics. However, perceptions of careers are far from fixed, and good science teachers can have an important effect on their students’ physics identities. Teachers who can make explicit the gender differences in the field, and helpfully addressing the gender imbalance in physics, could be an avenue to helping encourage female students towards a physics career.

Marie-Claire Shanahan is an assistant professor of science education at the University of Alberta, president of the Canadian Science Education Research Group, and a former school district teacher. Her research examines the impact of social factors such as identity, confidence, and expertise recognition on adults’ and youths’ participation and persistence in science.

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Endnotes


2. Funded by the National Science Foundation (NSF), PRiSE (http://www.cfa.harvard.edu/PRiSE/priseprogram.html) surveyed 2,000 high school students enrolled in introductory English courses in the fall of 2007 about their interests and experiences in science. The survey can be reviewed at http://www.cfa.harvard.edu/PRiSE/priseproject_spring07.html