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Science In Iran Faces Hurdles
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APS Report Spurs Congressional Action on Critical Elements

By Michael Lucibella

Rare and exotic elements have sparked a flurry of activity on Capitol Hill. A bevy of bills have been brought forward by members of both the House and Senate to secure continued supplies of rare elements important to cutting edge technology and research. This comes in part as the result of a recent joint APS and Materials Research Society (MRS) report looking at the future of uncommon elements critical to the nation's future energy technologies.

The report, "Energy Critical Elements: Securing Materials for Emerging Technologies" highlighted the need to secure supplies of exotic elements ranging from cerium to yttrium. Dubbed "energy critical elements," their unique properties have made them critical both for energy research and in modern electronics. Oftentimes these elements are rare and

Photo by Michael Lucibella/APS

Chair of the APS-MRS study Robert Jaffe (left) shakes hands with Rep. Doug Lamborn (R-CO) after testifying about energy critical elements before Congress

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SESAME Progresses Despite Mideast Turmoil

Despite political upheaval in the Middle East and earlier financial concerns, efforts to bring a particle accelerator to the region are continuing forward as planned. The report from the May 30-31 council meeting of the Synchrotron-light for Experimental Science and Applications in the Middle East, better known as SESAME, is that the project is on schedule and close to being fully funded.

"I think the main thing was we really feel pretty secure about funding now," said Sir Chris Llewellyn-Smith, president of the SESAME council. "We're in a position to really go full steam ahead."

SESAME is the multinational project to build a 2.5 GeV synchrotron light source in Jordan. Currently there are about 60 synchrotrons around the world; however, none is located in the Middle East. The multinational SESAME collaboration, organized by UNESCO and modeled after CERN, aims in part to revitalize science in the region. At the same time, SESAME is seen as a major diplomatic effort, bringing nine nations together on the project, including historical rivals such as Israel, Iran, Pakistan and the Palestinian Authority.

Much of the construction of the facilities is already completed, and workers are preparing to install the accelerators themselves soon. The tunnels and radiation shielding walls have all

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2006 Blewett Recipient Now on Tenure Track

By Gabriel Popkin

Seven years ago, APS established a fellowship with a bequest from M. Hildred Blewett, an accelerator physicist who died in 2004. The fellowship was created for women physicists returning to research after having taken a break from their careers, for family or other reasons. To date, nine women have been awarded the fellowship, and one of them now has a tenure-track position, a key measure of success for the program.

Elizabeth Freeland

Elizabeth Freeland, who became the second recipient of the Blewett Fellowship in 2006, will start teaching this fall at Benedictine University, a small, primarily undergraduate institution in Lisle, Illinois, a suburb of Chicago. Freeland, a high-energy physicist, says the position is exactly what she was looking for. "I'm very excited to have this position. I've known for a long time that I wanted to teach at a primarily undergraduate institution." And just as important for Freeland, who has been a postdoc at both Washington University in Saint Louis and the University of Illinois at Urbana-Champaign, "My entire life will now be in one geographical location."

Receiving a tenure-track position represents the culmination of a journey back to physics research that began after the birth of Freeland's second child. She left research after receiving a PhD in physics from The Johns Hopkins University in 1995, when her husband took a position at Brookhaven National Lab on Long Island, where few other physics positions existed. Around that time, the couple decided to start a family.

A few years later, Freeland's husband took a position at Argonne National Lab near Chicago, an area with more job opportunities in physics, and Freeland began looking to re-enter physics research. She found a supportive research group at Fermilab, but became stymied when she went to look for funding. Freeland found that most early-career grants required the applicant to have institutional affiliation, and be no more than five years removed from a PhD. "The grants were written with a certain idea of what a scientific career looks like, and when you deviate from that, people don't know what to do with it."

Finally Freeland found a grant she was eligible for from the American Association of University Women (AAUW), and applied and received it. The next year she applied for and received the Blewett Fellowship. "The Blewett Fellowship was a critical piece," in restarting her career, Freeland says; "It filled the gap for my younger child to get day care." Freeland also notes, "There are other aspects of the Fellowship that are powerful. One is the autonomy–I was in control of the money and what I did with it, as opposed to working for someone else. It puts you on a different footing in work with other people when you have your own money."

Thanks to her years of grappling

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Home Schooling Co-op Takes PhysicsQuest Top Prize

APS has announced the winners of this year's PhysicsQuest competition for middle-schoolers. Taking the grand prize this year are the students at a home schooling cooperative in Wexford, Pennsylvania.

The eight students, ranging in ages from nine to fourteen, conducted the experiments in the PhysicsQuest kit and solved the puzzles correctly. Their entry was selected at random from all the correct answers to receive the grand prize. Each student on the winning team will receive an apple iPad and APS memorabilia, and the team as a whole will receive a $500 gift certificate to the teaching supply company Educational Innovations who produced the APS-designed kits.

This year's second place winners are Susan Phillips' sixth grade class at St. Vincent Elementary in Perryville, Missouri, who will receive a $300 gift certificate to Educational Innovations. Third place went to Jannae Monnet's class at Friedell Middle School in Rochester, Minnesota who will receive a $100 gift certificate. All the winning classes will also receive physics toys from Educational Innovations, a classroom set of autographed Spectra comic books and APS "Future Physicist" buttons.

Started by APS during the World Year of Physics in 2005, PhysicsQuest has brought interactive physics experiments to hundreds of thousands of middle school students every year. The free kits include the materials for four physics experiments centered on a field of physics. This year's version ties the experiments together with a comic book narrative "Spectra's Force", starring APS's original laser superhero Spectra. The kit focuses on force and motion, and features the titular hero squaring off against the brilliant but misguided General Relativity.

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Five from High School Physics Elite to Represent US at Bangkok Physics Olympic Competition

By Mary Catherine Adams

In a quiet laboratory down a short corridor in the University of Maryland's physics building, about a dozen students are tinkering with weights and ropes, scribbling notes on formula-filled papers, as they scramble to finish that afternoon's experiment. When time is up, they'll pack up their calipers and calculators and move on to their next brain-squeezing exam.

These aren't physics undergraduates–these are high school superstars, some of them just finishing their sophomore years. These twenty members of the US International Physics Olympiad team are undergoing the final selection process to see which five will represent the United States at this year's physics Olympiad held in Bangkok, Thailand.

It's Friday afternoon and though the students have been in labs and lectures all week, they still have the weekend to go before the traveling team is chosen. Breakfasted at 7 a.m. and out the door by 7:30, the students' rigorous schedule has them cramming in fluids and thermo, waves and relativity, all before lunchtime. Afternoons are filled with more lectures, labs and exams, and study time follows a late dinner

Photo by Mary Catherine Adams/APS

The twenty members of the Olympiad team enjoy a rare moment of relaxation.

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Members in the Media

"He had an idea a minute,"

***Martin Blume**, APS, on fellow physicist Maurice Goldhaber, who passed away in May,* The Los Angeles Times*, May 25, 2011.*

"We and a few other experiments are projecting that we might be able to get sensitivities that's a factor of a hundred, a thousand, maybe even in the long-term, 10,000 times better."

***Dave DeMille**, Yale, on a recent experiment that measured the shape of an electron to unprecedented levels,* NPR*, May 25, 2011.*

"We take a proton beam and slam it into a target… Off comes a series of particles and antiparticles, some of which are antiprotons that can be captured electrically and magnetically."

***Keith Gollwitzer**, Fermilab on how antimatter is created in a lab,* The Washington Post*, May 30, 2011.*

"These recent results are significant in showing that some antihydrogen atoms can indeed be trapped long enough to reach the ground atomic state by radiation of photons–just the state needed for precision measurements… Longer confinement times also translate to more precise measurements of antiatom properties."

***Clifford Surko**, University of California at San Diego,* USA Today*, June 6, 2011.*

"We have never talked about holding on to these things for so long… If you want to study these antiatoms, you need to use electromagnetic radiation, microwaves, lasers and other tools."

***Jeffrey Hangst**, Aarhus University, on trapping antimatter at CERN for more than 15 minutes,* The Los Angeles Times*, June 6, 2011.*

"Right now, we have real gaps in our energy research portfolio. We cannot fill those gaps without large-scale, long-term, well-funded and well-coordinated research programs that bring together the best and most innovative scientists and engineers in academia, industry and the national laboratories."

***Eric Isaacs**, Argonne National Lab,* CNN.com*, June 6, 2011.*

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with a system that expects uniformly linear career paths, Freeland has become an expert on scientific career breaks. A few years ago she started a website for others considering or taking breaks. "I had to do so much work when I was first trying to get a grant that I thought this really needs to be written down," she says. The website features grants available to scientists who have taken career breaks, stories of women who have successfully returned from such breaks, and articles and reports on this and related issues, including the infamous two-body problem faced by many scientist couples. It can be found at http://home.earthlink.net/~papagena .

Now that she has her tenure-track position lined up, Freeland can reflect on the journey that got her there. "One piece of advice [for scientists considering a career break] would be to do a postdoc for at least one year. Once you have some postdoc experience, you're seen by the community as an official, independent scientist. That will put you in a better position to come back after the break." And, she says, "Really plan out and brainstorm all of the options you have, before you take a break. The plan itself will change, but you'll know what options you have."

Freeland also has advice for funding agencies. "I encourage institutions to write applications in such a way that people without institutional affiliation aren't excluded," she says. "More flexibility in terms of career paths would, I suspect, help diversify science in the United States. In many cases it's just a phrase" in the application that needs to be changed.

Freeland plans to continue doing research at Fermilab, where she began her high-energy physics research and where she still has many collaborators, and she will now be able to offer summer research opportunities to her students. She is also looking forward to teaching and designing new courses. She says, "I have a lot of experience teaching non-scientists and creating new courses; and I have a lot of new ideas I'm excited to try."

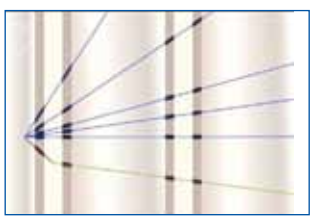
This Month in Physics History

July 21, 2000: Fermilab announces first direct evidence for tau neutrino

"Neutrinos, they are very small/ They have no charge and have no mass/ And do not interact at all," John Updike wrote in his 1960 poem, "Cosmic Gall." Neutrinos were a fairly recent discovery then, and within two years physicists would discover that they were only just beginning to understand this mysterious "ghost particle." For instance, there was more than one kind of neutrino, and it would take physicists another 40 years to find them all.

Wolfgang Pauli first proposed the existence of neutrinos in 1930 while investigating the conundrum of radioactive beta decay, in which some of the original energy appeared to be missing after an electron was emitted from an atomic nucleus. He hypothesized that in order to abide by the laws of energy conservation, another, as-yet-undetected neutral particle might also be emitted, accounting for the missing energy.

Wolfgang Pauli, who first hypothesized the neutrino



A tau neutrino event as recorded by DONUT

Pauli was reluctant to publish a paper on this unusual hypothesis, but he penned a letter to a group of prominent nuclear physicists gathering for a conference in Tuebingen, Germany in December asking for input regarding means of detecting such a particle experimentally. "I have done something very bad today by proposing a particle that cannot be detected; it is something no theorist should ever do," he wrote, describing his idea as "a desperate remedy."

Among the physicists who took Pauli's idea seriously was Enrico Fermi, who developed the theory of beta decay further in 1934, coining the name "neutrino" ("little neutral one") in the process. It became clear that if such a particle existed, it must be both very light–less than 1% the mass of a proton–and interact very weakly with matter, making it very difficult to detect. But in 1956, Clyde Cowan and Frederick Reines succeeded in doing just that, sending a telegram to Pauli informing him of their discovery. "Thanks for message," Pauli telegrammed back. "Everything comes to him who knows how to wait."

Pauli died two and a half years later, and thus missed the discovery in 1962 of a second type of neutrino, dubbed the muon neutrino, corresponding to the charged muon lepton. (The latter caused I.I. Rabi to famously exclaim, "Who ordered that?") In 1975, a third charged lepton, tau, was discovered, and subsequent experiments hinted strongly that there should also be a third kind of neutrino. While scientists at CERN uncovered further proof in 1989 of the tau neutrino's existence, it would be 25 years from the discovery of the tau before the technology was available to actually detect its neutrino directly.

In the 1990s, Fermilab designed the DONUT (Direct Observation of the NU Tau) experiment to search specifically for tau neutrino interactions. The scientists used the Tevatron to produce an intense neutrino beam, predicting it would contain at least some tau neutrinos. After deploying an elaborate system of magnets and iron and concrete to eliminate as many background particles as possible, the beam was fired at a three-foot-long fixed target: iron plates alternating with layers of a special emulsion sandwiched between them.

Those emulsions captured the tracks of any electrically charged particles produced by the extremely rare (about one in one million million) tau neutrino interactions, which were then electronically recorded by scintillators. The emulsions were then photographically developed so that scientists could analyze the data, looking for the telltale distinctive short track with a kink that indicates a tau lepton, the result of a tau neutrino interacting with an atomic nucleus. They were literally connecting the dots: small black dots left by particles passing through, which could then be connected to retrace the particles' paths.

After the experimental run in 1997, it took three years of painstaking analysis to sift through all the data, winnowing some six million signatures down to 1000 candidate events. On July 21, 2000, scientists from the DONUT collaboration announced they had identified four tau neutrino signatures demonstrating an interaction with an atomic nucleus. The experiment also validated a number of new techniques for neutrino detection, most notably the emulsion cloud chamber, which significantly increased the number of observed neutrino interactions.

Leon Lederman, who had shared the 1988 Nobel Prize in Physics with Jack Steinberger and Melvin Schwartz for the discovery of the muon neutrino, called the achievement "an important and long-awaited result. Important because there is a huge effort underway to study the connections among neutrinos, and long-awaited because the tau lepton was discovered 25 years ago and it is high time the other shoe was dropped."

Among the questions physicists were still pursuing was whether neutrinos might have a tiny bit of mass, and whether they could oscillate and change flavors over time as they traveled through space. For instance, would it be possible for a muon neutrino to change into a tau neutrino via oscillation?

That question was answered with a resounding yes in 2010. Scientists with the OPERA experiment at Gran Sasso National Laboratory in Italy reported that they had found four instances of the telltale signature of the tau neutrino among a stream of billions of muon neutrinos generated at nearby CERN–the first direct observation of a neutrino transforming from one type into another. Experiments are ongoing to further explore this phenomenon and possibly determine specific masses for neutrinos.

With the discovery of the tau neutrino, only one more particle remains to be found to complete the Standard Model of Particle Physics: the elusive Higgs boson. Fermilab's soon-to-be-retired Tevatron is racing against the clock, competing with the Large Hadron Collider at CERN, to make one more significant discovery that will herald the dawn of a new era in particle physics.

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Education Corner

A column on educational programs and publications

Committee On Education Departmental Award
The APS Committee on Education has established a new award to recognize departments and programs that support best practices in education at the undergraduate level. Programs will be recognized for a three-year term, acknowledged on the APS website, awarded a plaque, announced in APS News, and recognized at an annual meeting. These awards are intended to acknowledge commitment to inclusive, high quality physics education for undergraduate students, and to catalyze departments and programs to make significant improvements. APS will recognize one to three programs and departments each year.

A full description of the award and the application are available at www.aps.org/programs/education in the "Undergraduate Physics" section. The deadline to submit nominations is July 15.

Physics Research Mentor Training
The Physics Research Mentor Training Seminar is a facilitation guide to a training seminar for physics faculty, postdocs, and graduate students who are in mentorship roles. The guide is intended to help physics researchers improve their mentoring skills, and to improve the research experiences of the next generation of physicists.

For more information on mentor training workshops and to download the training guide, visit www.aps.org/programs/education/undergrad/faculty/mentor-training.cfm

Joint NSBP and NSHP Annual Conference
The National Society of Black Physicists (NSBP) and the National Society of Hispanic Physicists (NSHP) will be having their Joint Annual Conference in Austin, Texas from September 21 to 24, 2011. The meeting is the largest gathering of African-American and Hispanic physicists in the world and is an excellent opportunity for students to present posters or oral presentations, attend professional development sessions and scientific sessions, and network with faculty and fellow students. The theme of this year's meeting will be "Global Competitiveness Through Diversity."

Task Force on Teacher Education in Physics
The full report of the Task Force on Teacher Education in Physics is expected to be available this summer. It is currently in the process of being edited. A printed copy of the report will be sent to all physics departments and schools of education, and a PDF version will be made freely available on the PhysTEC website. See www.PTEC.org/taskforce for more information and a copy of the report synopsis.

Speakers Program
The APS Speakers Lists contain names, contact information, and talk titles of physicists who are willing to give talks on a variety of subjects. A general search can be done at www.aps.org/programs/speakers/.

Advanced searches allow one to search specifically for women and minority physicists and Physics Education researchers.

Iranian Scientists Battle Numerous Restrictions

By Michael Lucibella

Scientists in Iran are facing difficult times, as political and academic freedoms in the country have eroded in the last few years. Universities have been coming under stricter scrutiny from the government, especially since the student-led protests two years ago. The political situation, combined with limited available resources, has left science in Iran barely able to limp along.

Iran has had a complicated history of academic freedom. Before the revolution of 1979, the old regime under Shah Mohammad Reza Pahlavi kept careful tabs on the activities of students and professors at academic institutions. Academic institutions suffered as a result.

"During the Shah's time, the environment, the atmosphere was extremely repressive," said Mostafa Hemmati of Arkansas Tech University, who is the president of the Iranian-American Physicists Network. He added that following the revolution in 1979, that changed for a while under the new regime. Surprisingly, academic freedom at universities and colleges started to burgeon, and the quality of the universities improved tremendously as well. For several years, a certain amount of academic freedom, and student organizations on school-related subjects, were tolerated at universities.

Cultural and scientific collaborations with the United States reached a peak in the mid 1990s. "Especially in the last 14 years, when Khatami [Iran's former reformist president] was elected as president, the atmosphere in universities became a lot more open," said Hemmati, "It was easy to speak your mind."

However at the end of the 1990s, the tide started to turn away from the open atmosphere that academics once enjoyed. "Gradually at the end of Khatami's first term, the conservative part of the government tried to start tightening the screws. And during Khatami's second term it's gotten worse. Since Ahmadinejad, things have gotten worse and worse and worse," said Hemmati.

The conservative Ahmadinejad replaced the reformist Khatami as president in 2005 after a controversial election in which Iran's Guardian Council banned thousands of reformist candidates from participating. Under the current president, the student organizations were harassed and where organizations once were allowed office space to operate, nearly all have been quietly closed down. Ahmadinejad signed a law requiring guards to be stationed in the universities, and instituted a "three strikes" policy for students who were seen as challenging the status quo.

In June of 2009 the disputed reelection of president Ahmadinejad sparked massive protests across the country. For over a month, the country was rocked with unrest, with protestors calling the election fraudulent and demanding that Ahmadinejad not be sworn in as president. The unrest sparked a government crackdown, especially against universities and university students whom the government saw as leading the unrest.

"Almost everything is being done with an intention to control the environment in the university. This is all due to a very vibrant opposition movement," Hemmati said.

Professors and faculty have also been the targets of government harassment. The most dramatic example happened in January of 2010 when a bomb detonated outside the house of professor Masoud Ali Mohammadi, a theoretical physicist at Tehran University, killing him as he left for work. Though the Iranian government blamed the United States and Israel for the attack, many believe he was targeted by the Iranian government because of his open support for Ahmadinejad's opposition.

Such an overt attack is rare, and most of the pressure felt by academics is more subtle.

"The political situation is very different. If you participate in politics of any sort you would be facing a very different situation than you would in America," said Farhad Ardalan, a string theorist at Sharif University of Technology in Tehran. "If you are on the wrong side of politics, you might not be able to get employed."

It is a problem that Ardalan has personally faced. Though he is one of the most prominent physicists in Iran and responsible for establishing the first doctoral program in the country, his pro-democracy stance has garnered the ire of the conservative government. Two years ago the university hastened his retirement, and the Iranian Academy of Sciences refused to recognize him. "I was not welcome in the political picture here now," said Ardalan.

The curricula at universities have also come under the close scrutiny of the Islamist government. Over the last two years Supreme Leader Ayatollah Khamenei has called for a review of the material taught at universities in order to bring it more in line with Islamic doctrine. The minister of education has set up a committee tasked with reviewing university curricula. During that time, the heads of most major universities in the countries have been replaced with religious leaders, resulting in religious requirements for unrelated degrees.

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been finished. Germany donated the booster ring from its decommissioned BESSY1 light source, while the United States and European countries have donated other extra parts including wigglers, undulators and five beam lines. Construction on the main storage ring is about to begin. The project is on schedule to have experiments begin in 2015 with three beam lines. More will be added over time.

"We're on track to get experiments going," said Llewellyn-Smith. "I think the problem is going to be building up staff rather rapidly, and building up the community." He added that a new grant from the Washington, DC-based Lounsbery Foundation is sponsoring travel grants for students to travel to existing synchrotrons to build up skills for operators and users of SESAME once it comes on line.

Until recently, the collaboration had been looking at a $35 million deficit. However, at the May meeting, members were able to pull together about $25 million in funding, leaving only $10 million needed to start experiments on schedule. Iran, Israel and Jordan each confirmed their matching contributions to the project of $1 million each year for the next four years. Turkey's delegation also promised to contribute funding; approval is needed first in its parliament, but is expected to pass. Pakistan likewise promised $5 million, and the Palestinian authority pledged $2 million.

Egypt pledged funding as well. Prior to the meeting there was some concern about Egypt's continued involvement in the project because of the recent political upheaval in the country. Egypt has long been a supporter of the project, and it was feared that after the overthrow of the Mubarak regime, the new government might not back the project. However, the new Minister of Higher Education, Scientific Research and Technology held the post prior to the recently deposed minister. He is in the process of reapplying for SESAME funds to the new minister of finance who is also seen as a supporter of the project. The funding is expected to come through.

"Any of the disruptions or changes due to the Arab spring do not seem to be affecting SESAME," said Amy Flatten, APS's director of international affairs, who attended the council meeting in Jordan.

Llewellyn-Smith thinks that the remaining funds needed should be raised fairly easily. He has been in touch with members of Congress in the United Sates and the Office of Science and Technology Policy to try to get a contribution from the United States. In a 2009 speech in Cairo, President Obama emphasized the need for science and technology investment in the Middle East and the OSTP has recommended contributing to SESAME, but so far no money has been appropriated.

"Now's the time to be getting back in contact with people in Washington," Llewellyn-Smith said, adding that he hoped that it would be easier to coax the United States into contributing with the program close to completion.

South Africa Hosts Conference on Women in Physics

The International Union of Pure and Applied Physics (IUPAP) held its fourth International Conference on Women in Physics in early April. Hundreds of participants from around the world travelled to Stellenbosch, South Africa to share observations and discuss issues facing women physicists.

"One of the main aims is to highlight the situation of women in physics around the world and to compare and contrast," said Meg Urry, an astrophysicist at Yale and head of the US delegation. "Another is to learn from one another practices and policies that have been effective."

The experiences and issues faced are as varied as the home nations of the participants. In some of the developing nations, women face issues of outright discrimination and failing infrastructure, while in industrialized countries, career balancing and creating inclusive academic environments are more at the forefront.

One of the main recommendations developed by the United States delegation focused on establishing a better system of professional development for women physicists.

"We found a real need for that professional development starting in undergrad school and extending throughout her entire career," said Beth Cunningham, Executive Officer of the American Association of Physics Teachers (AAPT).

Other recommendations included developing ways to create a more inclusive academic environment for both boys and girls to study physics in school, in part by using more findings from social scientists who have studied the issues. Mentorship programs and finding ways to have more women apply for prizes and awards were also included in the list of recommendations.

In addition to developing these recommendations, the conference was also an opportunity for participants to engage in some of their own professional development and network with physicists from around the world. Sessions included talks about particle phys-

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Letters

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

Column Pins Unwelcome Label on Obama

Noting the use of the label, "African American President", in the otherwise timely and informative May Inside the Beltway column, is a disappointment. The label is unwelcome particularly as President Barack Obama could equally be referred to as the White American president. Indeed, the President's substantive exposure by birth to two ethnic value systems during his formative years is a strong attribute to his leadership in the hoped-for elimination of unwarranted ethnic labeling of any one American. For an educated readership as that of *APS News*, one would ask its articles continue to manifest the objectivity that underpins the community of scientists by forgoing such references in the future.

J. V. Martinez
Silver Spring MD

Women Face Slim Odds for Academic Careers

Regarding the Back Page in the June *APS News*, "Can We Declare Victory in the Participation of Women in Science? Not yet.": I was disappointed to read some of the purported reasons that women don't pursue advanced physics careers, especially professorships. It's as if the authors never bothered to actually interview us young women to get our take on the matter.

I have no special desire to "work with people," as was suggested by Dr. Tilghman. I do, however, have the desire to earn a decent paycheck and have a modicum of job security. Given that a physics PhD's chances of landing a tenure-track professorship are nearly nonexistent, and that a woman needs to be twice as productive as her male colleagues just to be regarded as equally competent, many of us women make the pragmatic decision to leave academia to seek gainful employment elsewhere rather than lose a decade or more of our lives pursuing the one-in-a-million shot of becoming a tenured professor. It's not that we don't want to be professors–it's *the* dream for most all of us grad students, myself included–it's that we're smart enough to know that the odds aren't in our favor.

In addition, many of us are married to other PhDs who refuse to leave academia. Perhaps because of the male tendency towards overconfidence in their abilities, these men seem to think they're better than the competition (à la the Lake Wobegon Effect) and that they will be the one lucky soul who will win the big Tenure Track Professor Lotto. Knowing that the odds of finding TWO such positions within a close geographical area is pretty much impossible, many of us women make the rational decision to leave academia so that there can be at least one steady income in the family.

Physics PhD Student
(name withheld by request)

Girls Must be Reached at an Early Age

In their Back Page in the June *APS News*, Shanahan and Hazari point out that there has been a large increase in the number of women going into the biological sciences, but not a comparable increase going into the physical sciences. They suggest that the physical science interest of women can be increased by having high school physics teachers discuss the discrepancy. I suggest that they are looking at the matter in the girls' educational careers at too late a stage. Peer pressure is very important to high school girls, and peer pressure often suggests that "real girls" do not excel in mathematics. Lack of confidence in their mathematical ability will easily explain the preference for the biological sciences over the physical sciences. I believe that emphasis must be addressed to the physics and mathematics education at a much earlier stage in their lives–middle school or even elementary school. Although we have no formal follow-up, my experience in a NSF funded physics and mathematics summer program for "rising 7th grade girls" some years ago certainly showed an increased interest in the physical sciences.

If we look at other countries, where science and mathematics are emphasized for girls as well as boys at a much earlier age, you see significantly better statistics.

Alvin M. Saperstein
Detroit, MI

Ethics Authors Don't Follow Guidelines

The ethics training described in the May *APS News* is apparently based on an APS survey of junior physicists. The authors of the survey failed to do a literature search.

They would then have found my own 1999 article "The authorship list in physics–postdocs' perceptions of who appears and why" or my 2002 article "Coauthorship in physics" (you can find them on the internet under coauthorship.com). I guess authors of ethics do not have to follow ethical guidelines. In a sense I did not either–the APS tried to stop my surveys but I went ahead anyway. And I put the manuscripts on the internet since the journal I published them in (*Science and Engineering Ethics*) has little or no readership.

In any case ethics training at least in medical publication ethics seems to lead to worse behavior. Young researchers find out just how they are expected to behave, which turns out to be...unethically.

Eugen Tarnow
Fair Lawn, NJ

Blowout Cause Challenged; Murray Responds

Some time after the Deepwater Horizon sank, when the scale of the disaster had become evident, I read an item in the news in which a Canadian petroleum engineer claimed that the catastrophe had been exacerbated by the firefighters who sprayed large quantities of water onto the rig, flooding it and causing it to sink. That effectively put out the fire, but it caused the riser (the pipe that carried oil up from the sea floor to the platform) to buckle and rupture in two or more places. As a result oil was released into the Gulf well below the surface, making it hard to determine how much was escaping and harder still to shut off the flow.

This sounded plausible to me, but no more than that. I never saw any follow-up to this report or any official pronouncement that would have confirmed or refuted it. When the *Final Report of the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling* (http://www.oilspillcommission.gov/final-report) came out, I scanned it to see what it had to say about the sinking. The only mention I found is on page 132: "As Coast Guard vessels continued the search and rescue operation, private offshore supply vessels sprayed water on the fire. [...] By the morning of April 21, the rig was listing. At 11:53 that evening, it shifted and leaned even more. At 10:22 a.m. on April 22, the rig sank[.]"

This is a serious omission. If the fire had been left to burn and the Deepwater Horizon had not sunk, no oil whatever would have been released. This is especially ironic in view of the considerable effort made to dispose of the spilled oil, in part by collecting and burning it. (According to the pie chart on page 162, ultimately 5% of the oil was disposed of by burning.)

I am disappointed that the interview of Cherry Murray on the Back Page of the May issue of *APS News*, like the Final Report, glossed over this question, and in fact (again like the Final Report) focused more on human-interest angles and the societal implications of the spill than on technical issues.

David L. Book
Monterey, CA

Ed. Note: *Cherry Murray, whose interview appeared in the May* APS News*, is Dean of Engineering and Applied Sciences at Harvard, and served on the Commission. Here is her response:*

In the Chief Counsel's Report, http://www.oilspillcommission.gov/chief-counsels-report, there is a detailed description of the events that led to the blowout of the Macondo well. It appears from forensic evidence and available records that the blowout occurred through the production casing and through the shoe track in the well (center of the well, not the annulus) because of a failed cement job, with a force strong enough to severely erode the annular preventer and the blind shear ram in the blowout preventer (BOP).

Several more studies including an interim National Academy of Engineering report appear to corroborate this evidence, and to suggest that the blowout was sufficiently severe that it rendered the BOP on the sea floor incapable of shutting the well (either through the severe erosion, or by buckling the drill string up into the BOP, thus preventing the shear ram from working–or both.) See pp 196 and 221 of the Chief Counsel's Report.

Unfortunately the mixture of oil and gas was heavily gas, and by the time anyone noticed on the rig, gas was already in the riser expanding into a jet-engine-like roar and it was too late to contain–see Chapters 4.1-4.9–the explosions on the rig were inevitable if the BOP could not be shut. Therefore, although the pouring of water onto the rig may have helped to sink it, the sinking of the rig was considerably AFTER the blowout and did not cause the blowout, and the oil and gas would still have been released even if the rig had not sunk as quickly. There was no other means of containing the blowout but the damaged BOP.

Nietzsche, Robinson Crusoe, and Women in Physics

When Zahra Hazari and Marie-Claire Shanahan assert that it is not yet time to "declare victory in the participation of women in science" ("The Back Page" June 2011), their rhetoric implies both a specific stance in moral philosophy, and a specific philosophical anthropology, neither of which are addressed explicitly in their article. But these unstated matters form a critical part of their argument.

First, the moral philosophy. The term "victory" implies a conflict. The conflict under examination by the authors is presumably between women who wish to have careers in physics, and the social, institutional, and other factors which prevent them from doing so. The primary means by which the authors judge whether this conflict is continuing is statistical: they compare the percentage of those earning bachelor's degrees in physics who are women (21% in 2007), to the percentage of women in the general population from which their samples are drawn. As of 2010, an estimated 50.7% of the US population was female. Presumably, if the percentage of women earning physics undergrad degrees is less than 50.7%, there is prima facie evidence of "underrepresentation." No one disputes these statistical facts.

The dispute is whether this statistical anomaly provides direct evidence that a moral wrong is being committed. Without raising the question directly or providing philosophical arguments for their position, the authors simply assume that underrepresentation is morally wrong.

The ostensible focus of the authors' article is the possibility, raised by President Shirley Tilghman of Princeton University, that only 21% of physics BS degrees were obtained by women in 2007 because that represents a free and unbiased choice on the part of women, and it is simply the case that relatively few women choose to enter physics as opposed to, say, the life sciences. When President Tilghman says "As scientists we have to be open to that possibility," she means that no interpretation of data should be ruled out without a good reason for ruling it out. The authors try to provide reasons to rule out President Tilghman's interpretation, but in my opinion, fail to do so.

No number of surveys or statistical facts can resolve a dispute about philosophical anthropology, by which I mean one's fundamental beliefs about the nature of human beings. The authors seem to believe that underrepresentation is a moral wrong. This position is historically associated with the philosophy of feminism, which attempts to treat one's gender as an arbitrary and fairly unimportant feature. Like hair color, it should play little or no role in whether a person can pursue a given career. In feminism, as in many other modern philosophies, Nietzschean radical individualism prevails, and entails the right to define one's own meaning of life and the universe. According to this philosophy, women (and men) are autonomous agents, free to create their own meaningful lives in any way they choose. They should not be restricted in these choices by anything: their sex, their hair color, or the opinions of others, which means society.

The individualistic aspect of feminism is why the authors cite "social influences" as a significant harmful influence on women who might otherwise choose to pursue physics in larger numbers. In a radical individualist philosophy, no one has a right to tell or even advise anyone else what to do.

But no one except Robinson Crusoe can live a consistent radical individualist philosophy. We are social creatures, dependent for our very lives on the unseen thoughts and actions of others. When the authors say that society adversely influences women with its "stereotypical views of interest and ability in science," they imply that society should change, and keep changing, until it reaches the feminist ideal of perfect 50.7% representation of women in physics, and everything else. If this is what they want, they should simply say so.

I would respectfully request that the authors do some introspecting in order to discover what they truly believe about their moral philosophy and about the nature of the human person. The one useful fact that they seem to have found is that you can motivate women to pursue physics by telling them there are few women in physics. I will remember that, but as for the rest, I am still waiting for a philosophically cogent argument against President Tilghman's idea that perhaps all the women who want to enter physics and have the ability and persistence needed can currently do so.

Karl D. Stephan
San Marcos, TX

Texas Hosts Lively Teacher Preparation Conference

By Gabriel Popkin

During two warm, workshop-packed spring days in Austin, Texas, 120 physicists and educators came together to discuss topics as disparate as undergraduate course reforms, student teacher mentoring, poverty's effect on student achievement, and negotiating with university administrators for funding. The occasion was the seventh annual Physics Teacher Education Coalition (PhysTEC) Conference, which took place on the campus of the University of Texas at Austin.

The PhysTEC Conference, organized by APS and the American Association of Physics Teachers and formerly known as the PTEC Conference, is the nation's largest event focusing on physics teacher preparation, and brings together experts in this field from around the country. This year's conference was back-to-back with the annual meeting of the UTeach Institute, a project based at the University of Texas, Austin that prepares science and math teachers at sites around the country.

The theme of this year's conference was sustainability, and workshops developed this concept in a number of contexts. Panels explored ways to sustain various components of teacher education projects, including physics-specific pedagogy courses, the hiring of master teachers to work in physics departments, and teaching reforms in introductory physics courses. In a popular session entitled "It takes a University for Science Teacher Preparation," an education chair, and science dean, and a university provost provided insight into the issues that administrators grapple with when deciding how to allocate resources.

Numerous speakers presented data supporting teacher preparation efforts. Among these was Carl Wieman, Physics Nobel laureate and OSTP Associate Director for Science, who spoke about the importance of high-quality data for policy makers hoping to justify the costs of education programs. Wieman also described his work in promoting a more scientific approach to teaching and learning. "We need to have all students think about and use science more like scientists," he said.

Photo by Ted Hodapp/APS

Stefan Zollner of New Mexico State University (left) chats with PhysTEC consultant Jon Anderson.

Sharing Wieman's passion for data is Michael Marder, a University of Texas physics professor and UTeach co-director. In a session on teacher quality and poverty, Marder argued that student poverty is a dominant–and often ignored–factor in determining achievement. Drawing on the history of the now-defunct British airplane maker de Havilland, Marder drew an analogy between poverty in schools and faulty airplane design, stating that "Attempting to improve student achievement by training teachers better is analogous to attempting to train pilots better to solve the problem of planes falling out of the air."

Erik Brewe, a Florida International University education professor, gave another data-rich presentation. He provided evidence that a technique called Modeling Instruction had greatly improved learning and attitudes toward science among FIU undergraduates. Delving into the new field of social network analysis, Brewe also presented data showing that students taking courses that use Modeling collaborate with far more of their peers than those who receive traditional physics lectures.

Many conference attendees remarked on the community the PhysTEC Conference has helped build. Noah Finkelstein, a seven-time conference veteran and frequent presenter, said that the conference is "the right size and scale, friendly, and personable." Kathy McCloud, a program officer at the National Science Foundation, which funds the PhysTEC project, said, "It's encouraging to see people who care about teacher education exchanging ideas."

The sessions on the afternoon of the second day of the conference were open to both PhysTEC and UTeach conference attendees. One panel discussion, entitled "Educating Physics Teachers at UTeach Replication Sites", included representatives of universities that are both PhysTEC and UTeach sites. Several participants noted that PhysTEC was in a good position to provide an extra push in physics for UTeach sites, many of which have not seen the same increases in physics teachers as they have in other math and science fields.

Monica Plisch, Assistant Director of Education at APS and the main organizer of the PhysTEC Conference, was pleased with this year's event. "This year's conference really showcased the community and energy that the project has built around physics teacher education," she said. "The UTeach connection brought together people with common interests, and provided a lot of interesting new perspectives."

Information about the conference is available at www.ptec.org/conferences/2011

INSIDE THE BELTWAY

Caught in a Vise

by Michael S. Lubell, APS Director of Public Affairs

When I read Gus Tyler's obituary in *The New York Times* on June 12, it reminded me how easily political passions can poison the well of sensible dialog. Gus, a socialist, had devoted much of his 99 years to labor issues and was as uncompromising in his commitment to the cause as he was pugnacious.

I met him more than four decades ago, when he was vice president of the International Ladies Garment Workers Union, and I was in my fifth year of graduate work at Yale. We were at an elegant dinner party in Kings Point, a posh suburb of New York City, and during cocktails I found myself standing next to Gus and his wife, Marie.

We got on famously until I casually mentioned that I had done fieldwork for New York Republican Governor Nelson Rockefeller in his 1966 campaign and was then working as a policy advisor to New York Senator Jacob Javits. Gus's eyes narrowed, his face turning crimson as he spat out the words, "The only good Republican is a dead one." And with that he grabbed Marie's elbow, and swiftly guided her away as they sought out more politically acceptable guests.

Scientists may not be union rabble-rousers in the mold of Gus Tyler, but many of them harbor the same instinctive distaste for Republicans, based upon my anecdotal experience. And a Pew Foundation poll carried out two years ago backs that up. It found that only six percent of scientists identified themselves as Republicans, while fifty-five percent called themselves Democrats. Nine percent said they were conservative, while sixty-six percent said they were liberal or very liberal. Among the general public, I should note, conservatives outnumber liberals by a three to two margin.

Less than a month ago, a young physicist, who clearly matched the Pew profile, was sitting in my Washington office, gleeful over the recent upset Democrat Kathy Hochul had scored in a special election in New York's 26th congressional district, a conservative bastion. "We only need to win 24 more seats in 2012 to reclaim control of the House," he observed.

He paused and then quickly added, "That election will really help science."

"Not so fast," I said. "Democrats believe they won that election because Hochul's Republican opponent, Jane Corwin, endorsed Paul Ryan's House budget plan, including the Medicare cuts it contains. What Democrats are carrying away from Hochul's win in the 26th is a 2012 road to electoral success based on fencing off Medicare in any deficit reduction plans."

My new young acquaintance was a quick study. "So what you're saying is Democrats will oppose cuts to Medicare and, of course, Social Security, and Republicans will oppose tax increases and serious reductions in defense spending."

"That about sums it up," I said. "It leaves science caught in the vise of a reduced domestic discretionary budget and having to compete with all of the other popular programs it contains, many of them holding much higher priorities for Democrats and Republicans alike."

As my visitor left, I could only hope he would recalibrate his political thinking. Polling has shown the public loves science, but the public also wants the federal government to begin to balance its books.

For Democrats, Social Security, Medicare and Medicaid represent the legacy of the era of enlightened public policy. For Republicans, reducing taxes, cutting spending and downsizing govern-

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Public and High-School Libraries Provide Access to APS Journals

A year after the announcement by APS that public libraries can access its journals free of cost, the number of libraries participating and the number of journals downloaded have both been growing incrementally but steadily.

The policy allows anyone to access any article from the APS journals, as far back as their founding in 1893, from any library enrolled in the program. People can freely download articles from library computers with approved IP addresses, whether they are members of APS or not. Any public or high-school library can participate for free.

APS has been keeping track of the number of downloads since the public library program since January. While the number of papers downloaded is still relatively small, the program has been gaining in popularity. By the end of May, 1,611 papers had been downloaded from public libraries, the most popular journal being *Reviews of Modern Physics*.

The total number of libraries participating has been steadily increasing as well. At press time, 573 public libraries and 161 high school libraries from across the country had signed up.

"I think it's great that we were able to find a way to make our journals accessible and do it in a way that doesn't hurt our business model," said APS treasurer and publisher Joseph Serene.

The inclusion of high-school libraries occurred shortly after the beginning of the public library program. Several high schools approached the Society and requested if they could have access to the journals as well. Shortly afterwards, APS announced the start of a new program specifically targeted at high schools.

The schools that have signed up for the program are a mixed bunch. Many are private academies and magnet science and engineering schools. However, several regular public high schools are participating as well.

"We're trying things and seeing what people like," Serene said about allowing open access to journals in libraries, "It's a great thermometer for gauging the public's interest in the physics literature."

In recent years, APS has been working to increase its open access portfolio. *Physical Review X* is APS's newest journal, an online-only open access journal that publishes research across all disciplines of physics. The online-only journals *Physical Review Special Topics: Accelerators and Beams* and *Physical Review Special Topics: Physics Education Research* were the first open access journals published by APS.

Though many publishers are understandably cautious, as an industry science publishing has been trending towards the introduction of more open access journals. The biomedical community has been in the lead in pushing for open access. The National Institutes of Health, under its former director Harold Varmus, made open access a priority by requiring that published NIH-sponsored research has to be freely available after a year. Other organizations and publishers have similarly been exploring new open access or hybrid access models. Perhaps understandably, physics journals have not been in as high demand from the public as have biomedical journals.

"There is no question that there is going to be more open access publishing. How much more and in what form nobody knows," Serene said.

CO-OP continued from page 1

"This was PhysicsQuest's sixth year. It's a program that comes with everything you need to do four physics experiments," said Rebecca Thompson, APS's head of public outreach, "It's done with things they can find in their kitchen. It's done to teach them that physics is everywhere, not just in a lab."

Past kits featured puzzles and experiments themed around famous scientists, including Nicola Tesla teaching about electricity and magnetism, Marie Curie describing heat and energy transfer, and Benjamin Franklin teaching static electricity. The superhero Spectra made her debut in the 2009 laser and optics kit, to coincide with LaserFest, 2010's celebration of the 50th anniversary of the first working laser.

Next year's kit will return to heat and thermodynamics as Spectra faces off against the mean new girl in school Taylor Maxwell and her pet demon.

The kits are sent out to 13,000 classes each year. More than 500 teachers participated in the contest this year by submitting their answers online at PhysicsCentral.com.

"The program is wonderful. We've done it for the past couple of years. And the kids think it's great," said Amy Wilks, one of the parents and teachers of the winning cooperative. "We make lunch and we make it a whole day event."

Photo by Amy Wilks

All eight members of the home schooling cooperative get together to do the "Watch it Fly" activity from the 2011 PhysicsQuest kit.

She added also that she felt the flexibility of homeschooling works well with an exploration-based kit like PhysicsQuest, giving kids the opportunity to investigate more subjects they're interested in.

"It is really beneficial to have a whole packaged program," Wilks said. ''Its something we can do with our kids, and they enjoy it, and all the materials are all there."

Thompson added also that PhysicsQuest has been popular with home school students and teachers since its inception.

"Traditionally we have a lot of home schoolers participate, which is great," Thompson said. "We've had such a strong home school following. It's neat that they've finally won."

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almost every evening.

"Every year, we ramp up the training. Every year, we give them harder questions. Every year, we push them harder, and every year we find maybe we didn't push them hard enough. They are exceptional," said Paul Stanley, the team's academic director, during a welcome reception early in the week.

"Congratulations for getting to this point," he said to the students.

Twenty high school students out of about 400 nationwide were chosen to participate in a 10-day intensive training course at the University of Maryland. The students represent some of the best and brightest in the US, the seniors in the group bound for Harvard, Princeton, MIT, and Caltech in the fall. As smart and physics-obsessed as they are, though, they're just regular kids too.

Ante Qu, sporting a pair of neon yellow cardboard diffraction glasses he was given before lunch, is having a debate with some of his lunch mates about whether Lego, his building blocks of choice, are better than K'NEX.

"You can do so much more with K'NEX," Adam Jermyn said.

"If you have enough Lego pieces, you can do anything," Qu responded.

With Lego, though, "You can't make things that are isotropic," Jermyn said. Okay, maybe they're not exactly like regular kids. Jermyn tells time using his binary watch, effortlessly counting the 0 and 1 indicators to tell the hour.

The students are the latest additions to an elite group of high-school students who have participated in the Olympiad for the past 24 years. Two of this year's coaches are former members of traveling teams: Andrew Lin is a former silver and gold medalist for the 1998 and 1999 teams that went to Iceland and Italy. Marianna Mao traveled with the team to Mexico where she won a gold medal in 2009.

The Olympiad, an international physics competition for high school students, started in Eastern Europe in 1967, before growing into a worldwide competition. The US joined the competition in 1986 when three team members won bronze medals, the best debut of any participating team.

This year, five outstanding physics and math students from each of 86 national teams will vie for gold, silver and bronze medals. The medals are awarded to individual students based on their scores. Those that score 90 percent or better on the exams will take home gold medals. Competition lasts three days, with one day devoted to theoretical problems, another day devoted to experimental problems and a day of rest in between.

The students face exams on a range of physics subjects. They will spend the weeks leading up to the competition preparing and will have an idea of what topics might appear on the exams. The exact subject matter, however, is kept secret until the exams are passed out. After all the labs and exams are completed, all the teams' coaches review the answers and calculate the winners.

The American Association of Physics Teachers (AAPT) and the University of Maryland have organized and trained each US team from its inception. APS and the American Institute of Physics (AIP), along with more than a dozen other organizations, also sponsor the team.

The selection process for the team starts in January when high schools register for their students to take the "F=ma exam." The top 400 or so scorers move on to take the semi-final exam. From there, 20 students are selected to be on the US Physics Team and spend a long week training at the University of Maryland in late May. At the end of the training course, five students are chosen to be on the traveling team and represent the US at the international competition.

Since first competing in 1986, US team members have won 41 gold medals, 28 silver medals, 29 bronze medals and 11 honorable mentions. Last year's team earned one gold, two silver and two bronze medals. More importantly, perhaps, the participating students got a jump-start on their first-year university physics curriculum.

Back in Maryland, the 10-day training course has come to a close and the traveling team has been announced. Representing the US this year in Thailand will be high school seniors Lucy Chen, of Ames High School in Ames, Iowa; Andrew Das Sarma, of Montgomery Blair High School in Silver Spring, Md.; Ante Qu, of West Windsor-Plainsboro High School South in Princeton Junction, N.J.; and Brian Zhang, of Henry M. Gunn High School in Palo Alto, Calif. Eric Spieglan, a junior from Naperville North High School, in Naperville, Ill., is the fifth traveling team member. Spieglan represented the US last year in Zagreb, Croatia, where he earned a silver medal as part of the 2010 traveling team.

For the five travelers and the rest of the team as well, the days of saturated training are over and it's time to head back home, just in time for final exams at school. The five travelers will continue to study during the summer before heading to Bangkok where the competition starts July 11.

Swedish Accelerator Will Be Carbon-Neutral

By Calla Cofield

In 2019 the European Spallation Source (ESS), a pulsed neutron beam research facility, will begin operations in Lund, Sweden. It will also be the world's first carbon-neutral accelerator facility. ESS's energy plan will raise its initial costs, but should eventually save the facility millions of Euros a year. In the interest of fostering discussion about making science more energy efficient, ESS announced that they will host their first Green Energy for Sustainable Science conference in October of this year.

Talks at the 2011 APS April Meeting in Anaheim, California and at the 2011 Particle Accelerator Conference in New York City were both well attended, and met with questions from the audience about the specifics and the feasibility of the ESS energy plans.

"We get phone calls from people who say they want to come work for ESS specifically because we are doing this, they think it's so cool," said ESS Energy Manager Thomas Parker. "Most of the scientists I've met are very concerned about the environment… and are really enthusiastic about this project."

The ESS will be an accelerator-based spallation source, so it will generate neutrons by first accelerating pulses of protons, and then colliding those protons with neutron-rich sources, such as mercury. The collision gives the neutrons enough energy to escape the nucleus and then interact with sample materials. By observing the interaction between neutrons and other materials, scientists can study the atomic and molecular structure of those materials. Research done with neutron sources includes in-depth chemical analysis of materials, identifying elements in archeological findings, developing new materials, purification of materials, the study of biological structures such as proteins or the development of new medicines, and fundamental neutron physics, to name a few.

In 2009, the OECD declared Lund the winning city in a bidding war to host the European Spallation Source, ESS. The city's proximity to top science research institutes and relatively easy accessibility to other parts of Europe contributed most greatly to the win, but the "cream on top," as ESS Communications Officer Marianne Ekdahl describes it, was the goal to make the facility carbon neutral, and to save money doing so.

"Saving money is what policy makers are most concerned about," said Ekdahl. "But the scientists too…because the more money we save the more money we have to do science."

Perhaps the most ambitious part of ESS's carbon neutral plan will be to build enough new renewable energy sources, most likely wind turbines, to meet 100 percent of its electricity needs. The site of the future facility, where construction is set to begin in 2013, is a stretch of grassy farmland, spotted nearby with wind turbines. Parker says scientists have called it the facility "that makes neutrons out of wind."

Even after incorporating the cost of building and maintaining a wind farm, ESS will save roughly eight million Euros a year from not relying on traditional electricity sources. The facility can expect an additional four million Euros in direct income from their plan to recycle their heat waste. Rather than dissipate the waste via cooling towers, as is common at most large facilities in the US, ESS will feed the heat into Lund's district heating system. The energy savings from not using cooling towers, combined with efficiency gains in the accelerator design, will give ESS another 3 million Euros in energy savings a year, or a total savings of about 15 million Euros a year.

"So it is a useful revenue stream for us, but not something to boast about on Wall Street," said Parker. But more than income, the renewable energy source will stabilize the cost of energy over the facility's lifetime. If the price of non-renewable electricity goes up, the facility doesn't have to worry that their operating budget will increase.

Parker and Ekdahl say the new plan has stirred up conversation in the physics community and gathered attention from other facilities. Parker even puts forth the prediction that, "this is how big science facilities will be designed in the future."

But much of ESS's energy plan is made possible by its location. Only a few cities in the United States utilize a district heating system like Lund, not to mention that in the United States, large science facilities tend to be located far away from large cities. Not all locations are ideal for renewable sources like wind or solar, and even ESS will have to take into account the inconsistency of some renewable sources, like wind farms. America also doesn't have the kind of voucher system used in Europe, or quite as large an infrastructure for renewable energy sources. Kevin Jones, director of Oak Ridge's Accelerator Research Division, says it is limitations like these, not a lack of desire, that has limited United States facilities in energy-saving approaches similar to Lund.

"If any accelerator facility in the United States could find the right balance between its geographical location and its ability to draw on renewable, predictable sources of energy," said Jones, "I think the management teams would jump at that opportunity."

Most of the ESS's energy plans concern policy and management decisions, but improvements to the efficiency of these large machines and facilities is something accelerator physicists have been working on for decades. One of the techniques ESS used to reduce its annual energy bill was adopting superconductivity in some areas. Superconductivity trades the cost of heat lost through resistance in traditional magnets for the much lower cost of cooling the liquid helium needed to keep superconducting magnets at 2 Kelvin.

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difficult to acquire, leading the report to recommend that the federal government do more to collect and disseminate information on their various supply chains, and support more research into their production and reprocessing.

So far six bills in the House and three in the Senate have been proposed to address securing continued supplies of these rare elements. The strategies include more mining efforts, further research and development and an increase in emphasis on recycling and reprocessing.

The bill that most closely matches the recommendations in the APS-MRS study is that sponsored by Representative Randy Hultgren (R-IL), "The Energy Critical Elements Advancement Act of 2011" (H.R. 2090). It calls for the Department of Energy, working with the Department of the Interior, to put together a report investigating the lifecycle of energy critical elements from discovery and mining through production and uses on to disposal and potential for recycling. The bill focuses especially on research into better ways to collect and recycle these elements.

"Right now no one element is in immediate jeopardy of not being available, but we are seeing less and less availability here, especially domestically, so we need to do all that we can in a market-friendly way to recognize that this is important, clearly significantly important for energy and our future in energy, but also in research," Hultgren said in a press conference after the introduction of his legislation.

Robert Jaffe of MIT and chair of the report committee said that "[Hultgren's] bill really includes the most important features of our report in a very compelling way."

In the Senate, two bills similarly contain many of the same research recommendations. The bills are "Critical Minerals and Materials Promotion Act of 2011" (S. 383) proposed by Sen. Mark Udall (D-CO) and "Critical Minerals Policy Act" (S. 1113) sponsored by Sen. Lisa Murkowski (R-AK).

At a recent House Science Committee meeting, John Holdren, head of the Office of Science and Technology Policy, said that while the administration has not formally taken a position on any of the proposed legislation, it supports much of what is in Hultgren's bill and the APS-MRS report.

"[Hultgren's] bill calls particularly for three focuses; one is on better information, one is on recycling and one is on research. We agree with all of that, and we are already pursuing those avenues," Holdren said.

Other bills have focused more on mining assistance, and streamlining the permitting process for new mines. Jaffe said that while important, mining won't solve all of the United States' future supply issues on its own. Elements such as terbium simply aren't found in any minable quantities in the United States, while other countries like China can produce them cheaply.

"It's a much more complex issue. Mining is an important component to a wise mineral policy, but it is only a component," Jaffe said. "We have a diverse network of international suppliers, and it would be foolish to limit ourselves to U.S. sources."

Francis Slakey, APS associate director of public affairs, says that likely none of the bills proposed thus far will be signed into law in their current form. "The only way for a bill to get to the President is if there is some merging," Slakey said. He said that right now the various representatives and senators are negotiating to work out a more expansive bill that will cover the gamut of issues.

Though no final bill has yet emerged, critical materials have been quickly gaining a lot of interest in Congress. "We're really on the fast track," Slakey said, adding that typically it can take between three and four years from when an issue emerges and congress passes final legislation. The APS-MRS study however was released in February of this year, as reported in the March *APS News*.

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"If you look at the transcripts of any Iranian student who applies to a university abroad, you'll see that in areas such as hard science, physics or English, a large fraction of the classes that are forced on these students are based on Islamic items," said Hossein Sadeghpour of the Harvard-Smithsonian Center for Astrophysics and a member of APS's Committee on International Freedom of Scientists. He estimated that between 15 and 20 percent of a physics student's transcript would be comprised of classes on Islamic ideology and philosophy.

This new state of affairs has meant that more resources are devoted towards religious study.

"You just imagine the ayatollah, with a very conservative point of view, serving as your university president. What is going to be receiving the most emphasis?" Hemmati said.

Though it seems that the actual science content of the classes themselves has remained largely intact, which subjects the university wants to emphasize has shifted. The government is less likely to financially support fundamental research than research with military or social applications. Though this is true in many countries it is more acute in Iran, said one source who has worked in both Iran and England. He requested anonymity to protect family members still living in Iran.

"Either you are one of the people that government is in favor of, or you have a hard time," the source said.

Acquiring the needed equipment to carry out research is another thorny problem, even when funding resources are available. A weak currency exchange rate combined with international sanctions means that much of the cutting edge equipment needed for research is priced out of the range of most Iranian science institutions. Cheap alternatives are sometimes available from China, but the quality is often not comparable to Western products.

"For something that you could buy in Europe and get it after six months, you have to spend five years and redo all research that people have done before," the source said. "You do a lot of work but you end up with not really the standard frontier of results."

The difficulty in setting up a lab has had two effects on the physics community in Iran; a disproportionate number of theorists because it is cheaper to host them, and a general brain drain from the country.

However traveling abroad presents its own difficulties. In 2010, when Ardalan tried to come to the APS March Meeting, visa complications prevented him from entering the country. Other physicists have also said that long visa delays have prevented them from traveling to the United States.

"As soon as someone is tagged as a physicist from Iran, they immediately identify them as part of the nuclear program," Ardalan said. "I'm one of the usual suspects."

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ment represent an overdue return to Reaganism.

It's hard to see either party ceding ground. Both have lost substantial numbers who comprised the center of the political spectrum.

The Blue Dogs, a coalition of conservative House Democrats, who counted 54 members before the 2010 election, total only 26 today.

And moderates, who represented at least a quarter of the Republican conference in the House two decades ago, have all but vanished. As Joe Scarborough, the conservative co-host of MSNBC's "Morning Joe," recently observed, there are two blocs of Republicans in the House of Representatives today: those who are followers of presidential candidate and House Tea Party Caucus leader, Michele Bachmann (R-MN), and those who are scared she will work to defeat them.

In this polarized climate it is stunning to me that so many scientists still remain disengaged from the public discourse. Both parties need to hear from the community and pronto.

This is what former House speaker, and now minority leader, Nancy Pelosi (D-CA)–a big science booster–told me a few weeks ago in Washington: "I'm concerned the science community is resting on its laurels. It needs to get active now. Otherwise, I'm afraid great damage will be done."

ANNOUNCEMENTS

Reviews of Modern Physics

Recently Posted Reviews and Colloquia

Colloquium: Physics of optical lattice clocks

Andrei Derevianko and Hidetoshi Katori

The accurate measurement of time is fundamental in many different areas in physics and engineering. In this Colloquium, a way to measure time with high accuracy is discussed which is based on clocks made out of cold atoms trapped in optical lattices. Within this method a clock "would neither lose or gain a fraction of a second over an estimated age of the Universe."

http://rmp.aps.org

Correction

In the story in the June *APS News* about using Cherenkov radiation for medical imaging, the element involved was mis-identified as Actinium 235. It should have been Actinium 225. *APS News* regrets the error and apologizes to the extra neutrons that were inadvertently implicated.

Correction

We inadvertently failed to acknowledge the source of the Back Page in the June *APS News*. We should have noted that a version of the article by Marie-Claire Shanahan and Zahra Hazari first appeared as a guest blog by the former author on the website of *Scientific American*. See http://www.scientificamerican.com/blog/post.cfm?id=can-we-declare-victory-in-the-parti-2011-03-29.

SOUTH AFRICA continued from page 3

ics and an update on a global survey of women in physics. After the conference, attendees had the opportunity to travel to a nearby elementary school and talk about science to the students.

"It was a jam-packed few days. I met some really interesting people," Cunningham said.

The event drew men and women from a wide range of physics disciplines who were at various stages of their careers. Attendees included undergraduates, graduate students, faculty, society members and industrial physicists.

The conference brought together nearly 300 participants from over 70 countries from across the world, including Burkina Faso, Japan, Russia and Nigeria. Egypt also sent a delegation despite the recent political upheaval in the country.

IUPAP picked South Africa for its fourth conference on women in physics for a combination of reasons. A major factor was to try to get more people from developing nations in Africa to participate. Hosting the conference in South Africa cut travel costs for those on the continent, dramatically increasing the participation of people from African nations. Past conferences were held in Paris, Brazil and South Korea.

In addition, South Africa has been aggressively pushing its science programs and building its academic credentials. It already is home to the Southern African Large Telescope (SALT), the largest optical telescope in the Southern Hemisphere, and is vying to host the Square Kilometer Array of radio telescopes.

"They're really entering the big time in that field. They see the strategic investments in science as important," Urry said.

The conference featured a number of prominent speakers. Wednesday's plenary speaker was Jocelyn Bell-Burnell, who discovered pulsars. Earlier in the day, Mae Jemison, the first African-American woman astronaut, delivered a talk about experiential science education.

Many of the talks were video-recorded and can be accessed online. Emma Ideal, a graduate student at Yale, was in charge of putting together the video archive from the meeting. She said that they hoped that attendees would be able to keep a record of the talks.

"Others who weren't able to make it for whatever reason… this broadcast would allow them to have a greater participation role by means of the post-conference dissemination," Ideal said.

The videos can be accessed at http://physics.yale.edu/4th-international-conference-women-physics.

SWEDISH continued from page 6

At ESS's Green Energy for Sustainable Science conference, which Parker says is open to all areas of science, attendees will have a chance to discuss the changing demands on large science facilities to conserve more energy and be environmentally conscious. The conference will also discuss goals to lower energy consumption by big science facilities, new techniques to improve efficiency, and how laboratories can implement the technologies and approaches already available.

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"We do not see the signal… If it existed, we would see it. But when we look at our data, we basically see nothing."

***Dmitri Denisov**, Fermilab, on the DZero detector's null result when looking for the "bump" seen at CDF,* FoxNews.com*, June 10, 2011.*

"But all that's really important to know is that all the putts nearby are related to each other… A few steps to the left, a few steps to the right, they all have a target point which you can align yourself."

***Robert David Grober**, Yale, on how to line up a putt in golf, MS-*NBC.com*, June 13, 2011.*

The Back Page

The Sanford Underground Research Facility at Homestake–an Opportunity for the United States to Lead *Profound* Physics Experiments

By Kevin T. Lesko

The Department of Energy's (DOE) Office of Science has the opportunity to enhance the prospects for major scientific discoveries in the US in the coming decade by supporting underground physics experiments that will profoundly advance our understanding of the physical universe.

Last December, the National Science Board (NSB), in its role as the oversight body for the National Science Foundation (NSF), unexpectedly decided to deny further NSF funding for the Deep Underground Science and Engineering Laboratory (DUSEL) [1] As it did so, the NSB nevertheless expressed its interest in the scientific programs moving forward. [2,3]

These programs have been thoroughly vetted by the High Energy Physics (HEP) and Nuclear Physics (NP) communities and are essential elements to advance these disciplines. The US and international communities have been actively engaged with the DUSEL Project team. With NSF and DOE sponsorship, about 25 collaborations with over 700 researchers are developing experiments. The DUSEL Project, including NSF and DOE, have spent ten years forging the path for creating these experiments and providing the facilities necessary to lead the worldwide effort.

The DUSEL Project and the entire US underground-science community are hopeful for a successful evolution in the DOE and NSF stewardship of these efforts. DOE leadership will empower the HEP and NP communities to not just participate in, but lead world-class experiments. We applaud the Office of Science for their leadership in seeking solutions in the midst of such uncertain funding times.

Following the NSB's decision, three significant events occurred: 1) DOE established a committee to assess options for underground physics experiments–efforts that were underway: the Long Baseline Neutrino program (LBNE), searches for Dark Matter (DM), and for Neutrinoless Double Beta Decay ($0\nu\beta\beta$); 2) The DUSEL Preliminary Design was completed; and 3) the National Research Council's report assessing DUSEL's science opportunities is anticipated shortly [4].

Fortunately there is a path forward that preserves US leadership roles, leverages the existing efforts designing the facility, capitalizes on South Dakota's inspirational investments, and maintains the existing momentum.

In February, William Brinkman, Director of DOE's Office of Science, announced the formation of the *Independent Review of Options for Underground Science Committee* to assess the costs, as well as siting and staging alternatives to achieve cost-effective options for implementing a world-class program of underground science [5].

The Compelling Science has been Identified and Prioritized

In 2008 the Particle Physics Project Prioritization Panel Roadmap of the HEP Advisory Panel (HEPAP) and in 2007 the Nuclear Science Advisory Committee Long Range Plan assessed these high priority research topics as the DOE and NSF jointly pursued concepts for an underground facility. The full suite of scientific experiments has been critically assessed by APS reports, including *The Neutrino Matrix* (2004); National Academy Reports–*Connecting Quarks to the Cosmos* (2002), *Neutrinos and Beyond* (2003); NSF reports–*Deep Science* (2007); and Joint DOE and NSF scientific assessments–*Discovering the Quantum Universe* (2004), the Dark Matter Scientific Assessment Group (2007), and the Particle Astrophysics Scientific Assessment Group (2009). Internationally, underground physics is the focus of the OECD Global Science Forum in its Report of the Working Group on Astroparticle Physics (2011). In 2010 the DUSEL Program Advisory Committee summarized: [6]

We are impressed by the breadth and depth of the DUSEL science. The envisioned program in physics and astrophysics will address fundamental questions about the Universe and its fundamental laws, such as the question of why the universe contains matter but no antimatter, the nature of dark matter, the origin of neutrino mass, and the genesis of the chemical elements. … In addition, the Committee felt that the interdisciplinary laboratory, with sustained support, will provide unique scientific opportunities that engage and educate the next generation of scientists and engineers.

Direct Detection of Dark Matter: There is compelling evidence that most of the matter in the universe consists of non-Standard Model particles subject to gravitational forces. This material directly influences large-scale cosmology, galactic formation, and evolution, and provides convincing evidence for new physics beyond the Standard Model. DM experiments have made impressive advances in sensitivity, pursuing multiple technologies and techniques. The Sanford Underground Research Facility is poised to provide excellent facilities for DM programs on a competitive time scale. The rock is an order of magnitude lower in U and Th than found at other proposed sites. A DM experiment is currently being deployed at Homestake and Generation-2 (~ 1 tonne) experiments can be installed in advance of new construction to support the Generation-3 (~ 10 tonne) experiments. These experiments are necessary to complement the LHC experiments in seeking to identify DM and capitalize on the current US leadership.

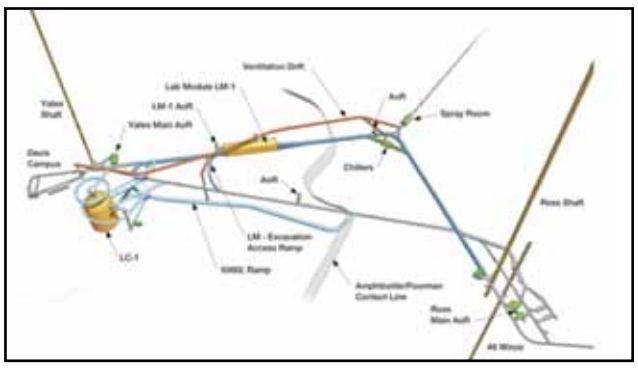

Figure 1. The reduced-scope option at the 4850 ft level (feet underground), showing a 100kt cavity and a 100m-long lab.

Neutrinoless Double-Beta Decay Searches: Much of underground physics focuses on completing our understanding of neutrino properties. While oscillation experiments have presented compelling evidence that neutrinos oscillate between massive families, there remain significant challenges to completing our understanding: the absolute neutrino mass, the ordering of the neutrino families (mass hierarchy), the full mixing matrix describing the oscillations among the three families, and possible charge and parity (CP) symmetry violating phases and/or Majorana phases. The $0\nu\beta\beta$ experiments will address the determination of the absolute neutrino mass, mass hierarchy, and Majorana phases which would indicate that the neutrino is its own antiparticle. When coupled with other experiments, even null $0\nu\beta\beta$ results are extremely valuable. The deployment of tonne-scale experiments would: capitalize on the US investment while developing this essential component of the US program; exploit the unique opportunity for a low-background experiment; and launch a world-leading effort with high discovery potential.

Long Baseline Neutrino Experiment and Proton Decay Searches: There is an abundance of evidence that neutrinos oscillate among the three known flavors ν_e, ν_μ, ν_τ, indicating that they have masses and mix with one another. Indeed, *modulo* an anomaly in the LSND and MiniBooNE experiments, which report excess candidates, all observed neutrino oscillation phenomena are well described by 3-generation mixing, which is described by two mass squared differences Δm^2_{12}, Δm^2_{23} three mixing angles (θ_{12}, θ_{23}, θ_{13}) and a phase (δ_{CP}). As yet, the sign of Δm^2_{23} is undetermined. Resolving the sign of the mass hierarchy is an extremely important issue. Δm^2_{12} is large enough, compared, to Δm^2_{23}, to make long baseline neutrino oscillation searches for CP violation feasible and likely to yield positive results. Currently, we know nothing about the value of δ_{CP} and only have an upper bound on θ_{13}: $\sin^2 2\theta_{13} < 0.2$. Knowledge of θ_{13} and δ would complete our determination of the lepton-mixing matrix and provide a measure of leptonic CP violation. LBNE provides the clear path to obtaining the best sensitivity to all these parameters. *NB: on 15 June the T2K collaboration reported the observation of six electron-like events. At 90% C.L., the data are consistent with $0.03(0.04) < \sin^2 2\theta_{13} < 0.28(0.34)$ for $\delta_{CP} = 0$ and normal (inverted) hierarchy. While requiring additional confirmation, T2K's measurements of a relatively large θ_{13} indicate that the LBNE goals are well within the capability of the experiment design parameters. [7]*

CP violation has only been observed in the quark sector. Discovery in leptons should shed light on the role of CP violation in nature. Most important, unveiling leptonic CP violation is compelling because of its potential connection with the observed matter-antimatter asymmetry of our universe, a fundamental problem at the heart of our existence. These studies will provide additional, sensitive probes for "New Physics" deviations from 3-generation oscillations.

LBNE's large detector offers a rich field of physics discovery by pushing the limits on proton decay into modes suggested by supersymmetric GUTS. Establishing baryon-number conservation violation would have profound implications for cosmology and particle physics. The same detector can pursue astrophysical neutrino observations including measurements of supernova neutrinos.

To update the science the NSF and DOE requested a National Research Council assessment. This assessment and the Office of Science Report are anticipated by the end of June (shortly after *APS News* goes to press).

Facility Preliminary Design

The DUSEL Project completed its Preliminary Design in March. The design proposes the former Homestake Mine as the site. The Berkeley team is a collaborative effort working with South Dakota government and university entities. South Dakota established its Science and Technology Authority (SDSTA) to facilitate the development of DUSEL and to advance higher education and technology activities.

The SDSTA received title to the site in 2006. The property includes 186 surface and >7,000 subsurface acres with 600 km of existing shafts and tunnels. The SDSTA, using a HUD grant, state funding, and $70M of philanthropic funding, stabilized and re-established access to the underground, and re-established pumping of the accumulated underground water. The impacts of flooding the 4850 ft. level have been mitigated. Significant infrastructure and safety enhancements have been installed. The Davis Laboratory, which housed Davis' Nobel Prize-winning solar neutrino experiment, has been expanded and a new hall excavated. Both are being outfitted to support physics experiments.

Geotechnical investigations affirm that the 100 ktonne cavity design poses few problems. Recent analyses indicate that 200 kt class excavations are well within existing excavation and ground support technologies.

The Facility Design was critically reviewed by a 23-member committee, who report: *The costs are mature, well supported and well documented. Many sections of the report are well beyond the Preliminary Design Report (PDR) stage. There is a strong core team that understands the issues and knows how to address them. The project continued to do very high quality work on the PDR, despite the very chaotic environment and reductions in staff. The PDR is of very high quality and is at the level expected for a CD-2 review in the DOE system.*

Advancing Underground Research with DOE Leadership

The Project team, working from the PDR, created reduced-scope options for consideration by the Office of Science Committee. One option for the newly named Sanford Underground Research Facility at Homestake (SURF) is shown in Figure 1. The designs are tailored to the DOE's science goals, while maintaining flexibility to develop new areas. The options accommodate LBNE's Water Cherenkov and/or Liquid Argon (LAr) detectors at the 4850 ft. level, and/or shallower depths for the LAr. In addition to LBNE's detectors we propose a laboratory module capable of supporting two to three experiments. The 4850 ft. level option proposes experiments share a 100m long module, while at the 7400 ft. level we propose a 75 m long module. An independent construction management firm validated cost and schedule estimates. These options support all of DOE's world-leading science programs in a single facility, while maintaining on-going efforts in DM and $0\nu\beta\beta$: LUX and MAJORANA DEMONSTRATOR in the Davis Campus. The aggressive schedule is supported by the state's efforts. The design benefits from the substantial synergisms of a single site with coordinated design, construction, and operations.

The transition to DOE leadership introduces the opportunity for additional funding paths for the variety of project scales which may benefit the science. Experiments can develop and be integrated as their plans sufficiently mature, rather than being funded "all at once" as required by an NSF Major Research Equipment and Facility Construction account Project.

While some efforts more clearly align with one agency, all involve both DOE- and NSF-supported scientists. It is among our highest priorities to maintain NSF's engagement. Through the involvement of both agencies we foresee the greatest benefits to the physics program, the maximum realization of synergistic benefits, and greatest reduction of overall costs through the increased sharing of facilities.

We strongly encourage the DOE to assume leadership of SURF, to work with the scientific collaborations to maintain NSF's engagement in the science, and to take advantage of the existing Project Team to produce a facility that will propel the US into world-leadership with efforts in neutrino studies and dark matter searches. All the essential elements for success exist now.

Kevin T. Lesko of UC Berkeley is the DUSEL Principal Investigator.

(1) http://news.sciencemag.org/scienceinsider/2011/05/chu-calls-nsfs-decision-to-aband.html?ref=ra (2) http://www.aps.org/publications/apsnews/201101/nsffunding.cfm (3) http://sites.nationalacademies.org/BPA/BPA_060036 (4)http://lbne2-docdb.fnal.gov/0035/003501/001/DUSEL_Charge_Letter.pdf (5)http://sites.nationalacademies.org/BPA/BPA_058955 (6) http://www.dusel.org/html/pac.html (7) arXiv:1106.2822v1 [hep-ex]

APS News welcomes and encourages letters and submissions from its members responding to these and other issues. Responses may be sent to: letters@aps.org