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APS physics

Kokabee Gets 10-Year Sentence

See Page 5

APS-led Teacher Preparation Program Announces Seven New Funded Sites

By Bushraa Khatib

The Physics Teacher Education Coalition (PhysTEC) will award new funding to seven universities to develop their physics teacher education programs. The newly selected sites are Arizona State University; California Polytechnic University-Pomona; Central Washington University; James Madison University; University of Alabama-Tuscaloosa; University of Missouri-Columbia; and University of Wisconsin-La Crosse. The latest round of awards brings the number of funded PhysTEC sites across the US to 27.

The PhysTEC project, a partnership between APS and the American Association of Physics Teachers (AAPT), strives to improve and promote the education of future physics teachers. The project does this in part by selecting colleges and universities to develop their physics teacher preparation programs into national models with substantial project support. PhysTEC-supported sites have collectively more than doubled the number of physics teachers they graduate. The project has also built a broad coalition of 258 institutions committed to improving physics teacher preparation.

Bob Hilborn, Associate Executive Officer of AAPT, notes that the joint APS/AAPT project has already made significant progress towards increasing the number of physics majors interested in high school teaching. "This year's solicitation for PhysTEC funding resulted in a set of strong proposals from a broad spectrum of colleges and universities," he added.

The new features that this year's funded sites bring to the PhysTEC program were emphasized by Theodore Hodapp, APS Director of Education and Diversity. "Several sites intend to focus on the synergy between in-service and pre-service efforts, an interaction that PhysTEC is eager to develop," he says.

PhysTEC students at the University of Alabama-Tuscaloosa will gain early teaching experiences through the school's partnership with Alabama Science in Motion (ASIM), a statewide program that provides high-tech

SITES continued on page 7

APS Signs MOU with Korean Physical Society

In April, the presidents of the American Physical Society and the Korean Physical Society agreed to a memorandum of understanding between the two societies to promote scientific exchanges across the Pacific.

"There is a shared interest in promoting physics and diffusing the knowledge of physics in published work and meetings," said APS President Robert Byer. "There is also a shared interest in education and outreach and in improving international cooperation and collaboration. The MOU affirms that both the APS and the KPS will collaborate in areas of common interest."

Signed by Byer and KPS president Sung-Chul Shin, the memorandum encourages the two societies to work closely together, and to foster scientific partnerships between the two nations. Specifically it calls for joint meetings to be held in areas of physics in which both societies share an interest. In addition, it calls for more support for physicist exchanges and for the APS Office of International Affairs to maintain close contact with KPS's International Cooperation Committee to continue discussions of future collaborations.

"The MOU formally establishes a partnership and gives clear goals for joint activities. This increased collaboration will have a 'snowball effect,'" said Amy Flatten, APS Director of International Affairs. "The more we do, the more we can do with activities, further strengthening relations, communication and collaboration, and thus better serving phys-

MOU continued on page 3

Cultures Collaborate at Daya Bay

By Calla Cofield

In early March, the Daya Bay neutrino experiment announced a measurement of the highly-sought-after mixing angle θ_{13}. The experiment made headlines by reaching its goal after only 55 days of data-taking, ahead of two competing experiments.

"It's a shining moment for us," said U.S. Project Manager Bill Edwards of Lawrence Berkeley National Laboratory (LBNL). By us, Edwards means himself, Kam-Biu Luk, the American spokesperson for Daya Bay, and Yifang Wang, the Chinese spokesperson and project manager. Daya Bay is the largest US-Chinese physics collaboration in history, but the accomplishment wasn't without struggle. In addition to the difficulties that face any large experiment, there was also the challenge of combining cultures. It was, as Edwards describes it, "An experiment within an experiment."

In 2003, Luk, a member of the LBNL physics division and a professor of physics at UC Berkeley, conducted an international search for potential sites for a multi-detector, reactor-based neutrino experiment. The fission processes inside

BAY continued on page 6

New Technique Combines Solar Cells and Semiconductors

By Calla Cofield

In an effort to lower the cost of solar cells and increase their functionality, scientists at Sandia National Laboratories are producing cells using the manufacturing processes of the semiconductor and microelectronics industries. At the APS April Meeting, Sandia scientist Jeff Nelson highlighted progress in getting these small, lightweight and flexible solar cells to market.

Solar cells on the market today are most often made of crystalline silicon, used because of its high light-to-energy efficiency. Silicon is also the primary material used in semiconductors and computer electronics, which have seen a rapid decrease in cost over the past three decades. So, "Why shouldn't the solar industry see a similar drop in price?" says Vipin Gupta, a co-lead in Sandia's Microsystems Enabled Photovoltaics group. "There seems to be an intuitive sense that the two ought to be connected."

Photo courtesy of Sandia National Laboratories.

A flexible mechanical model with embedded microscale photovoltaic cells.

At a press conference at the APS April Meeting, Jeff Nelson held up the product of Sandia's efforts to combine these two fields: a vial of liquid containing solar cells so small they look like bits of decora-

SOLAR CELLS continued on page 7

Groundbreaking Event Ushers in APS Building Expansion

At a ceremony on May 8, attended by APS staff, local dignitaries, and construction contractors, APS formally kicked off the construction phase of the long awaited expansion to its editorial office on Long Island. The new construction will be the first addition to the building since 1997.

The office is responsible for the publishing of all APS journals, *Physical Review A* through *E*, *Physical Review Letters*, *Physical Review X*, *Reviews of Modern Physics*, and the online-only special topics journals for *Accelerators* and *Beams* and for *Physics Education Research*. The building will have a second story added with space for offices, a lunch room and roof deck. The first floor will also be reconfigured to add more office space.

"Since the building was last expanded, the number of manuscripts [per] year has doubled. In order to handle the papers, the number of editors continues to grow, and we need more space for them and for other staff," said APS Editor in Chief Gene Sprouse. "It feels great to be over the delays that we could not control and finally get moving on the construction."

The construction had been delayed for about a year after a complaint from a local environmental group, the Pine Barrens Society. The complaint was thrown out of court in September of last year, and the rest of the required permitting followed in due course.

Sprouse and APS past President Barry Barish both gave brief speeches before ceremonially overturning the first shovelfuls of dirt in front of the offices. Town supervisor Mark Lesko and Lisa Broughton, the Acting Energy Director and Bio/High Tech Specialist at Suffolk County also spoke at the ceremony. Sam Aronson, Director of Brookhaven National Laboratory, attended as well. The APS office is located in Ridge, New York, just across the William Floyd Parkway from the De-

EXPANSION continued on page 6

Photo by Michael Lucibella

APS past President Barry Barish tips his hat to acknowledge the plaudits of the multitude as he formally breaks ground for the building expansion. Standing behind him, left to right, are APS Editor in Chief Gene Sprouse (partially obscured), Brookhaven Town Supervisor Mark Lesko, and Acting Suffolk County Energy Director Lisa Broughton

Members in the Media

"If you would only replace the radars by real radars and you replace the interceptors by faster interceptors and you find some way of discriminating between a warhead and a decoy, then yes, it's a good foundation for moving forward."

***Richard Garwin**, IBM, on a Department of Defense report highlighting challenges facing the United State's missile shield,* The Associated Press*, April 21, 2012.*

"All you need to know is classical mechanics and a little bit of geometry."

***Dmitri Krioukov**, University of San Diego, on the physics he used in his paper to get out of a traffic ticket,* The Los Angeles Times*, April 23, 2012.*

"One of the most basic questions in cosmology is whether the universe had a beginning or has simply existed forever… It was addressed in the singularity theorems of Penrose and Hawking, with the conclusion that the initial singularity is not avoidable."

***Alexander Vilenkin**, Tufts University, from a paper published with mathematician Audrey Mithani analyzing the beginning of the universe,* The Daily Mail*, April 25, 2012.*

"Given the international attention it has gotten from parading these missiles you could argue that the cost of buying the large trucks–which add a lot of credibility to the images of the missiles–was money well spent in terms of projecting an image of power."

***David Wright**, Union of Concerned Scientists, on the possibility that North Korea was showing off fake ICBMs before its failed missile launch,* The Associated Press*, April 26, 2012.*

"[W]e should be looking at what the wiring diagram [inside of cells] looks like."

***László Barabási**, Northeastern University, on how genes from disparate diseases might trigger each other,* The Wall Street Journal*, April 30, 2012.*

"There's nothing better than waking up in the morning with a new idea. I feel lucky to be able to pursue these ideas, day-in and day-out, and to know that every once in a while, a new idea will turn into a whole new approach for doing things that can actually change the world."

***Jacob Taylor,** NIST,* The Washington Post*, May 7, 2012.*

"Of course, there are ways to control coffee spilling…a flexible container to act as a sloshing absorber in suppressing liquid oscillations, a series of annular ring baffles arranged around the inner wall of the container to achieve sloshing suppression, or a different shape cup."

***Rouslan Krechetnikov**, University of California Santa Barbara, on his research into spilling coffee,* MSNBC.com*, May 9, 2012.*

"I just wanted to say I had a little bit of this when I must meet with scientists, and many of them would basically say something along the lines of: What ever led you to go to Congress? I mean, what was wrong with your mind that you decided to do that? And scientists tend to look down on it. And I just thought it was a great opportunity to continue educating, which I had done for many years as a professor."

***Former Congressman Vernon Ehlers**, on scientists' aversion to serving in public office,* National Public Radio*, May 11, 2012.*

"They're saying cancer research is bad? It's a strange message."

***Herbert Levine**, University of California San Diego, referring to tobacco-industry-sponsored advertisements in California opposing a new cigarette tax,* The Los Angeles Times*, May 12, 2012.*

"The [obesity] epidemic was caused by the overproduction of food in the United States. Beginning in the 1970s, there was a change in national agricultural policy. Instead of the government paying farmers not to engage in full production, as was the practice, they were encouraged to grow as much food as they could. At the same time, technological changes and the "green revolution" made our farms much more productive. The price of food plummeted, while the number of calories available to the average American grew by about 1,000 a day."

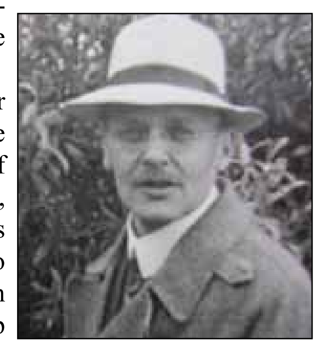
***Carson Chow,** National Institutes of Health,* The New York Times*, May 14, 2012.*

This Month in Physics History

June 1911: Invention of the Geiger Counter

It is impossible to discuss the history of the atom without reference to the famous gold foil experiment spearheaded by Ernest B. Rutherford in 1909, which demonstrated experimentally for the first time the existence of the atomic nucleus. The results disproved J.J. Thomson's earlier plum pudding model of the atom, and paved the way for Niels Bohr to develop his own atomic model, which continues to play an important pedagogical role today. A key element of that experiment was the invention of a reliable device capable of measuring alpha radiation, by Rutherford's lab assistant, Hans Geiger.

Born in 1882, Geiger was one of five children born to a philosophy professor at the University of Erlangen in Germany. Young Hans studied physics at the University of Munich and served a stint in the German military before pursuing graduate studies at Erlangen, earning his PhD in 1906 with a thesis on electrical releases through gases. He then moved to England to become a laboratory assistant in Rutherford's laboratory at the University of Manchester.



Hans Geiger

Working with Rutherford, Geiger demonstrated that in the radioactive decay of uranium, alpha particles of two different energies are emitted, caused by two uranium isotopes. This led to his work with J.M. Nuttall to formulate the Geiger-Nuttall Rule in 1912, describing the linear relationship between the radioactive time constant and the logarithm of the range of alpha particles.

To probe the structure of the atom, Rutherford wanted to devise an experiment to measure the electric charge of a stream of alpha particles hitting a target and scattering, hoping to demonstrate that alpha particles carry a double positive charge. Working with one of Rutherford's undergraduates, Ernest Marsden, Geiger came up with an ingenious device that fired alpha particles through gold foil onto a screen, where they could be detected as scintillations.

But how would they count the number of small flashes of light per minute with any suitable degree of accuracy? Initially, they used a microscope that could be rotated around the gold foil, and took turns counting the flashes. It was hard on the eyes, however: one had to sit in a dark laboratory and wait 30 minutes for one's eyes to adjust, and an observer could usually manage only about one minute of accurate counting before needing to be relieved.

Still, they persevered, and the results of the gold foil experiment are now legendary. Instead of merely passing through the foil with only minor deflections–as one would expect if the Thomson plum pudding model were correct–some alpha particles appeared to bounce back at the source, "as if you fired a 15-inch shell at a piece of tissue paper and it came back and hit you," Rutherford recalled. Clearly, a new model of the atom was needed.

Geiger still thought there had to be a better way to measure the scintillations, and in 1911 he invented a device to count radioactive alpha particles automatically in normal light. It used a Crooke's tube as one electrode, with a thin wire running through the middle of the tube as a second electrode. When a voltage was applied, any alpha radiation passing through ionized the gas, giving rise to an avalanche of electrons. An electrometer would then register each passing particle.

In 1914, Geiger returned to Germany, initially to take charge of radiation research at the country's National Institute for Science and Technology. But the outbreak of World War I put a damper on science: he served as an artillery officer with the German army instead. The harsh conditions in the trenches on the front lines took their toll: Geiger developed painful rheumatism, which plagued him for the rest of his life. After peace returned, Geiger returned to research, finding positions at the University of Kiel and the University of Tübingen before landing the position of physics chair at the Technische Hochshule in Berlin in 1936.

It was during his stint at Kiel that Geiger collaborated with one of his doctoral students, Walther Muller, on improving his original Geiger counter device, making it more efficient, responsive, durable and portable. Unlike the earlier version, which could detect only alpha particles, the new improved Geiger-Muller counter could detect many different kinds of ionizing radiation. He used his new toy to confirm the existence of light quanta in 1925, and later to discover cosmic ray showers, which would claim his scientific attention for the remainder of his career.

Then came the rise of Adolf Hitler and the draconian policies of the National Socialist Party, and the eventual outbreak of World War II, which combined served to decimate an entire generation of German physicists. Geiger decried the politicization of the universities and signed a petition with 74 other colleagues urging the new government not to interfere with their work–to little avail. But reports differ as to whether he helped or rejected his beleaguered Jewish colleagues, many of whom were forced to flee the country.

He was also a member of the so-called Uranium Club, a clandestine German effort to develop and produce atomic weapons after the discovery of atomic fission in 1939. The program splintered in 1942, with its scientists moving to other areas of research deemed more urgent, after it was determined (incorrectly) that nuclear fission would not play a major role in ending the war.

Geiger's chronic rheumatism continued to worsen in his final years. He lived just long enough to see the fall of the Nazi regime. Just as Geiger's health seemed to be improving, his home city of Babelsberg was occupied by Allied forces, and he was forced to flee to Potsdam. Already frail, he died there on September 24, 1945, at 62.

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E. Rutherford and H. Geiger. (1908) "An electrical method of counting the number of α particles from radioactive substances," *Proceedings of the Royal Society* (London), Series A, vol. 81, no. 546, pp. 141–161.

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H. Geiger and W. Müller. (1928) "Elektronenzählrohr zur Messung schwächster Aktivitäten" (Electron counting tube for the measurement of the weakest radioactivities), *Die Naturwissenschaften* (The Sciences), vol. 16, no. 31, pp. 617–618.

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Workshop on Building a Thriving Undergraduate Physics Program
June 10-12, 2012 at the American Center for Physics
APS, in conjunction with AAPT and the National Science Foundation, will be holding a workshop to assist departments in developing strategies for increasing the number of physics majors. Institutions are encouraged to come as teams of two or more to help develop effective, workable plans that can be implemented on their campuses. Plenary speakers Carl Wieman, Office of Science and Technology Policy, and S. James Gates Jr., University of Maryland, will contribute their insights along with faculty who have been instrumental in dramatically increasing the number of undergraduate majors at their institutions.

Space is limited and will be assigned on a first-come, first-served basis, so register early. For more information and to register, visit www.ptec.org/conferences/enrollment/

2012 Physics Department Chairs Conference
The biennial Physics Department Chairs Conference will be held June 8-10, 2012 at the American Center for Physics in College Park, MD. The conference will begin about 5 p.m. on June 8 and end by noon on June 10. These conferences, co-sponsored by the APS and AAPT, have proven to be valuable to department chairs in bringing them up-to-date on trends in physics research and education while providing an opportunity to meet and learn from other department chairs.

For more information, please visit www.aapt.org/Conferences/deptchairsconf.cfm

PAIR invites nominations and applications: Deadline is September 15, 2012
Physics and Instructional Resources (PAIR) is a pilot project in physics teacher professional development designed to support physics teachers in significant need of content and/or material resources. This effort, funded by an APS member donation, will support up to 20 teacher+professional physicist teams to develop and implement new content-rich lessons. A grant of up to $1,200 will be provided to each team to purchase classroom materials required for the lessons. Travel support will also be provided to the team to share their project at a regional professional meeting.

PAIR is seeking high school physics teachers who are in particular need of professional development and material support and professional physicists (including post-docs and graduate students) in academe or industry who would like to work closely with a high school physics teacher. The collaboration will require several face-to-face meetings, so the teacher and professional physicist should be within a comfortable driving distance.

If you know of high school teachers or professional physicists who might be interested, please let them know about this opportunity, and send their names and contact information to Jacob Clark Blickenstaff (blickenstaff@aps.org). For more information, please visit www.aps.org/programs/education/highschool/teachers/pair.cfm

PRST-PER welcomes Charles Henderson as new Senior Editor
Physical Review Special Topics - Physics Education Research (*PRST-PER*) is a peer-reviewed online open-access journal of the APS. The journal has been steadily growing since its inception in 2005 and covers the full range of experimental and theoretical research on the teaching and/or learning of physics. Charles Henderson of Western Michigan University has been chosen as the new Senior Editor of *PRST-PER*.
Learn more about *PRST-PER* at http://prst-per.aps.org/

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. Advanced searches allow one to search specifically for women and minority physicists and physics education researchers. Learn more at www.aps.org/programs/speakers/

MOU continued from page 1

icists from both communities."

The agreement came about after a meeting between Byer and Shin in February when Byer was visiting Seoul for a separate meeting. The two presidents met for a brief, informal conversation, and began discussing the idea of a memorandum between the two societies. After Byer returned to the United States, the final wording of the agreement was worked out. APS past President Barry Barish brought the final draft of the agreement to Seoul in April when he was visiting for the 60th anniversary celebration of the KPS. At the celebration, Shin signed his name to the document, formalizing the agreement between the two societies.

The memorandum builds on a reciprocal agreement signed in 1993, which allows members of both organizations access to each other's meetings, as well as the ability to submit papers to these meetings. APS has so far signed such reciprocal agreements with a total of 43 national and regional physical societies.

Talking Science on Capitol Hill

Photo by Jodi Lieberman

Each year, APS participates in a Congressional Visit Day, sponsored by The Science-Engineering-Technology Working Group. Scientists travel to Washington from all over the country for a full day of visits with their Senators and Representatives, to make the case for science on the Hill. In the photo, R. Zach Lamberty (right), who is currently a graduate student at Cornell, chats with his home-state Senator, Republican John Thune of South Dakota, during this year's CVD on April 25.

To Infinity and Beyond with Physics

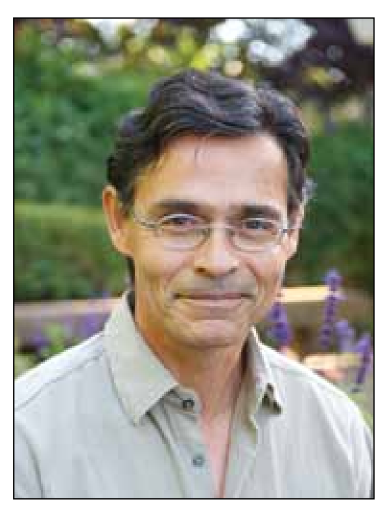
By Alaina G. Levine

The Incredible Tony DeRose spends his days thinking about computer rendering and algorithms and his nights dreaming about cars, monsters and toys. The greatest aspect of his job, as Senior Scientist at Pixar Animation Studios, is that he gets to bring these dreams to reality and create true movie magic. "My goal is never to grow up," he concedes. "I have one of the best jobs in the world. It is a fantastic opportunity to do work that is intellectually interesting and, with all the artists and storytellers, package it in a way that the whole planet enjoys."

Pixar's films, including Toy Story, A Bug's Life, Monsters, Inc., The Incredibles, and Finding Nemo, rely on an army of applied mathematicians, computer scientists, engineers and physicists to take artistic ideas and convert them into visually stunning (and moving) imagery. "There's a huge amount of science and technology behind every frame of every film we make," notes DeRose, who leads a research team of six scientists, postdocs and interns. "The level of craft in the industry has increased amazingly. It used to be really difficult to watch anything. Sometimes now I'm completely fooled."

DeRose came to Pixar after a decade in the Ivory Tower. He had been on the academic fast track, briskly acquiring a bachelors in physics from UC Davis and a doctorate in computer science from UC Berkeley, skipping the postdoc altogether, and accelerating directly into a tenured position at the University of Washington. But after 10 years of attending faculty meetings and grading papers, the trappings of scholarly existence had begun to take their toll and zap his creativity. "I had been promoted to professor and had figured out the academic career track thing," he recalls. "And I realized I was never going to do anything else for 30 years."

It was 1995. The iPhone didn't exist yet and the Newton was a spectacular failure, and computer graphics were in their pre-pubescence. Pixar, "a small scrappy company, with no legacy code base," as DeRose describes it, had already emerged as an innovator in a new kind of animation that required unique skill sets at the junction of physics, math and computer science. It was being led by President Ed Catmull, himself a computer scientist, who knew DeRose by reputation. He invited DeRose to join the firm, which DeRose happily did.



Tony DeRose, Senior Scientist at Pixar Animation Studios.

"The jump to Pixar allowed me to take some of the things I had been working on in the lab at the University of Washington and try them out in industry," he says. His research was in subdivision surfaces and wavelets, which he realized would not be as appreciated in big firms like Boeing and Ford, where it is difficult to effect change. "I thought I had an interesting and powerful technology in my pocket," he adds, and Pixar, still a small and flexible company, would give him the opportunity to apply his technology to real-world problems.

"Subdivision surfaces allow shapes to be described using polyhedra, that are faceted models, that are repeatedly refined by simple algorithms that can be shown to converge to smooth, differentiable surfaces in the limit," he explains. One of the first projects on which he worked after being hired focused on making skin, cloth, and other movable shapes more believable on screen. This technology contributed greatly to this effort, as seen in Geri's Game, which won the Academy Award for Best Animated Short Film in 1998. "Toys are compelling as lifelike characters, but creating human characters is much more difficult," he says. "People are squishy things that move in much more complicated ways." Using subdivision surfaces "gave me a way of modeling, a simple and artist-friendly way of creating complicated shapes that move." For example, animating skin so it looks realistic is very tricky. "Mathematical techniques made that problem tractable," he says.

DeRose's problem-solving tool box consists of other techniques in applied physics and math such as approximation theory and differential geometry. But it is the capability to utilize subdivision surfaces which has caused Pixar and the entire industry to expand to infinity and beyond. "The adoption of subdivision surfaces is becoming an industry standard," he notes.

It's a good thing he has all of these skills, because the four-year-long process of bringing a story concept to the theater is "so inherently messy," he admits. Two years are spent on story development and another two years are expended on converting the story to the screen. But then things can really shake up. "Once you create the imagery, you start to notice the need to redesign–the character of the story may not be working," he says. For example, Toy Story 2 was largely rewritten in the last year of production because of the need to alter the script to coalesce with the capacities of the technology.

DeRose relishes these scientific challenges. "This is the perfect

INFINITY continued on page 7

Letters

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

Fukushima Still Imperils Northern Hemisphere

I agree that all of the world's nuclear fuel stored in spent fuel pools should be moved into dry cask storage as soon as possible ("Regional Fuel Storage Could Lessen Radiation Hazard," April *APS News*). But it is also important to mention that the fuel rods stored at the Fukushima site continue to imperil the northern hemisphere.

There are 1535 fuel rods in the unit 4 fuel pool. This pool is located 100 feet above the ground in a structure badly damaged by both the earthquake and the hydrogen explosion. A significant earthquake could easily collapse or puncture the pool, draining the water so that the fuel rods catch fire. Recently published work has shown that there is a high probability of a major earthquake near the Fukushima site in the near future, so we are all on borrowed time.

Once the fuel rods from unit 4 are exposed, the gamma radiation will be so intense that it will be impossible to access much of the Fukushima site for corrective action or maintenance without receiving a lethal dose. Within a few weeks the water from all the fuel ponds on site would evaporate and the radioactivity from all 11,421 fuel rods stored on site would be released; this would amount to 85 times the radioactivity released by Chernobyl.

I am also concerned about the proposal to transfer nuclear waste to a host country for storage. After witnessing many thousands of square miles permanently contaminated by Chernobyl and Fukushima, most of the world's population is not enthusiastic about receiving nuclear waste from someone else. I am concerned that the lowest bidder may be an economically disadvantaged country or a country whose political elite benefit from the arrangement against the wishes of the people. It seems most appropriate that nuclear waste should forever remain with the country that creates it, where it would continue to influence the political debate over whether to build a new nuclear power plant.

Geordie Zapalac
Santa Cruz, CA

Students are Confused by Meaning of Heat

While it may be acceptable in a column written for APS members, the way the term "heat" is used in the April "This Month in Physics History" can be quite misleading to students who have not yet mastered the first law. There is evidence that students find the concept of heat very confusing, convoluting it with thermal energy as a property of an object. This leads them to not be able to use the first law correctly. When something melts, the correct way to think about it, if you don't already completely understand what is going on, is that it absorbs thermal energy. The amount of thermal energy that was transferred in the process is the term heat in the equation. Heat is never a property of a single object. You cannot say how much heat is in something, but you can measure its thermal energy. Although as physicists we all know what we mean, it does not hurt to remind ourselves that our students hear what we say, not what we mean. I know this publication is intended for those who do understand, but I love sharing some of the features with teachers and potential students. This one will require some careful framing!

Gay B. Stewart
Fayetteville, AR

Secretary of Energy is a Political Job

In his column "Can Science and Politics Coexist?" (April *APS News*), Michael Lubell complains that Secretary of Energy Chu, who is a scientist, has been criticized for his political positions. But the Secretary of Energy does not principally serve as a scientist; the Secretary is the administrator of the department that is charged with setting policy, which will among other things determine the energy future of the country.

A more balanced article would have had merit; instead, the assertion that science and politics should be insulated results in a politically motivated assault on Republicans and defense of the Obama Administration.

Peter Friedman
Dartmouth, MA

Verifying Casimir Effect Took a Long Time

I enjoyed reading the history column about Casimir in the May *APS News*. However, I feel I must correct two errors.

First, Casimir worked with Polder on the so-called Casimir-Polder force between two atoms, and between an atom and a conducting plate, but it was only in the following year, 1948, that Casimir alone published his paper on the Casimir force between parallel conductors. This followed a conversation with Niels Bohr who suggested the CP force must have something to do with zero-point energy. And I believe that Casimir never attempted an experiment to verify his theoretical work. The first experiments may have been attempted by Derjaguin and Abrikosova in 1957, but these were inconclusive, and even Sparnaay's experiment had 100% error. The Lifshitz theory was verified with good accuracy in 1973 by Sabisky and Anderson.

Kimball A. Milton
Norman, OK

Correcting an Omission in the Timeline of Fission

In an interesting letter in the March *APS News* commenting on the history column's article on Fermi that was in the December 2011 issue, Fred Peet says, "Thus Meitner did not learn of fission as a result of Hahn's and Strassmann's manuscript as the *APS News* article implies, but rather she explained the observations (with her nephew) as a result of Hahn asking her if she could do so." Although this is correct, it is nevertheless historically incomplete, because four years earlier, in 1934, following the publication of Fermi's work which suggested that the bombardment of the uranium by slow neutrons had resulted in the production of transuranic elements, a German woman chemist, Ida Noddack, published an article in *Anwendte Chemie* (Applied Chemistry) entitled, "Zur Element 93," in which she pointed out that in chemically identifying the products of the bombardment, it was not sufficient to test chemically around uranium, but all the way down the periodic table, since the neutrons might have fractured the uranium nucleus. Although she wrote to Fermi about this possibility, he rejected her suggestion on theoretical grounds, as did everyone else working in nuclear science. She even sent her husband (who together with her and a colleague had earlier discovered the element rhenium) to speak to Hahn about her idea, but Hahn rejected it as impossible. Consequently, when Hahn wrote to Meitner on Dec. 19, 1938 (as quoted in Peet's letter), "Perhaps you can put forward some fantastic explanation,"as to how he and Strassmann had found barium, there is an obvious puzzle as to why Noddack's proposal of 1934 wasn't mentioned.

The failure to mention Noddack in many accounts, or to relegate her 1934 proposal to a footnote has had some unfortunate consequences in the public domain. This shows up in Michael Frayn's play "Copenhagen," in which the following dialogue occurs early in Act I:

"Bohr: Otto Hahn–he's still there. He discovered fission, after all./ Margrethe: Hahn's a chemist. I thought that what Hahn discovered..../ Bohr: ...was that Enrico Fermi had discovered it in Rome four years earlier. Yes–he just didn't realize it was fission. It didn't occur to anyone that the uranium atom might have split, and turned into an atom of barium and an atom of krypton."

Obviously it did occur to Noddack that the uranium atom might have split, that is why she emphasized the importance of testing all the way down the periodic table, which is what Hahn and Strassmann did, and found barium.

However, this story about Ida Noddack has even greater ramifications, because it is clear that all the other nuclear scientists of the time, not just Fermi, were not following the scientific method on this matter, which stresses that one does not have scientific knowledge unless one has empirical foundations for that proposed knowledge. Instead, the nuclear scientists relied on theoretical arguments based on the limited understanding they had of nuclear physics at that time. If they had followed Noddack's suggestion, they would have found that Fermi had indeed split the nucleus, and the recognition that followed in 1939 that there was the possibility of a uranium bomb (or atom bomb as it came to be known) would have arisen four years earlier in 1935. This would have had significant consequences for the subsequent development of world history, since it raises the question as to whether the WWI allies would have allowed Hitler's war machine to start to build it, and hence mobilized and taken military action if necessary. Thus, undoubtedly, the failure to follow the scientific method and experimentally test Ida Noddack's suggestion in 1934 obviously had consequences best left to historians and novelists to envisage.

Frank R. Tangherlini
San Diego, CA

Joseph Black was not a Scot

I enjoyed the column in the April 2012 *APS News,* which celebrated the discovery of latent heat by Joseph Black, especially the author's understated little joke about the historical importance of the careful lecture notes taken by Edinburgh students! However, one point should be corrected: Black was not a Scot. At his death in 1799, a newspaper in Belfast, in the north of Ireland, claimed he had been born in Belfast, but it seems he was actually born in Bordeaux, France, son of a Belfast man who was a wine factor there. Black returned to join the rest of his family in Belfast, where he attended school. He is one of many notable scientists whose careers are recorded in the *Dictionary of Irish Biography*, which was published in 2009 by the Royal Irish Academy and Cambridge University Press.

Linde Lunney
Dublin, Ireland

Physics PhD Data Clarified

In his Back Page article in the April *APS News*, Geoff Potvin raises a number of very important issues. However, he makes and repeats an incorrect statement. I feel the need to correct the record so that this might not become another myth about physics graduate education.

Potvin states that "the time needed to get a physics doctorate is getting longer on average" and that "doctorate completion times … have steadily risen in recent decades." There are, of course, many ways to measure time to degree. However, one of the simplest is age at time of degree. According to the NSF annual Survey of Earned Doctorates (SED), the median age of new physics PhDs is unchanged since the class of 1990.

Potvin also states that the "number of PhDs awarded to US-born citizens has been stagnant or declining for some time." I am happy to report that the number of US citizens who entered physics PhD programs has been larger than the number of foreign citizens for each of the last 6 years and thus we will soon see a dramatic increase in the number of US citizens earning physics PhDs.

Roman Czujko
College Park, MD

Ed. Note: *The author is Director of the Statistical Research Center at the American Institute of Physics.*

Geoff Potvin Replies:

Thanks to Roman Czujko for providing more clarity on two of the trends to which I obliquely referred. I particularly appreciate his broader message: that we should endeavor to be clear and precise in our discussions of graduate physics education, especially so that we do not discourage potential future physicists from considering a doctorate through the creation or transmission of myths.

He is correct to point out that the age of PhD recipients (a reasonable though imperfect proxy for doctoral completion time) is approximately the same as in 1990; however, the trend to which I referred was over several decades going back at least to the 1970s. In fact, the length of a physics PhD appears to have incrementally crept upwards for many years, reaching an all-time high in the late 1990s and has since come down somewhat to approximately the same level as 1990–but it is still longer on average than, say, the 1970s (a common trend in the physical sciences and many other fields). To be sure, these shifts from year-to-year are not monumental, but incremental. I did not intend to suggest that a PhD in physics has suddenly turned into a ten year ordeal for most students, but the historic trend is important to note.

Similarly, Czujko rightly noted that the number of US-born graduate students entering physics doctorates has been higher than foreign-born students for the past six years; however, the number of such students has only recently gotten back up to the level of an earlier peak around 1990, a peak which was transitory and was followed by a decade-long decline. Thus we should be cautiously optimistic on this point.

I would also like to take the opportunity to thank Czujko and the entire AIP Statistical Research Center staff for their invaluable efforts over many years to collect and publicize critical information on physics.

Iran Sentences Kokabee to Ten Years in Prison

Omid Kokabee, a graduate student at the University of Texas at Austin and an APS member, was sentenced to ten years in prison in Iran. This follows 15 months of harsh imprisonment in Iran's notorious Evin prison for political dissidents in Tehran. Without access to his lawyer, he was tried and convicted of "cooperating with Mossad in Israel."

Kokabee was convicted on May 13, along with 14 other defendants accused of conspiring with enemies of Iran. The judge presiding over the case, Abolghasem Salavati is notorious for harsh sentences, including death sentences. He has presided over many high-profile cases in Iran, including that of the US hikers arrested in the country in 2009, the 2012 trial of an ex-U.S. Marine Amir Hekmati, and numerous students involved in the 2009 student protests. Several of the other defendants at Kokabee's trial received death sentences.

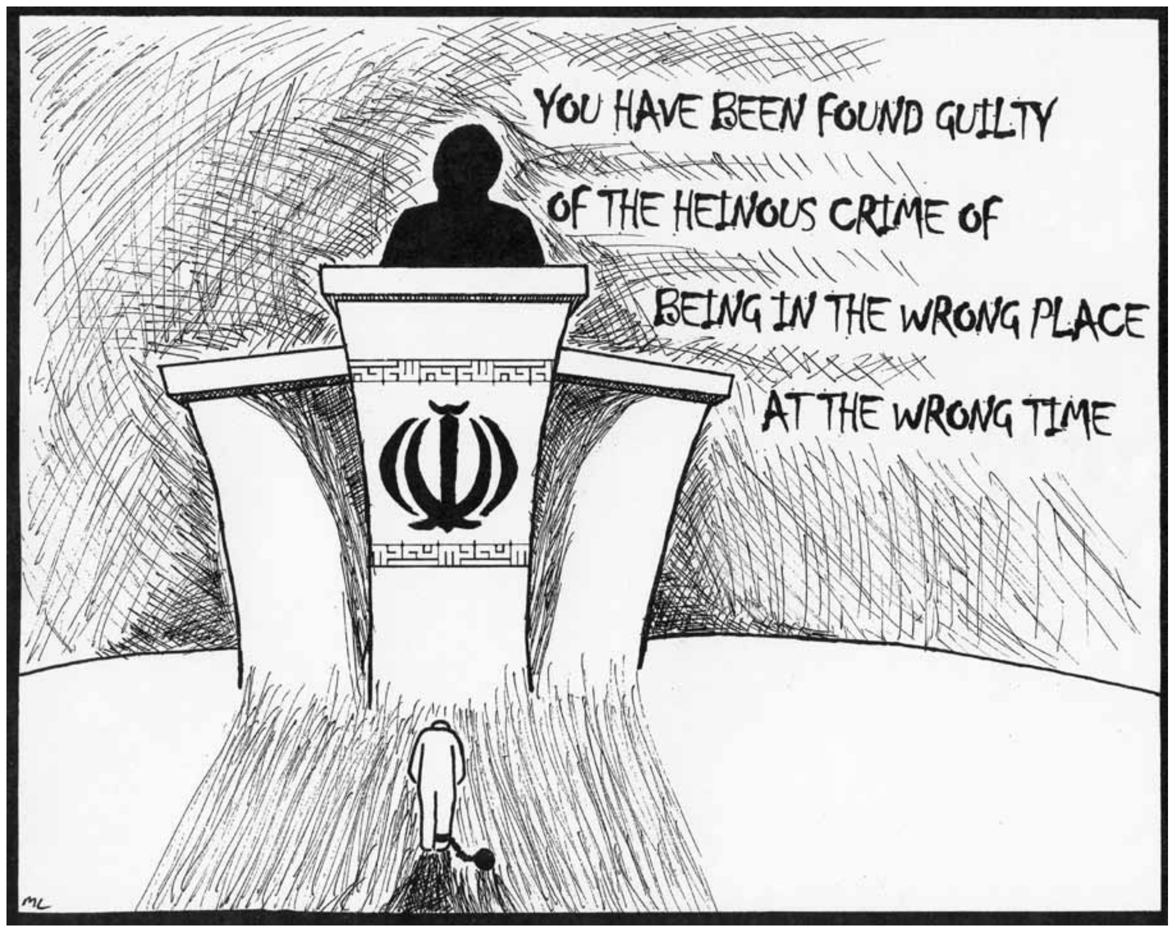
Human rights observers and those close to Kokabee say that he did not receive a fair trial.

"It's not really a trial in the sense that we are used to. He was not allowed to speak to a lawyer," said Eugene Chudnovsky of Lehman College, one of the cochairs of the Committee of Concerned Scientists.

During the trial, no evidence was brought against him. He was not permitted to see a lawyer during his incarceration or the trial, and was not told his court date until he was brought to the courtroom. During his imprisonment, Iranian security forces used harsh techniques to coerce confessions from him.

Friends and coworkers of Kokabee say that his biggest focus has always been on his science and he is not a politically active person. He was in his first year of the

IRAN continued on page 7



Muon Detectors Hunt for Fissile Contraband

By Michael Lucibella

Hunting for a concealed nuclear weapon can be harder than looking for a needle in a haystack. Though exposed plutonium's radiation is easy to detect, uranium's is less so, and both can be shielded. At the APS April Meeting, researchers presented an improved technique for using the natural radiation of cosmic rays to peer through solid objects and find any hidden fissile material.

When a cosmic ray strikes the nucleus in the atmosphere, it produces a shower of subatomic particles, including pions and kaons which decay into longer-lived muons. These muons travel down at high speeds through the atmosphere and can pass through solid objects. Michael Staib of Florida Institute of Technology and his team are harnessing this natural phenomenon to scan for hidden nuclear materials, and for any shielding hiding it.

"Muon tomography is a passive vehicle interrogation technique designed especially for detecting well-shielded nuclear contraband," Staib said. "We simply use cosmic ray muons. Those are constantly being produced in the upper atmosphere and passing through us all the time."

A muon strikes every square centimeter of Earth once a minute on average. Gas electron multiplier (GEM) detectors can detect their location, and when several are stacked on top of each other, they can track the paths of the fast moving particles. The denser the material a muon passes through, the more its path is deflected. Uranium and plutonium are two of the densest elements in the periodic table, so the detectors are used to look for places where the paths of muons are the most disrupted.

"Uranium doesn't have a very strong signal for radiation detection, but you simply use the fact that uranium is very heavy and very dense and so you can try to find a way to detect it using those characteristics," Staib said. "No artificial radiation source [is needed] so there's no exposure of an object to radiation beyond what it would be experiencing anyway."

To look for nuclear materials, a shipping container is placed between two sets of large GEM detector plates. Two plates on top of the container track the paths of incoming muons, and two plates underneath track them on their way out. If there's little or no dense material in the container, than the two parts of the muon's path should line up. Even iron won't deflect muons a great deal. However, if there's a lot of dense material, like plutonium, uranium or lead shielding, the paths should veer sharply.

"If I can force them to put five tons of lead around it, I'm good because it's easier to detect five tons of lead than the radiation," said Michael Kuliasha from the Defense Threat Reduction Agency. "You have to have a robust radiation detection because it forces them to do something that's actually easier to detect."

He added that the difficulty of finding concealed nuclear weapons is not a new problem. "In 1945, Robert Oppenheimer, who was head of the Manhattan project, was actually asked in a congressional hearing by Senator [William] Milliken … how would you detect an atomic bomb hidden somewhere in a city. And [Oppenheimer] says, 'I'd get a screwdriver and open each and every suitcase and crate,'" Kuliasha said.

GEM detectors were first developed at CERN to detect muons and other particles produced in collisions in accelerators. The idea to use passive scanning to find hidden fissile materials was first developed at Los Alamos in 2003, and has been developed further by the company Decision Sciences. Their method, which uses drift tube detectors, is about to undergo the first test commercial application in the Bahamas. Drift tubes are relatively inexpensive, but take longer to make a measurement than the GEM detectors.

Because both methods

HUNT continued on page 7

Panel Stresses Communication with Congress

By Calla Cofield

At the APS April Meeting in Atlanta, a panel of physicists agreed that America's position as an international leader in science might be slipping away. The panel, which featured high-ranking officials in the Department of Energy, the former director of the National Science Foundation and a Nobel laureate, urged physicists to participate more in the policy making process and communicate with the public.

"There are some facts and figures that are very disturbing, which show the United States might be losing ground in science and discovery, whereas other countries are gaining," said moderator Pushpa Bhat, a physicist at Fermi Accelerator National Laboratory (Fermilab), at the panel's press conference. "We can't sit back and watch … so how do we strengthen and enhance the science and technology enterprise in the US, so that we compete [and] prosper?"

Bhat cited possible reasons for the shift, which are familiar to many physicists: fewer graduates in STEM fields, reduced federal funding for basic research, and private research and development divisions moving overseas. The session aimed to identify the new problems facing science, but many of the solutions have yet to become clear. Nobel laureate Frank Wilczek emphasized the need to keep scientific borders open, particularly to students from outside the US. DOE's Associate Director for High Energy Physics, Jim Siegrist, and Associate Director

PANEL continued on page 6

INSIDE THE BELTWAY

Timing Is Everything

by Michael S. Lubell, APS Director of Public Affairs

The modern atomic clock began with a 1945 suggestion by Columbia University physicist and Nobel Laureate I. I. Rabi. It is the product of more than 60 years of discovery and development by scientists and engineers at the National Institute of Standards and Technology–formerly the National Bureau of Standards. And it is the heart of today's global positioning system (GPS).

But its accuracy of a few parts in 10^{16} is far greater than any policy wonk requires for predicting when the wheels might come off the federal budgetary train. For that, a simple congressional calendar will do.

During the 21 post-election legislative days labeled "Lame Duck," Congress will face a series of policy issues that are epic in their reach and consequences. The Bush-era tax cuts will be ending. The national debt will reach the mandated ceiling. And absent an 11th hour deal between the White House and Congress, last year's Budget Control Act will trigger $1.2 trillion in discretionary spending sequestrations on January 2, 2013.

That's just for starters. Here are three more from a lengthy list: the "doc fix" to prevent Medicare reimbursement rates from dropping by a third; the alternative minimum tax "patch" to prevent middle class wage earners from being anointed "wealthy" even if they aren't; and extension of the 2 percent Social Security payroll tax cut to give the average family $1,000 a year more in take home pay.

According to a recent Goldman Sachs report, failure of Congress to resolve these issues could create as much as a 4 percent drag on the gross domestic product, as $600 billion vaporizes from the economy.

With such a dire prediction, you might think Democrats and Republicans would resolve their differences and strike a deal. But you would probably be wrong. Consider just a few indicators.

Last year, hyper-partisanship, especially in the House of Representatives, helped push the federal government to the brink of a shutdown four times. And since Democrats took control of the Senate in 2007, Republicans have employed the filibuster 360 times to tie up legislation–an astonishing rate by any historic measure. Meanwhile, to avoid politically embarrassing votes, Senate Democrats have refused to author a budget resolution for the last three years, contravening the intent of the 1974 Budget Act.

This year's primary season offers a few more warning signs. In Indiana, GOP voters sent Richard Lugar packing. The six-term Senate icon, known for working across the aisle, couldn't muster more than 39 percent of the vote.

His victorious opponent, Tea Party favorite Richard Mourdock, made it clear he doesn't share Lugar's bipartisan approach to legislating. In a CNN interview, immediately following his ringing primary success, Mourdock had this to say: "I don't think there's going to be a lot of successful compromise. I hope to build a conservative majority in the U.S. Senate so bipartisanship becomes Democrats joining Republicans to roll back the size of government."

And in Utah, Orrin Hatch, also seeking a seventh Senate term, found himself unable to muster enough votes at the Republican state convention to avoid a primary against another aggressively partisan aspirant, Dan Liljenquist.

TIMING continued on page 7

Hammer and Nails

APS led a team of six societies to create the "Big Top Physics" spectacular as part of the USA Science and Engineering Festival, which filled the big exhibit halls in the Washington, DC Convention Center from April 27 to 29. Long lines of children and adults alike waited to see the demonstrations inside the big red tent, while outside additional attractions kept them intrigued. One of the most popular was the bed of nails, which came in two pieces, a "mattress" with over 3000 nails, and a smaller "blanket" with over 1500. In the larger photo, APS Head of Public Outreach Rebecca Thompson lies on the bed of nails (lower left), while Bo Hammer of the American Institute of Physics (right) lifts one of the spectators on top of the blanket. In the inset, Thompson shows more graphically what's involved in being the filling in a bed-of-nails sandwich. This demonstration was performed many times a day (only by the staff, not the attendees), and no one was hurt.

Photo by Donna Hammer

Photo by Stephen G. Benka

PANEL continued from page 5

for Nuclear Physics of the DOE Office of Science Tim Hallman emphasized the need for scientists to increase communication with the public, and optimize shrinking budgets. But in these tight financial times, it seems physicists wish to do more to encourage change. One audience member asked, "What can working physicists, those who don't wish to dedicate their careers to a job in policy or politics, do to get involved in the national politics that affect science?"

Panelist Neal Lane, who served as Science Advisor to President Clinton, and also as Director of the National Science Foundation, emphasized the importance of encouraging and guiding young people with an interest in politics and policy; in his talk he highlighted the many physicists in important policy positions and the influence they have on the national science climate. There are summer internship opportunities for students (listed, for example, at www.science-policy.net/11627.html); for PhD level scientists, APS, AIP and AAAS offer fellowships to work in congressional offices in Washington D.C. for a year.

But physicists who have completed postdoctoral work or those with families often find it difficult to move to Washington for a year. And what can former Fellows do once they return home? If national budgets and science policy are determined by those in Washington, what power do physicists have in their local districts to inform politicians and policy makers, and influence their decisions? It is important to recall the famous words of Tip O'Neill, "All politics is local."

"We are a representative democracy. We elect representatives to represent our views," says Brian Mosley, Grassroots Manager in the APS Office of Public Affairs in Washington. "In order for representatives to do that, they need to hear from their constituency."

Each year at the APS general meetings, Mosley, with other APS staff, can be found at a bank of computers labeled "Contact Congress", where they ask attendees to sign a letter to their Senators and Representatives. For Mosley, it makes for long days, but he understands the importance of getting physicists involved. Mosley echoes a concern of many science lobbyists, policy makers and science communicators: that physicists are not communicating with their Congressional representatives as much as other groups do.

"There's a sense among some scientists that funding through NSF or the Department of Energy is so obviously good for the country that it should happen regardless of whether scientists ask for it. And that's just not true," said Alex Saltman, former APS Congressional Fellow and Executive Director of the Commercial Spaceflight Federation. "The American people, through members of Congress, continuously need reminders that what the scientists are doing is important."

After his APS Fellowship with Rep. Adam Schiff (D-CA) Saltman worked on Schiff's staff as legislative director for four years. Saltman says that the most direct and perhaps the most powerful way for working physicists to influence national politics is through their own representatives. It is, after all, the votes of the local constituents that determine whether representatives are re-elected.

When meeting with congressional representatives, Lane argues that physicists "need to be clear about what they want," such as support for a specific bill, budget item, or an agency that brings jobs to a district. But there is also the need to establish long-term relationships with representatives and their staff.

"You're not going to walk in and get a commitment from [your representative] to spend 600 million on your experiment," said Judy Jackson, former Director of Communications at Fermilab. "What you want is to begin to have the kind of relationship with this member and his or her staff so that when you really need them you know who they are, and you're not just coming to them in your hour of need. You don't want to give them a jargon-filled 40 pages for them to read. It's just as if you were wanting to create a relationship with anyone; you want to think about how can you reach them on their terms."

Jackson pointed to the turnover in Illinois's 14th Congressional District as a case study of how physicists acting locally can impact national policy. In 2008, Bill Foster (D), a former Fermilab physicist, won the congressional seat in the district encompassing Fermilab, the largest high energy physics laboratory in the United States. Physicists rejoiced. Then in 2010, Foster lost the election to Randy Hultgren (R). Hultgren might have felt unwelcome at the laboratory; he had, after all, replaced one of their own. But Fermilab welcomed Hultgren with open arms. Today, says Jackson, "you could not find a more ardent supporter of Fermilab and particle physics than this conservative Republican representative."

To better communicate with Congress, scientists can join science coalitions, which unite multiple organizations to target specific topics of concern, such as the Coalition for National Science Funding (see a list of coalitions at www.aps.org/policy/tools/coalitions/). Many large labs and universities, through their communications and/or government offices, will provide employees with resources and opportunities to communicate with Congress. Physicists can also contact their member organizations for help in preparing for meetings with their Congressional representatives. Physicists can set up meetings in the Congress person's local or Washington office, bring up issues at town hall meetings, or meet them at community events. In addition to talking to the representatives, it is always important to communicate and develop relationships with local and Washington staff as well.

"It's important that there be people in the Congress who, despite all of this noise about all of these other issues, spend a little time thinking about the science," said Lane. "It sounds a little self-serving talking with them about science, but nobody else is going to do it for us."

BAY continued from page 1

nuclear power plants naturally produce a flux of electron antineutrinos, which over a short distance become muon neutrinos; θ_{13} measures the rate of this transformation. Two other sites presented themselves in the US, but the site that won out was the one Luk found 35 miles east of Hong Kong, on the coast of the Daya Bay.

Building the experiment in China would mean shared cost, combined expertise, and new collaborations among scientists; but for the American members, many aspects of the project, such as communicating with the power plant and the Chinese government, would be left in the hands of their Chinese colleagues. In fact, Luk's first attempt to contact the Daya Bay power plant to discuss the possibility of building the experiment there was met with silence; it wasn't until his Chinese collaborators got involved that the wheels started to turn. And there was simply the challenge of having to work together largely over the phone, across time zones and language barriers.

"Certainly at the beginning, there were concerns even by myself," said Luk. "Because even though I had worked with Chinese collaborators on another experiment before, it's not the same as doing it in China."

Luk says in some instances things seemed to go much faster in China than they do in the US. In other cases, they went very slowly, such as waiting for a year to secure approval of the radioactive material used to test the detector.

Wang says many challenges the project faced weren't always made apparent to his American colleagues because, "We didn't know how to explain it to them…and even if they knew they couldn't help."

With many American members joining the experiment in Daya Bay, the collaboration attempted to create a system of combined safety standards from the US and China. But this posed a problem for both sides because the systems differ so much, and neither group of collaborators was totally familiar with the other system. Disagreements arose as to which country's regulations should be implemented.

"You know, it's confusing," said Luk. "Say we use the US requirements or the Chinese requirements: what are the implications? So it took some time to iron those out."

Wang, now the director of the Institute of High Energy Physics, previously led the BESIII experiment at the Beijing electron positron collider (BESIII was the largest US-Chinese collaboration in China prior to Daya Bay). In the 1990's Wang worked on the Palo Verde reactor-based neutrino experiment, which was originally planned for a site in California, but was moved to Arizona after five years of delays. Major scientific experiments in the US can face delays due to financing, proper approval from various bodies and organizations, and environmental issues, to name a few. Navigating those issues becomes as much a part of the experiment as the science. Wang says every country has these obstacles, and adds, "I've had good experiences in the United States and bad experiences. A worse one [in the US] is worse than in China, but a good one [in the US] is better than in China."

Ultimately the collaboration was necessary, as neither country could support the experiment on its own. China would cover the cost of civil construction of the tunnels and facilities, and roughly half the cost of building the experimental system; the US would cover the other half of the experimental system. The US commitment came to $35 million dollars. While it is impossible to say exactly how much the project would have cost had it been built entirely in the US, Luk and Edwards say estimates were on the order of $100 million.

The cost benefit was important to the Chinese side as well, according to Wang.

"Everybody seems to now think that China has a lot of money," said Wang. "But without US participation, getting all the funding in China would have been difficult."

Wang did his PhD in Florence, and subsequent research at MIT and Stanford University, where he worked with Luk at the KamLAND neutrino experiment in Japan. For the many students of high-energy physics in China who won't have the opportunity to go abroad, as Wang did, Daya Bay offers an international, competitive particle physics experiment at home. Conversely, the collaboration provides native Chinese collaborators on the US side, like Luk, the opportunity to visit home. Xin Qian, a postdoc at the California Institute of Technology, says he chose to work on the Daya Bay project partly because it would allow him to visit his hometown of Beijing.

The Daya Bay experiment is set to complete construction this year, when the last two of its eight detectors come online. The experiment will continue to run for three to four more years, and ideally will lead to a continuing neutrino physics program in China. But Luk, Wang and Edwards talk in a way that makes it seem as though the experiment has already passed its most difficult days.

EXPANSION continued from page 1

partment of Energy's Brookhaven National Lab.

Barish oversaw the planning for the new construction on behalf of the APS Presidential Line. "The APS journals operation continues to grow, attracting more of the best work of physics researchers worldwide. More submissions require more editors to conduct peer review, and that meant that the building had to be expanded," he said.

Construction is expected to last sixteen months, and be completed in the fall of 2013.

SOLAR CELLS continued from page 1

tive glitter, which has earned them the nickname "solar glitter."

Basic crystalline silicon solar cells are made from wafers of silicon roughly four to six inches squared and 200 microns thick. Each wafer makes a single cell, and the cells are lined up together to make solar panels that must be placed between plates of glass for handling. Overall this makes the panels rigid and heavy. The Sandia team has managed to cut up the solar silicon wafers into many smaller cells, between 100 and 750 microns squared, and thin them down to 10 to 20 microns thick.

Individual cells cut from the same piece of silicon can be connected into single panels, but mounted in flexible, light-weight materials rather than glass. Eventually, this could mean solar cells in fabric, such as clothing or tents, and solar panels that fit a wide variety of surfaces and are easily relocated.

Other thin-film solar cells exist on the market, but Nelson says these films don't use crystalline silicon, which reduces their efficiency. To create solar glitter, Nelson says the Sandia team used "standard layer transfer techniques": a sticky polymer film with an interconnect pattern is applied to the top of the 200 micron thick wafer, and then pulled away, taking an array of new, 10 to 20 micron-thick solar cells with it. More than 90 percent of the light conversion takes place in the first 20 microns of a solar cell, so little efficiency is lost. After pulling off the top layer of the silicon wafer, the remaining silicon can be used to create more cells, cutting down on the cost of the material and leaving none to waste.

"Other folks have been able to take a wafer and release small layers, but it takes a long time, and that drives up the cost and is not manufacturable," said Nelson at a press conference at the April Meeting. Those processes also take much longer than the peel-off method used by Sandia, which Nelson says allows the scientists to "release those cells when we need them."

Using smaller cells means that many techniques and tools from the semiconductor and microelectronics industry are available to solar panel engineers. The solar glitter cells are more robust than larger cells, so they can be handled with so-called "pick 'n' place" tools that handle microelectronics, which means more of the production processes are already established. Gupta says the smaller cells also allow for different "interconnect architectures," which the team is already using to give the cells better performance in partial shade–the efficiency of most solar cells goes down when they are not exposed to full sunlight. And the team is working on incorporating a device called a "micro-concentrator," which focuses more light into each individual cell, increasing its total absorption, and lowering the cost per watt.

The Sandia scientists are also using techniques from integrated circuit science to bond three types of solar glitter together–one made of silicon, one made of gallium arsenide, and one made of indium gallium phosphide–rather than using the more expensive process of growing them together. Collectively the different materials gather more wavelengths of light, and increase the cell's efficiency.

"What we're providing is the specific way to do design, simulation, fabrication, assembly, packaging and characterization of [solar] cells using semiconductor, LCD and microsystem tools," said Gupta. "We're laying out, here's how you do it, step by step."

Over the next two to three years Nelson says the project will continue within Sandia, where he says "we will take a lot of the concepts and cells we've produced and develop them into larger applications." After that, the lab intends to find partners in industry to commercialize the technology.

IRAN continued from page 5

doctoral program at UT Austin studying lasers and optics.

The family of Kokabee says that it will appeal the decision. According to Iranian law, he has the right to appeal, but the outcome of an appeal is uncertain. Human rights observers expressed skepticism about changing his sentence.

"According to the Iranian regime's penal codes there should be [a retrial], but whether such a thing will amount to anything, I do not know," said Hossein Sadeghpour, chair of APS's Committee on International Freedom of Scientists

As *APS News* previously reported, Kokabee was first arrested in January 2011 at Khomeini Airport while waiting for a plane to return him to the United States. He had been visiting his family in Iran over the winter break. The Iranian authorities held him in solitary confinement for 36 days and twice canceled his court appearances at the last minute.

"I think that now is the moment to really increase pressure on the Iranian judiciary and the Iranian regime from all sides," Sadeghpour said. "His case has been a celebrated case in the United States, and now is the time to step up pressure."

HUNT continued from page 5

rely on the natural rate of muons traveling through the atmosphere, the only way to speed up the detection of illicit materials is by improving the sensitivity of the detectors. Right now Staib's prototype takes about nine to ten hours to differentiate between different materials, but he says that with more development it should be able to get down to a few minutes.

In addition to scanning incoming cargo, Kuliasha said that the technology is promising for verification of arms reduction treaties like START. He said that a detector could be set up around a missile or submarine to see if nuclear warheads are still inside. At the same time there are limitations to the technology. Using it to scan an entire ship would be logistically impractical, and probably still wouldn't be as effective as boarding and searching the vessel.

SITES continued from page 1

laboratory equipment and experiences to poorly supplied science classrooms, as well as professional development for secondary science teachers.

The University of Missouri-Columbia proposes a host of efforts to establish a professional community of physics teachers that engages future teachers on campus and new teachers in nearby schools. Projects include a living-learning community for freshman students and mentoring from exemplary high school teachers.

"A number of this year's universities are adding to already robust undergraduate physics programs," said Monica Plisch, APS Associate Director of Education and Diversity. "These institutions are in an excellent position to develop their teacher preparation programs."

California Polytechnic University-Pomona, James Madison University, and University of Wisconsin-La Crosse are all ranked by the American Institute of Physics in the top ten percent of bachelor's-only departments in terms of the number of bachelor's physics degrees awarded; University of Wisconsin-La Crosse is one of the top 10 such universities.

Plisch also noted that two of the awarded universities plan to build on their connections with community colleges. Central Washington University aims to streamline the pathway for future physics teachers who begin their education at a community college and transfer to the university. The university plans to work with community colleges to develop an advising template for a more efficient associate degree in math-physics teaching that would eventually be implemented in all community colleges in the state.

Similarly, Arizona State University intends to tap into the Maricopa County Community College District–which has the largest enrollment of any community college system in the US with over 260,000 students–to disseminate information on its physics education program and expand its recruitment course for potential science teachers. The course gives students interested in science teaching the opportunity to teach 5th and 6th grade students in high-need schools.

Project funding for these institutions begins this summer and lasts for three years. The project will solicit another round of proposals in Fall 2012 for sites to begin funding in the 2013-2014 academic year. Visit www.ptec.org for more information.

TIMING continued from page 5

A Tea Party crusader, Liljenquist has vowed to hew to greater ideological purity.

The message Republican voters are sending to their Washington emissaries is simply this: We don't trust the federal government, and we don't want you cooperating with big-government Democrats. If you stray from these principles, your stay in Washington will be brief.

That message was not lost on House Speaker John Boehner (R-OH 8th). Bipartisan passage of legislation reauthorizing the Export-Import Bank provided a spark of hope that the two parties might be able to resolve some of their other differences during the remainder of the year. But Boehner, in an appearance at the 2012 Fiscal Summit in Washington, sponsored by the Peter G. Peterson Foundation, dashed any expectations of compromise.

In his speech, Boehner reiterated his demand that any increase in the debt ceiling later this year be offset with equal or greater spending cuts. Tax increases, he said are off the table. Boehner's challenge might be election-year posturing. But if it isn't, and if Senate Democrats and the White House refuse to accede to his demands, as they surely will, a government shutdown or credit default could spoil Washington's New Year's party.

What songs politicos will be singing at the party will depend on who wins what in November and what the lame-duck session actually delivers. I have a few suggestions from the gilded era of the 1920s, the last time wealth inequality in our nation was as great as it is today.

For Gov. Romney, the wealthiest White House jobseeker, "Puttin on the Ritz," words and music by Irving Berlin, seems about right. For President Obama, the latter-day "New Dealer," who wants to be vindicated by reelection to another four years in office, I think the old FDR favorite, "Happy Days Are Here Again," words and music by Milton Ager and Jack Yellen, would be appropriate.

And for either Romney or Obama, from the Bert Kalmar, Harry Ruby and Herbert Stothart collaboration, "I Wanna Be Loved By You," would pretty much sum it all up.

INFINITY continued from page 3

way to bring the concepts I love in physics to life," he says.

His time is structured around four different areas: his own research, which involves writing code and advising graduate students; leading the research group; co-owning Pixar's patent portfolio; and educational outreach at the middle and high school levels. In fact, he spends 20%-25% of his time as an "Evangelist" for the Young Makers Program for children. A collaboration between Pixar, *Make Magazine*, and the Exploratorium in San Francisco, the program cultivates and celebrates students' creativity and inventiveness, and pairs them with mentors to assist them in designing a project for the Bay Area Maker Faire.

Part of the reason DeRose (and Pixar) are dedicated to mentoring emerging stars of computer animation is because they want to be able to shape the new talent and inspire them to pursue careers in the industry. As for job prospects now and in the future, DeRose is confident that the need for highly-trained scientists, who can also act as generalist problem-solvers, will continue to grow. "Most others I know of on the entertainment side of computer graphics were trained in computer science or applied math, even though what they do is computational physics," he says. And yet, "physics teaches you to be fearless…You become used to having to chew on problems for a while."

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The Back Page

Is There a Future for the Advanced Lab?

by Jonathan F. Reichert

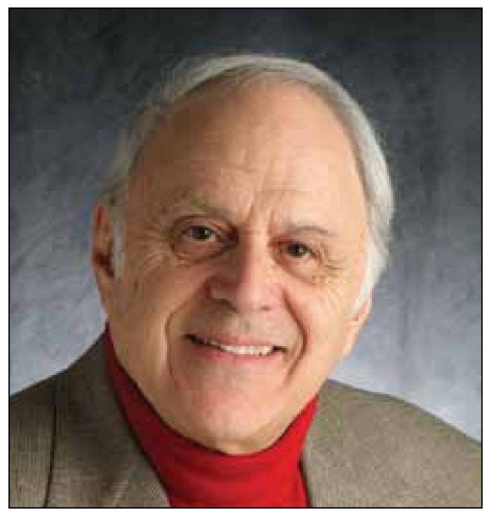

Photo by David Wahl

Have we created a kind of myth that a multi-topic advanced laboratory experience is no longer a meaningful bridge between introductory physics laboratories and experimental physics research? How tempting it is to engage our students in "real" research projects even in their junior year, to have them experience discovery, get their names on publications, and even have a chance at national recognition from the APS. Everybody wins! Or do they?

When are most students really ready to begin doing research? When do they have the level of theoretical and experimental expertise for the experience to benefit both parties? How about freshman year? I had such a student, who worked in my research lab for all four years and then went to the Princeton Gravity Group to become the principal design engineer of WMAP, the microwave background detector that changed our understanding of the universe. But we do not design and build undergraduate experimental physics programs only for the superstars of this world, just as it would not make sense to create a theoretical curriculum for the Feynmans and Einsteins that so rarely come along.

For most students, three or four years of laboratory instruction, with increasingly sophisticated experiments, is a far better preparation. The advanced laboratory is the essential bridge between highly scripted exercises demonstrating a phenomenon and the independence of an actual research setting. It is a bridge that offers exposure to a breadth of topics and a wide variety of techniques, as well as reasonable ownership of the experiments themselves. For many students, it is the seminal experience in which they discover their future research interest. And the expertise gained in the advanced laboratory is a gift they bring to any research or industrial lab.

This article is hardly the first call for more attention to be paid to advanced laboratory instruction. Dick Peterson wrote an inspiring piece[1] in the March/April 2007 issue of *Interactions*. "Lighting the Fire," drawn from his many years of experience in running such a program at Bethel College, describing just why it is "crucial to bring the advanced physics lab in from the cold." Harvey Leff, in his 2007 AAPT President's Commentary, both laid out the case for advanced lab support and discussed some of the efforts that had already been initiated. They included the Advanced Lab Listserv, http://lists.aapt.org/avlab, the newly formed professional organization, ALPhA (Advanced Laboratory Physics Association) and the NSF-sponsored Topical Conference at Michigan in 2009. In addition, with NSF support, ALPhA has launched a highly successful series of Immersions where faculty members "immerse" themselves in one advanced laboratory apparatus for three days in order to become confident enough to teach that experiment in their home institutions. The aim of all these efforts has been to create a community of faculty committed to advanced laboratory instruction that will not only continue to support existing programs but will also bring new experiments, new insights and new ways to evaluate and improve the advanced lab.

But others envision a different approach to advanced lab instruction. *APS News* published a Viewpoint in its February 2007 issue suggesting the replacement of the hands-on equipment laboratory with well-designed computer simulations.[2] "It's hard to imagine that significant damage would be done to the training of future generations of physics majors if most of their undergraduate laboratories were replaced by well-designed simulations on the computer," claims the author, relying on a study by Finkelstein et al. [3] that looked at large-scale introductory labs using simple dc circuits with batteries and bulbs. According to the results of the study, students using the simulations both performed better on physics concepts and developed greater facility at manipulating real components. The Viewpoint goes on to discuss the use of flight simulators to teach pilots how to fly particular aircraft.

But maybe a few sentences in the conclusion of Finkelstein et al.'s argument were overlooked. "We do not suggest that simulations necessarily promote conceptual learning nor do they ensure facility with real equipment ," the conclusion states. "Computers are far from the magic bullet many people look for in education." Do you want to fly on a plane whose crew only learned on a computer simulator? I'll wait for the next flight.

Computer simulation can be a wonderful aid for students, particularly in understanding the basic principles behind complicated experiments. Not only simulations but analogs can be of considerable help in introducing new abstract concepts with concrete examples. These aids can certainly enhance the educational experience for the student, but they are no replacement for the "real deal". One can study simulation of nuclear spins in a magnetic field and observe a precessing sphere, but students still need to put their own samples in a real pulsed NMR spectrometer and attempt to measure spin-spin and spin-lattice relaxation times as well as chemical shift and other NMR parameters.

At some time an experimental physicist should build a real circuit, trouble-shoot it, find the bad connections, the wrong connections, the bad components, the noisy power supply, the ground loops, the mismatched impedances, the wrong optical reflection, the misaligned crystal, the vibrating table, the 60 Hz pickup, the realities of experimental physics. This takes time, patience, skill, experience, and cultivated intuition based on fundamental physics principles. These skills are essential to experimental physics. This lack of hands-on preparation with real apparatus is already problematic in graduate research programs.[4]

A fair question to ask is whether it is the best use of our time and talent to develop the sophisticated and stable software that would be needed to replace advanced lab apparatus. I would argue that the time and talent would be better directed at developing new experiments and new apparatus. When I attend the APS March Meeting with its eight or nine thousand papers, I always wonder if there isn't at least the germ of an idea for a new advanced lab experiment in the research being presented. Among the ten thousand scientists, is anyone asking that question? Has anyone asked for NSF support to build an experiment or supply the necessary samples to study a new solid state effect? Has anyone thought about modifications that might make a research experiment robust and student-accessible?

Attending APS meetings with the express intent of finding new experiments for the advanced lab would be a perfect project for ALPhA. I even have a name for these volunteers, α-Miners. After all, they will be digging for the 'gold' of experimental physics; new, up-to-date, exciting experiments that can be adapted for the advanced lab. But, we need more than a few dedicated ALPhA members. We need the entire experimental community to, at a minimum, be on the lookout for new instructional experiments related to their own research. And, if there are, even if it is just 'maybe', they have a responsibility to let the physics community know. They need not take the responsibility for building the experiment, but they can put a suggestion on the listserv, publish an article in *AJP*, contact ALPhA or even inform one of the several companies that build advanced lab experiments.

What should an advanced laboratory look like? Having visited labs, seen equipment, talked to faculty, and even looked at student reports, I am personally aware of many outstanding programs. But no document better expresses the course goals than the one written for the University of Michigan's Physics 441/442.

This course is a hands-on survey of the experimental foundations of modern physics. Some of the goals of this course are:

1) To allow you to reproduce and understand the experimental results that are the underpinnings of modern physics.

2) To provide you with an opportunity to develop critical writing skills and understand how to effectively present your scientific work to a larger audience.

3) To familiarize you with experimental techniques employed in contemporary research and industrial laboratories.

4) To give you a survey, via experiment, of many of the sub-fields of modern physics, and the pertinent experimental issues in each.

5) To expose you to the realities of the laboratory experience, where things don't always work, where the issues are not always clear, and where progress depends on perseverance, ingenuity, and judgment.

6) To learn and appreciate the ethical and social issues that are involved in scientific research. These include the handling of proprietary information, respect for colleagues and adherence to high standards of honesty in reporting scientific results.

You should be prepared for a fundamental difference in difficulty and philosophy between this course and preceding physics labs. This is going to be a "problem solving" experience, as distinct from a "cook-book" laboratory. You may have to teach yourself how to use and calibrate many different kinds of test equipment. You may have to search for weak signals in the presence of noise. You may have to use statistical techniques to extract results from ambiguous data sets. Your success with the experiments, and with the course, will depend on the dedication and initiative that you apply to solving whatever puzzles arise. This is simply part of the reality and joy of the experimental method.

How do we go about evaluating an advanced laboratory program? Student popularity should not be a criterion, but evaluation by students several years afterwards, when they are working in industry or doing graduate research would be extremely useful. Feedback from industrial employers would also be important. Bob Fenstermacher, at Drew University, described the many letters he has received from graduates praising their advanced lab even though, at the time they were taking the class, many found it difficult and sometimes frustrating. He also described a young woman so empowered by her success with an optical pumping experiment that she is now studying atomic physics at the University of Virginia with Gordon Cates. Students can be "turned-on" in a well-designed, well-equipped advanced lab, but we need to acquire more than anecdotal data to assure support for these programs.

But what are the professional rewards or lack of them for faculty who create, improve and sustain these advanced lab programs? Here is an area of teaching where faculty need to spend long hours, have a wide breadth of knowledge, not only of theoretical concepts but of instrumental skills, data analysis, and trouble-shooting. They often have to make electrical and mechanical repairs themselves, build new equipment, and spend long hours tutoring students. These talents and efforts deserve a level of recognition including advancement, tenure, salary increases and collegial recognition that is often sadly lacking.

The APS has always recognized outstanding research and, in particular, through the Apker Awards, honors exceptional research performed by undergraduates. However, the physics community currently does nothing to recognize the altruistic and heroic work done by those who have created outstanding advanced laboratory programs. If we do not acknowledge and honor these exceptional efforts, I fear that our upcoming faculty and staff will be far less likely to develop the skills necessary to run this important program. In a recent faculty search, Drew University was able to identify few candidates among 85 applicants who were both qualified and willing to teach their advanced lab program.

An APS award for creating, developing, and maintaining an outstanding advanced laboratory program should be created. I urge the experimental physics community to let APS know that such a prize or award is long overdue. I am not so naive as to think that this will change the reward structure of academic institutions–but it is at least a first step in that direction. It will emphasize the importance of this essential teaching program. Laboratory exploration is America's physics heritage; we are the tinkerers, the builders; we have the history of great experimental physics, let's not lose it. Is there a future for the advanced lab? The answer lies in your hands!

Jonathan Reichert, an emeritus professor of physics at the University at Buffalo, is the founder and President of TeachSpin, a company dedicated to the design, development, manufacture, and marketing of apparatus appropriate for laboratory instruction in physics and engineering.

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