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APS helps end helium crisis
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Congressional Fellows Then and Now

Photo by Darlene Logan

APS Fellows from the Washington area gathered at APS headquarters in College Park on September 19 (see additional photo, page 3). It was one of several receptions for APS Fellows taking place throughout the year, but this one was special in that it also celebrated the 40th anniversary of the Congressional Science Fellows. Every year, APS sponsors one or two Fellows who bring their expertise to Capitol Hill as part of a program administered by AAAS. In the photo, left to right, are present and former Fellows Ben Cooper, Don Engel, Anthony Fainberg, Jennifer Wiseman, N. Richard Werthamer, Benn Tannenbaum, Ann Quider, Bo Hammer, Paul Davis, and Alex Saltman. Cooper and Werthamer constituted the original class of 1973. For more information on the Congressional Fellows program, including how to apply, see www.aps.org/policy/fellowships/congressional.cfm .

Shutdown is Symptom of Larger Science Funding Woes

By Michael Lucibella

The government shutdown, ending just as *APS News* goes to press, had serious but uneven effects on the country's federal science efforts. All federally operated laboratories were shuttered and employees furloughed, while labs run by contractors remained open. However, experts say that the bigger, longer-term danger to science was not the shutdown itself, but changing attitudes towards discretionary spending on Capitol Hill.

In the short term, the shutdown was disruptive to research at labs across the country. Existing experiments were halted and new experiments were delayed. However, it's unclear what effects the work stoppage will have on the nation's science output in the long run.

Work at most of the nation's radio telescopes was suspended, and some lab animals that were part of medical trials had to be euthanized. The Antarctic research station was put into "caretaker" status, delaying the setup and start of new experiments at the beginning of their busiest research season.

However, not all federal facilities were affected equally. Sixteen of the Department of Energy's 17 national laboratories are contractor-operated. They remained open, but as a precaution, most labs started restricting employee travel and instituting other cost-saving measures.

"If the shutdown had lasted five days, ten days [or] 15 days, those labs in general wouldn't have been affected," said Michael Lubell, Director of Public Affairs for the APS. "But if it had gone on for several months then yes, they would have been affected."

The legislation ending the shutdown did not provide a permanent solution to the problem. The government is currently funded through the middle of January. If a broader budget agreement is not reached in the interim, another shutdown could be in the offing.

During the shutdown, the National Science Foundation was dark and stopped issuing new grants, but researchers funded by NSF grants could continue to work at their own institutions. The Defense Department's

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Incarcerated Iranian, Russian Activist Share APS Sakharov Prize

An imprisoned Iranian laser physicist and a Russian scientist who devoted his life to the struggle for democracy and the rights of neglected children are the recipients of APS's 2014 Andrei Sakharov Prize. The award recognizes the efforts of scientists to advance human rights around the world.

"It's for people who have fought for and contributed to the human rights of scientists and human rights in general," said Joel Lebowitz, a physicist at Rutgers University and Chair of the award's selection committee.

Omid Kokabee, once a graduate student at the University of Texas in Austin, is now serving a ten-year prison sentence in Iran for "communicating with a hostile government" and possessing "illegal earnings" in the form of his college loans. Kokabee, who is an Iranian citizen, was picked up at the Tehran airport in January of 2011 and put on trial months later. After he was sentenced, he revealed in an open letter that the Iranian government had approached him on several occasions asking him to work for the military. He refused each time, and believes that is the real reason he was arrested.

"He is becoming, if not already, a symbol or icon of the pursuit of science free of political pressure," said Hossein Sadeghpour of Harvard-Smithsonian Center for Astrophysics, who nominated Kokabee for the award. He added that he nominated him because of "what he did in prison, in captivity. For not succumbing to the pressure to confess to crimes that were alleged against him, and for writing open letters which give us a window, at least partly, [into] why he was kept for refusing to participate in military research work on banned weapons."

He is the first Sakharov Prize recipient incarcerated at the time of the announcement. His affiliation on the award reads "Evin Prison, Tehran."

Boris Altshuler was a close friend and colleague of Andrei Sakharov at the Lebedev Institute in Moscow. The two worked together in the late 1970s advocating anti-authoritarian reforms within the Soviet Union. After Sakharov was arrested and sent into internal

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Nobel Prize Honors Two Physicists for Symmetry Breaking Mechanism

This year's Nobel Prize for physics was awarded to François Englert of the Université Libre de Bruxelles and Peter Higgs of the University of Edinburgh, for developing the theory of what is commonly called the Higgs field and the Higgs boson. Their research provided the mechanism that is used in the Standard Model of particle physics to explain why elementary particles have mass, and to unify the weak and electromagnetic forces.

The Nobel Committee's citation reads, "For the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS Experiments at CERN's Large Hadron Collider."

Physicists have been working to isolate the elusive Higgs boson and confirm the underlying Higgs mechanism in the decades since it was first predicted in the 1960s. CERN announced the discovery of the particle at the Large Hadron Collider in Geneva, Switzerland on July 4th of last year. The Higgs boson was the last missing piece of the Standard Model that was awaiting discovery.

"This year's prize is about something very small that makes

PRIZE continued on page 6

Profiles In Versatility

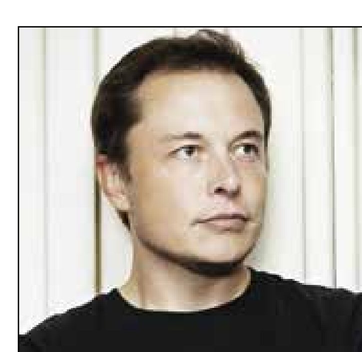
Part 2: Elon Musk on Mass, Mars, and MBAs

By Alaina Levine

Elon Musk, the founder of companies such as PayPal, Space X and Tesla Motors, studied physics and economics at the University of Pennsylvania. Part 1 of Alaina G. Levine's exclusive interview with Musk appeared in the October *APS News* (available online at www.aps.org under "Publications"). Below is part 2, in which he cautions that MBAs are a mistake, hints when we can expect to travel to Mars and explains why his Tesla Model S is making history.

L: *How do you approach business problems right now? Does your physics and your mathematics background help you look at business problems maybe in a different way, or think about them via a different process?*

M: It's helpful to study physics, because the math that's in the business stuff is so easy compared to physics. I remember I was in an advanced securities analysis class and they were teaching people what matrix math is. I was like wow, ok. If you can do physics math then business math is super easy. Probably a lot of people in the sciences sell themselves short on this front. Because they're actually way better than they think they are at this stuff. Just generally taking a physics framework



Elon Musk

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APS-led Education Program Funds 5 New Sites

The Physics Teacher Education Coalition (PhysTEC) is awarding three years of funding to five institutions to develop their physics teacher education programs. The newly selected sites are Georgia State University, University of Central Florida, University of Cincinnati, and North Carolina State University. James Madison University was selected in 2012 and deferred a year before starting the project. These awards bring the number of sites that have been funded by the PhysTEC project to 33.

The PhysTEC project, led by APS in partnership with AAPT, works to increase the number of highly qualified physics teachers. To do this, the project provides substantial support to select colleges and universities to develop their physics teacher preparation programs into national models. Collectively, PhysTEC-supported sites have more than doubled the number of physics teachers they graduate. Renee Michelle Goertzen, Education Programs Manager at APS, says "It is exciting to work with the enthusiastic leadership at the new PhysTEC sites. Their breadth of talent will help the project to touch the lives of

PHYSTEC continued on page 5

Members in the Media

"[It] really is the only option."

Mark Boslough, *Sandia National Laboratory, on using a nuclear weapon to deflect an incoming doomsday asteroid,* NBCNews.com, *October 16, 2013.*

"When you've got the weapons labs sort of pushing for this in the various countries, it starts to make me feel a little uneasy…Which doesn't mean it's not a legitimate thing to do, but you want to know it's being done for legitimate reasons."

David Wright, *the Union of Concerned Scientists, on making sure research into deflecting asteroids with nuclear weapons isn't just a "jobs program" for weapons scientists,* NBCNews.com, *October 16, 2013.*

"Our experiments are completely shut down, we can't do any experimenting right now. On the other hand, part of our work is thinking about the experiments and analyzing things, so we can work from home. They can stop us from being in a lab, but they can't stop us from thinking."

David Wineland, *NIST, on being furloughed during the government shutdown,* USAToday.com, *October 14, 2013.*

"You always hear about how the period from 1929 to 1950 was known as the Golden Age of Hollywood…There were big movies with big movie stars. But if you look at novelty at that time, you see a downward trend."

Sameet Sreenivasan, *the Rensselaer Polytechnic Institute, on developing an algorithm to determine the most creative period of Hollywood,* CBSNews.com, *October 14, 2013.*

"[Iran's nuclear industry investments,] often made in secret and dominated by black market purchases, have not been consistent with a strictly peaceful nuclear program."

David Albright*, Institute for Science and International Security,* The Chicago Tribune*, October 14, 2013.*

"Faced with a choice between their rulebook and an evenhanded judgment, the Swedes chose the rulebook…Not a graceful concession by any means, but that department has never been my strong suit."

Carl Hagen*, University of Rochester, on not winning the Nobel Prize for Physics along with Peter Higgs and François Englert,* The Washington Post*, October 8, 2013.*

"That will open promising territory into new physics."

Sergio Bertolucci, *CERN, on the upgrades to the LHC,* Reuters*, October 8, 2013.*

"I've just been totally flabbergasted at the number of responses."

Jonathan Mizrahi, *Sandia National Laboratories, on the interest in his blog post about the convergence of Thanksgiving and Hanukkah this year,* FoxNews.com, *October 7, 2013.*

"The computer algorithms that are used heavily for trading are designed to go in and look for certain types of opportunities, certain behaviors or patterns in the prices. And if prices are being quoted down on the millisecond scale, which they are, a millisecond is a long time for a machine. A machine can make many, many computations on that scale and decide on a strategy and jump in and do something."

Neil Johnson, *University of Miami,* CBSNews.com. *September 30, 2013.*

"The physics of what's happening in these molecules is similar to what we see in the movies."

Mikhail Lukin, *Harvard University, comparing his research making "light molecules" to the light sabers seen in Star Wars,* CNN.com*, September 26, 2013.*

"Sound recordings give us this magnificent window into the breadth of human endeavors."

Carl Haber, *Lawrence Berkeley National Laboratory, on receiving a MacArthur Foundation award for decoding very old sound recordings,* The Los Angeles Times*, September 24, 2013.*

This Month in Physics History

November 2002: Perelman Posts Proof of Poincaré Conjecture to arXiv

In 2000, the Clay Mathematics Institute announced it would award a $1 million prize for the correct solution to each of seven unsolved mathematical problems, collectively dubbed the Millennium Prize Problems. Only one of the seven has since been solved: the so-called Poincaré Conjecture, considered one of the most important open questions in topology.

The conjecture was the brainchild of Jules Henri Poincaré, born in April 1854, the son of a professor of medicine at the University of Nancy. A childhood bout of diptheria meant that Poincaré received his early schooling from his mother. But in 1862 he entered the local lycee, where he proved an exceptional student, excelling in all his subjects save for music and physical education. One of his instructors described him as a "monster of mathematics." After graduating, he and his father served in the Ambulance Core during the Franco-Prussion War.

Jules Henri Poincaré

In 1873, Poincaré began studying mathematics at the École Polytechnique, and went on to earn a degree in engineering from the École des Mines in 1879. He worked as an inspector for the Corps de Mines while completing his doctoral studies in mathematics at the University of Paris. His thesis, completed in 1879, proposed a new way to study the properties of differential equations. He taught at the University of Caen before taking a position at the University of Paris in 1881. By then he had already earned a reputation as one of the greatest mathematicians in Europe.

Poincaré, then just 32, was elected to the French Academy of Sciences in 1887, the same year he also won a competition organized by the king of Sweden to resolve the three-body problem on the free motion of multiple orbiting bodies. That work helped lay the foundation for modern chaos theory. Poincaré's many other contributions to mathematics would later prove seminal to establishing the field of topology, as well as the theory of special relativity.

As the 20th century dawned, Poincaré turned his attention to determining the topological properties of a sphere. Topology concerns those properties of geometric shapes that don't change when those figures are stretched, shrunk, or distorted in some way, such as whether there is knot in a closed curve in space, or whether or not it has a boundary. Poincaré was interested in spheres. A two-dimensional sphere–or, topologically speaking, the two-dimensional surface of a three-dimensional sphere –possesses a property known as simple connectivity, such that any given two-dimensional closed surface, regardless of how it is distorted, is topologically equivalent.

Poincaré's famous conjecture, outlined in a 1904 paper, simply states that the same holds true for three-dimensional spheres as well, or rather, the three-dimensional surface of a four-dimensional sphere. It is usually stated thusly: "Every simply connected, closed 3-manifold is homeomorphic to the 3-sphere." It is easy enough to make that statement, but far more difficult to devise a rigorous mathematical proof.

Poincaré died in 1912, from complications following prostate surgery. His conjecture would remain unsolved for nearly 100 years. The first claimed proof appeared in the 1930s, by the mathematician J.H.C. Whitehead, but he later retracted it. Other claims appeared throughout the 1950s and 1960s, but these, too, were quickly found to be flawed, and were retracted.

Many mathematicians made small steps toward the eventual solution. Cornell University's William Thurston pointed the way when he suggested exploiting the fact that spheres have constant curvature, regardless of dimension. His Berkeley colleague, Richard Hamilton, built on that work and employed a technique called Ricci flow, which treats transforming shapes in a similar fashion to heat flow. Much like flowing heat smoothes out irregularities in the temperature to make it more uniform, Ricci flows can smooth out irregularities in sphere-like shapes. Unfortunately, this process breaks down at some point, resulting in singularities, requiring topologists to perform a kind of "surgery" on the figure in question by grafting on pieces of other shapes.

But even Hamilton wasn't sure if all possible singularities could be repaired. The final piece of the puzzle was provided by a reclusive Russian mathematician named Grigori Perelman. In November 2002, Perelman submitted a short paper to the arXiv, followed by two more papers. He demonstrated that, indeed, it was possible to repair all such singularities and offered the first rigorous proof of the Poincaré conjecture. The papers caused a sensation in the mathematical community as teams of experts set about the intensive task of peer reviewing the work. "It has taken us some time to examine Perelman's work," admitted University of Michigan mathematician John Lot. "This is partly due to the originality of Perelman's work and partly to the technical sophistication of his arguments. All indications are that his arguments are correct."

In 2006, news broke that Perelman had been awarded the prestigious Fields Medal, the highest honor in mathematics, for "his contributions to geometry and his revolutionary insights into the analytical and geometric structure of Ricci flow." Always eccentric, the increasingly reclusive scholar turned it down, declaring "Everybody understood that if the proof is correct, then no other recognition is needed." It was not the first time he had turned down a prize, having previously declined

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Washington Dispatch

Updates from the APS Office of Public Affairs

POLICY UPDATE

Fiscal Year 2014 Appropriations and Government Shutdown

As *APS News* was preparing to go to press, federal agencies were just getting back to normal. The shutdown occurred when House Republicans insisted that a continuing resolution to keep the government funded be paired with modifications to the Affordable Care Act (ACA), also known as Obamacare. The stage had been set months earlier when the House and Senate had been unable to agree on fiscal year 2014 spending levels. The Senate Budget Resolution contained $1,057 billion in total budget authority, while the House Resolution contained only $967 billion in total budget authority. Consequently, the new fiscal year began without a single appropriation bill having been passed.

Although the Democratically controlled Senate had reluctantly agreed to a total spending level of $986 billion–which incorporated sequestration levels–Tea Party House Republicans demanded defunding, delaying or significantly altering the President's signature health legislation as a requisite for a continuing resolution. When the White House and the Senate rejected those demands, and Speaker John Boehner (R-OH) refused to allow the House to vote on a "clean" funding bill, government agencies were forced to shut down.

All non-essential government employees were furloughed, and non-essential activities were curtailed. Furloughs affected more than 95 percent of employees at the National Aeronautics and Space Administration and the National Science Foundation. The National Institute of Standards and Technology and the National Institutes of Health shut down all of their laboratories. The National Science Foundation shut down "FastLane," preventing scientists from submitting new grant proposals or fellowship applications. Although many Department of Energy user facilities had enough cash on hand to continue operations for a limited time, the agency was forced to curtail many other discretionary activities, including travel and purchases.

Even where research programs were functioning under prior grants, many were hampered by the inability of scientists to access data collected by government agencies such as the National Oceanic and Atmospheric Administration and the Department of Agriculture.

As was the case during last year's "Fiscal Cliff," a continuing resolution was not the only issue. The Treasury Department had indicated that on October 17 or within a few weeks thereafter the nation would reach a debt ceiling. Congressional failure to raise the ceiling would force the United States to default on its obligations. With economists warning of worldwide financial repercussions, Senate Democrats and Republicans were striving to achieve at least a short-term bipartisan agreement to avert the predicted upheaval, although House acceptance remained in doubt.

But even though the House accepted a Senate agreement, the consequence will be to postpone resolution of significant disagreements between Democrats and Republicans over defense and non-defense discretionary spending, mandatory spending, taxation and healthcare. It will simply set the stage for another major battle over the nation's fiscal future a few months down the road.

The Helium Stewardship Act

After nearly two years of intensive effort by the end user community, including the APS, the President signed H.R. 527, the Helium Stewardship Act of 2013, into law on October 2. P.L. 113-040 ensures that the Bureau of Land Management (BLM) can continue to supply crude helium to the market without interruption. It creates an auction process to determine a market price and to incentivize the private sector to develop additional helium reserves. Moreover, it ensures a steady supply of helium to the research community. Finally, it reserves 3 billion cubic feet of crude helium for federal use; this includes use by federal agencies and federal grantees through the In Kind program.

While the APS was successful in having Congress include language for membrane R&D to improve helium capture at the wellhead, the future of supply to federal users and federal grantees after the BLM leaves the helium business is not yet clear.

WASHINGTON OFFICE ACTIVITIES

Media Update

APS member Kenneth Rudinger, a PhD graduate student in the University of Wisconsin-Madison's physics department, authored an op-ed on Sept. 26 in the *Milwaukee Journal-Sentinel*. Titled "Government shutdown threatens scientific research," the piece urges Congress to avoid a shutdown and fully fund scientific research.

As a follow-up to the op-ed, Rudinger was interviewed on Wisconsin Public Radio about the effect the government shutdown is having on scientific research.

To read the op-ed, click the following link: http://www.jsonline.com/news/opinion/government-shutdown-threatens-scientific-research-b99107143z1-225419442.html

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APS Fellows Gather in College Park

Photo by Michael Lucibella

The rotunda at APS headquarters in College Park, MD was filled on the evening of September 19 by 130 APS Fellows and their guests, who mingled with APS leadership and staff and enjoyed the refreshments at a reception hosted by APS. The Fellows also heard brief presentations from APS President Michael Turner and Executive Officer Kate Kirby, and a panel discussion about the Congressional Science Fellowship Program, celebrating its 40th anniversary (see photo on page 1).

Last-minute Legislation Averts Helium Supply Crisis

Recently passed legislation will prevent a major disruption in the world's helium supply, but will cause prices to rise. The disruption would have followed the loss of authority to sell helium by the U.S. Bureau of Land Management; however, a concerted efforts by scientists, led in part by APS, helped pass legislation in Congress that averted the crisis.

"It's a huge win for us and the membership," said Jodi Lieberman, senior government relations specialist at APS. "Our membership really stepped up."

The BLM's Federal Helium Reserve supplies about 40 percent of all the helium in the United States, and about 35 percent worldwide. Because of legislation passed in 1996, the BLM could sell helium at a fixed price only until the reserve's substantial debt was paid off. It broke even in September, and had Congress not acted, would have stopped selling its helium come October.

The new law will let the reserve continue selling helium until it is almost totally exhausted. However, now it will be selling the gas at market prices, meaning that costs for consumers will go up. Exactly how much prices rise will depend on the market, but it will be less than market experts predicted had the BLM stopped selling its supplies.

Helium is vital to numerous scientific, medical and industrial processes. Welders and microprocessor makers use the inert properties of the gas for manufacturing. Its cryogenic properties are critical for MRI machines, as well as for physicists' ultra-cold experiments.

In recent years helium shortages had started growing acute. The low cost encouraged excess consumption, eating into supplies. Scientists have reported increasing numbers of instances when suppliers were totally out of helium. The higher cost should reduce some of the overconsumption and at the same time stimulate more investment.

"The price of helium will go up and hopefully that will encourage more mining and discovering of new helium," said Moses Chan of Penn State University, who was part of a 2010 National Research Council committee that studied the impact of closing the reserve.

A bill to avert the looming "helium cliff" was first introduced in the House in February, followed by a corresponding Senate bill in late April. The bills languished in Congress until September 10, when 120 scientific, medical and industrial organizations sent an open letter to the Congressional leadership demanding action. A week later APS President Michael Turner sent an email to the entire APS membership urging them to contact members of Congress.

"Partisan gridlock threatens to diminish the US Helium supply by 50% on October 1st unless the Congressional Leadership can enact bi-partisan legislation in the next two weeks of a very busy Congressional schedule," Turner said in the email. "I ask you to call the office(s) of at least one member of the leadership today or tomorrow…to urge them to find a solution that will ensure the continued supply of Helium for the research community as well for use in MRIs and in the semiconductor industry."

The Senate passed its version of the bill by a vote of 97 to 2. The House followed a week later. Because of differences in the House and Senate bills, the Senate had to pass the House version on September 26th. The bill then went to the president for his signature on October 2.

Federal scientists and researchers operating with a federal grant will have access to the "in-kind" program, which offers helium at deeply discounted rates. Some researchers have reported that in recent years as much as 70 percent of their grant money has gone towards procuring helium.

"A lot of what happened has been price speculation," Lieberman said. She added that the artificially low price distorted the market, and potential new suppliers were priced out because of the government's subsidized gas. Now new refineries are being developed in Russia, Algeria, Qatar and Wyoming. "That's the whole goal here, to incentivize the private sector and get [them] involved."

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to accept a prize from the European Mathematical Society, allegedly because he did not think the prize committee was qualified to assess his work.

Four years later, the Clay Mathematics Institute declared that he had indeed solved the first of the seven Millennium problems, and awarded him the $1 million prize. Perelman declined that honor as well, insisting that Hamilton had made comparable contributions to the solution, adding, "I have all I want." Increasingly disillusioned with the field, Perelman subsequently left mathematics altogether, leaving his position with the Steklov Institute. Today he is reportedly living with his mother in St. Petersburg, Russia. But his work on the Poincaré conjecture stands as the mathematical breakthrough of the century.

Further Reading:

Gessen, Masha. *Perfect Rigor: A Genius and the Mathematical Breakthrough of the Century*. New York: Houghton-Mifflin-Harcourt, 2009.

Nasar, Sylvia and Gruber, David. "Manifold Destiny: A Legendary Problem and the Battle Over Who Solved It," *The New Yorker*, August 21, 2006.

Perelman, Grisha "The entropy formula for the Ricci flow and its geometric applications," arXiv: math/0211159, November 11, 2002.

Poincaré, J.H. *Oeuvres de Henri Poincaré, tome VI.* Paris: Gauthier-Villars, pp. 486 and 498, 1953.

Letters

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

Clarifying the Record on the SSC

I am quite tired of being the only physicist quoted in assigning the blame for the demise of the SSC, in the history column in the October *APS News*, as in much of the publicity surrounding the recent award of the Nobel prize. This is extremely unfair, for one because my only public testimony on the subject was for a Senate committee, and it was the House of Representatives which took the crucial vote. Several other prominent physicists had testified before the House committee, including the then President of the APS.

One of the main points of my testimony was the extreme jingoism to which the selling of the project seemed to appeal; in my testimony I argued that such a large project should properly be done under international auspices and with less of a gung-ho attitude, as it has successfully turned out. As it is, I have been able to be sincere in congratulating the high-energy community on a job very well done, in discovering the Higgs particle in which I have a very personal and continuing interest.

The depth of our feelings about the PR surrounding the selling of the SSC and in particular their claims about **"**spinoffs**"** may be understood in the following anecdote: As I was leaving the committee room behind Steve Weinberg, the particle physicist who had testified for the SSC, one of the senators accosted him and effusively thanked him for his role in the development of MRI, which had been instrumental in treatment of a relative. Since close friends and I had been responsible for most of the basic research underlying MRI's superconductiing magnets, this was a bit of a bitter pill for me to swallow. In the end, the Senate committee came out quite favorable to the SSC.

Philip W. Anderson
Princeton, NJ

Doing Science "Online"

There is an interesting footnote to the article "Lord Rayleigh and the Discovery of Argon" in the August/September *APS News*. When Rayleigh and Ramsay were working on the problem in their respective laboratories (Ramsay at University College London), they exchanged results by telegraph–perhaps the first example of scientific collaboration in the digital age.

David R. Lide
North Potomac, MD

APS, AIP Launch Education Policy Fellowship

APS and the American Institute of Physics (AIP) announced in early September the formation of a new policy fellowship that will send recipients to work at the Department of Education for up to two years. The purpose of the fellowship is to place a PhD scientist within the department to advise on STEM education issues and policy. Organizers hope that the "STEM Education Policy Fellowship" will help the federal government better promote science, technology, engineering and math education in classrooms.

"The Department of Education has historically not done very much in STEM education," said Theodore Hodapp, APS's Director of Education and Diversity, adding that there is only one person devoted full time to STEM issues.

APS has been trying to establish a fellow at the Department of Education for some time. It has helped support the AAAS Congressional fellowships since 1973, but has had a harder time placing someone at the Department of Education.

"It started with our placing a science student as an intern last summer," said Tyler Glembo, Government Relations Specialist at APS. "Now we also have a fall intern. Due to the success of that… [it] has now given us the opportunity to take that up to the next level."

The focus changed last year when the administration announced the formation of the STEM Master Teacher Corps. As the program ramps up, the Department of Education intends to subsidize as many as 10,000 STEM teachers in four years.

"Because of this STEM Teach-

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exile, Altshuler became his biggest advocate, organizing petitions and publicity for the scientist turned activist.

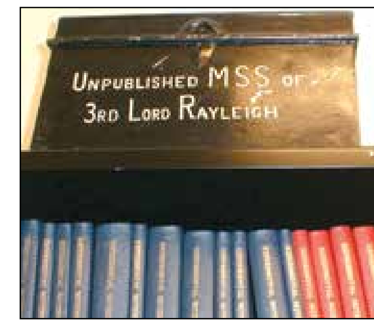
"When Sakharov had his struggle for human rights, Boris Altshuler was very much involved with that," said Eugene Chudnovsky of the City University of New York, and a member of the selection committee. "He didn't have the standing of Sakharov. He could easily have been sent to prison for many years."

The Soviet government attacked Altshuler's professional career because of his activism. For five years in the mid-eighties the physics professor was demoted to staff janitor at the Institute on the urging of the KGB. After the fall of communism, he continued to advocate for human rights in Russia. In addition, he established "The Right of a Child," to reform and raise awareness about the country's troubled foster care system.

A Rayleigh Miscellany

I enjoyed the Physics History column, "Lord Rayleigh and the Discovery of Argon" in the August/September *APS News*, particularly since Rayleigh is a favorite of mine. Rayleigh treated everyone well and would have fit the APS Strategic Plan nicely in his encouragement of women and young physicists. The Rayleigh-Jeans law mentioned in the article is so-called because the young Jeans (just graduated from Cambridge) pointed out an error in Rayleigh's comparison of his blackbody equation with that of Planck's; in *Nature*, Rayleigh responds, "I hasten to admit the justice of this correction." Regarding the joint credit for the discovery of argon by Rayleigh and Ramsay, Lady Rayleigh's journal (16 August 1894) says that Rayleigh "thinks Ramsay's cutting in hardly according to scientific etiquette, but did not complain," and Rayleigh suggested joint publication then, as well. One of my favorite quotes is from Rayleigh's Nobel lecture on the discovery of argon: "Argon must not be deemed rare. A large hall may easily contain a greater weight of it than a man can carry.**"**

It may not be widely known that Rayleigh's notebooks, beginning as a student at Cambridge in 1862, reside at the library of the U.S. Air Force Academy, for an interesting reason. Physicists at what is now called the Air Force Research Laboratory used airglow measurements to track the effect of solar activity, but had no data prior to 1950. They learned that Rayleigh's son, the 4th Baron Rayleigh, had made almost daily measurements from 1920 until his death in 1947. They were able to purchase his notebooks in a lot that included those of his more famous father, the final entry being in March of 1919, shortly before Rayleigh died. The collection includes many letters, papers related to invention of a foghorn, the laboratory notebook of Rayleigh's sister-in-law (beginning "Cavendish Laboratory, April 1880"), and a metal box marked "Unpublished



MSS of 3rd Lord Rayleigh" in which only a few fragmentary handwritten pages are found.

Foreign to me is the interest in spiritualism, séances, and psychical research of their time. Though skeptical, Rayleigh was President of the Society for Psychical Research in 1919, and his physicist son more passionately in 1937. Toward the end of his life the son gave £1000 to the Society, saying that his gift was more likely to bear fruit in this field than in any of the more orthodox branches of science.

Thomas Miller
Lexington, MA

International News

...from the APS Office of International Affairs

Asia-Europe Physics Summit Provides a Global Perspective

By William Barletta and Luisa Cifarelli

This past July the Physical Society of Japan and the Japan Society of Applied Physics organized the 12th triennial Asia Pacific Physics Conference (APPC12) under the auspices of the Association of Asia Pacific Physical Societies (AAPPS) in Makuhari, Chiba, Japan. APPC12 presented the most recent developments in physics in the Asia-Pacific region across a range of physics disciplines–condensed matter, nuclear and particle physics, neutron and synchrotron radiation science, plasma science, and computational physics. With respect to broadening participation in physics, sessions also included physics education and the topic of women in physics. APPC12 also provided an ideal occasion for the third Asia-Europe Physics Summit (ASEPS3), a collaboration between AAPPS and the European Physical Society (EPS).

Participants in ASEPS3 Round Table 2 (from left to right): Sun-Kee Kim, Shoji Nagamiya, Lyn Evans, James Strait, Guenther Rosner (hidden), Sergio Bertolucci, Satoru Yamashita and Tatsuya Nakada.

The Asia-Europe Physics Summit, which alternates between the two continents, is an extended opportunity for organizational and intellectual leaders in the respective physics societies to discuss research in the context of strengthening collaboration between Europe and the Asia-Pacific region. The goals of the Summit are threefold: 1) To discuss the scientific priorities and the common infrastructure that could be shared between European and Asian countries in various fields of physics research; 2) To establish a dedicated framework to increase the level of Euro-Asia collaborations in the next two decades; 3) To engage developing countries in a broad range of physics research.

The public program of ASEP3 included a plenary program with speakers from Europe to cover the latest physics results at the LHC, plasmonics that merges photonics with nanotechnology, fiber accelerators, and climate engineering –truly a broad range of topics to excite conference participants. Looking to future developments in physics without borders, ASEPS complemented the plenary lectures with four roundtable discussions that provided an intense exchange of ideas on topics for Asia-Europe cooperation, especially on the timely issue of international strategic planning for large research facilities worldwide.

Thanks to the initiative of EPS past-President Luisa Cifarelli, who has also been involved with APS as a member of both the Executive Committee of the APS Forum on International Physics (FIP) and the APS Committee on International Scientific Affairs (CISA), this year's Summit included a significant US perspective. In Round Table 1, which was moderated by Tastsuya Nakada, Scientific Secretary for the European Strategy Session of the CERN Council, William Barletta, Past-chair of FIP and the APS Division of Physics of Beams discussed the technologies for both high energy physics and photon science based on his service as convener for the Accelerator Capabilities Study in the APS DPF Snowmass process and facilities prioritization sub-panel for the U.S. Department of Energy Basic Energy Sciences Advisory Committee. European perspectives in these areas were given by Massimo Altarelli, Managing Director of European XFEL, and Frédérick Bordry, future CERN Director of Accelerator and Technology; the Asian contributions concentrated on the possibility of a large linear collider project and were given by Jie Gao, Chair of the Asian Linear Collider Steering Committee and Akira Yamamoto, ILC GDE Project Manager, KEK, and Yifang Wang, Director of the Institute of High Energy Physics, Chinese Academy of Sciences.

The strategy for the next generation of large-scale facilities must be driven primarily by an emphasis on the unity of interests of the relevant scientific user communities. Such a view of "big tent science" can make a strong case

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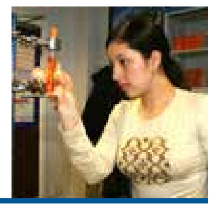
Education Corner



APS educational programs and publications

PhysTEC highlighted in NSF report to Congress
The PhysTEC project was highlighted in the 2014 National Science Foundation Budget Request to Congress. PhysTEC was one of eleven highlighted projects and the only one related to education. The highlight displayed the map of the 286 Coalition members, with a brief description of the project, some of which is excerpted here: "Only 35 percent of high-school physics teachers have a degree in physics or physics education…The PhysTEC project seeks to engage physics departments more deeply in teacher education so that every student will have the opportunity to learn physics from a qualified teacher." For the full Budget Request, visit http://www.nsf.gov/about/budget/fy2014/pdf/01_fy2014.pdf

Physlet Physics 2E now on ComPADRE
The collection of over of 800 interactive Java simulations and associated curricular materials for the teaching of introductory physics is now available on ComPADRE at http://www.compadre.org/Physlets/. This free online book can be used in introductory physics classrooms, from high school to university, as interactive lecture demonstrations, Just-in-Time Teaching exercises, as interactive homework assignments, or as interactive pre-class exercises to "flip" your classroom.

Save the Date: 2014 Physics Teacher Education Coalition Conference
The 2014 Physics Teacher Education Coalition (PhysTEC) Conference will be held May 19-20 in conjunction with the UTeach Institute Annual Conference in Austin, TX. The PhysTEC Conference is the nation's largest meeting dedicated to physics teacher education. It features workshops, panel discussions, and presentations by national leaders, as well as excellent networking opportunities. Workshop solicitations will begin in November. Learn more at http://www.ptec.org/conferences/2014/

Report Available on Distance Education and Online Learning in Physics Workshop
Over 100 participants gathered at APS headquarters in College Park on June 1-2 to learn about the opportunities and implications of distance education and online learning for the physics community. The report on the Distance Education and Online Learning in Physics Workshop discusses the workshop's major themes, online resources, and proposed next steps for the physics community. It can be found here: go.aps.org/YbGn9q

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many more future physics teachers."

The James Madison University (JMU) project plans to build on established programs for current teachers to expand the recruitment, mentoring, and retention of future teachers. PhysTEC funding will support (1) implementation of a science pedagogy course, (2) development of a sustainable Learning Assistant program, and (3) hiring a Teacher-in-Residence. "It is gratifying to see that many of the newly funded sites are building on previous efforts in physics teacher education and course reform," said Beth Cunnigham, Executive Officer of the American Association of Physics Teachers.

PhysTEC students at the University of Central Florida (UCF) will have the opportunity to enroll in a dual teacher-certification and physics-major track and will have more options to work with Learning Assistants in their introductory physics courses. The UCF project aims to prepare 15 physics teachers during the first four years, helping to respond to the current shortage of teachers in Florida.

Georgia State University (GSU) plans to increase the number of minority physics teachers to help meet Georgia's high need for qualified physics teachers. PhysTEC funding will support a Teacher-in-Residence, who will teach a physics pedagogy class and lead future teacher recruitment. The GSU project will focus on course reform, early teaching experiences, and mentoring.

North Carolina State University (NCSU) will focus on developing a Learning Assistant program and will partner with the NCSU STEM Education Initiative to assist with course reform and LA recruiting.

At the University of Cincinnati (UC), PhysTEC students will take courses specifically for licensure candidates such as Modeling Instruction. UC has a goal of increasing the number of new, highly-qualified high school physics teachers to five or more per year. They will use a variety of recruitment strategies, including providing flexible and accessible pathways to licensure for all STEM majors.

"This is the fourth solicitation for supported sites in four years, and we are really pleased that new institutions continue to step forward with excellent proposals," said APS Associate Director of Education & Diversity Monica Plisch. Project funding for these five universities began this summer and will continue for three years. All sites have committed to funding their projects for at least an additional three years after the PhysTEC funding ends.

Apker Finalists Meet and Compete in Washington

Photo by Shelly Johnston

On September 19, while APS Fellows were congregating in nearby College Park (see photo page 3), another group of distinguished physicists gathered in downtown Washington. These were the seven finalists for the APS Apker Award for outstanding research by an undergraduate. They were each interviewed by the Apker selection committee, in order to determine the ultimate recipients of the Award. APS typically presents two Apker Awards each year, one to a student from a research university, and the other to a student from an institution not granting the PhD. Photos of the two recipients will appear in next month's *APS News*. The finalists were (l to r): Nitayan Nair (MIT); Jonathon Hunacek (Michigan); Nathan Schine (Williams); Guy Geyer Marcus (Wesleyan); Hao Shi (Rochester Institute of Technology); Anshuman Pal (Penn); and Jeremy Perrin (St. Mary's College of Maryland).

Mass Media Fellows Learn on the Job

Ed. Note: *Each year APS sponsors two Mass Media Fellows as part of a program administered by the American Association for the Advancement of Science (AAAS). They each spend ten weeks over the summer working as a science reporter at a media outlet. This year's Fellows, Elizabeth Case and Jenny Laaser, worked at* The Oregonian *and the* Milwaukee Journal Sentinel*, respectively. They write about their experiences in the articles below.*

Fellowship Helps Launch Writing Career

By Elizabeth Case

Going into the AAAS Mass Media fellowship, I was hoping for a fully-immersive journalistic experience: one that would teach me the ins-and-outs of a longstanding professional newsroom. At *The Oregonian*, that's certainly a piece of what I found –but it barely hints at everything I learned this summer.

From experiencing the instant community with other AAAS Mass Media fellows to witnessing newspaper layoffs firsthand, I happily rode out the few lows and numerous highs of this rollercoaster summer. As August comes to an end, I'm left reeling a bit from the excitement, committed to becoming a journalist.

Portland and *The Oregonian* held nothing back, welcoming me to the summer with a characteristic Northwest shower that drenched my first interview. With my recorder wrapped in a thin black jacket, I spent an hour and a half documenting the deaths of 50,000 bumblebees. This first story, headlined on the front page, turned out to be my biggest of the summer, and the attention it received sparked new pesticide regulations and legislation.

My work on the bumblebees resembled much of the work I did for the paper: integrating science into everyday stories. While my scientific background helped me question the methods and models used by local researchers, activists, and public servants, the challenge from there was to figure out why these people and events were important to readers. Ultimately, as a reporter at a regional paper, my goal was to find the intersections between science and local society.

Elizabeth Case

Despite the slow decline of the science desk in traditional newsrooms, readers clearly resonated with the science and environment focus. Maybe it had something to do with being in the Northwest, but I received frequent emails, phone calls, and even a real letter, from readers concerned about pesticides, sending me information on gun statistics, asking questions, asking for more of the same coverage. The articles I wrote often prompted hundreds of comments, with (sometimes) high-quality conversations. It was so exciting, to see people so excited.

During the rest of the summer, I covered Obama's climate change speech, honeybee breeders, mummies, invasive species, wave energy, and contentious public hearings about coal exports. And each article I published, each interview, the thrill of reading reports, made me more and more certain that the newsroom is the right place for me right now. I get to learn *so much* science every day.

I still have six more months until I can hold my bachelor's degree in physics high in the air and I'm thrilled to have that time to learn as much as I can. Then, armed with the skills I've learned in the classroom and from this past summer, I'll see what I can do about making this into a career.

Good Writers Keep Their Audience in Mind

By Jenny Laaser

One of the first pieces I wrote for the *Milwaukee Journal Sentinel*–a blog post on how loggerhead turtles track their prey–came back from my editor with a note saying, "needs a sentence about loggerheads–how big? where do they live?"

These questions had nothing to do with the science in the story, but everything to do with the context. And as my editor pointed out, my audience (my readers) needed this sort of context to make the story accessible.

But sometimes, I also went too far in the other direction.

Several weeks later, I wrote a long story about the tests for testosterone used as a performance enhancing drug in baseball. That story came back with notes in several places telling me that I was "too far down in the weeds"–i.e., giving too many details, ones that didn't add much to the argument and just made the story drag.

That story went from almost 5000 words in the first draft, to less than 3000 in the final draft. Many of the details I found fascinating as a scientist–for example, why a certain genetic variation makes it easier for players to beat testosterone tests–landed on the cutting room floor.

And while I bemoaned their loss, paring things down ultimately made the story much more interesting for the news audience.

Jenny Laaser

My editors and I repeated this process many times over the course of the summer, and I got much better at gauging the level of detail that was necessary and appropriate in each of my stories. In the end, these experiences really emphasized for me that good science writing is just as much about understanding your audience as it is about being able to explain the science itself.

What do your readers know, and what will they find interesting?

Now, as I slip back into my academic mindset after my "summer vacation" in the newsroom, I am trying to remind myself that these questions aren't restricted to writing for the general public. Keeping the audience in mind is critical as a research scientist as well.

And it's tricky, because we speak to so many different audiences. Our research groups are a different audience than the attendees at a conference symposium, and these are both fundamentally different audiences than those at

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for cost-effective technical capabilities, that is, a broad scientific return on investment, including power efficiency, growth potential of the infrastructure, and flexibility to address evolving scientific priorities and science cases for upgrades and programmatic priorities. Whether for high-energy and nuclear physics or for photon and neutron science, the shared technologies of future large-scale facilities must deliver extreme temporal and positional precision and stability of particle and photon beams; facilities will generate very large data sets, stressing the importance of both data processing and data storage.

Looking to the issues of policy and cooperation inherent in the next generation of large facilities, Round Table 2 offered perspectives concerning future LHC operations from Sergio Bertolucci, Director for Research and Scientific Computing at CERN; the next steps toward an International Linear Collider from the head of the Linear Collider Collaboration, Lyn Evans; and progress toward the Rare Isotope Science Project in Korea from Sun-Kee Kim, Director of the Institute for Basic Science. Shoji Nagamiya, AAPPS President, described the perspective from J-PARC; Guenther Rosner, FAIR Managing Director for Research and Administration, progress toward the FAIR facility at GSI Darmstadt, and James Strait, representing the Fermilab Directorate, the policy issues in moving toward a robust design of the LBNE facility.

Large-scale facilities provide the opportunity and the necessity to demonstrate the excitement of forefront science, as well as its economic and societal value to both decision-makers and to the general public. Round Table 4 examined the responsibility of large facilities to undertake education and outreach programs and the impact these activities have had in different circumstances and locations around the world. Neil Calder of the Okinawa Institute of Science and Technology (past-head of Communication at CERN, SLAC and ITER) emphasized the ways in which large facilities can and must build trust with the public both by sharing the excitement of the scientific and technological enterprise and by being transparent with respect to issues of facility safety and prudent operation. Education programs based on the research undertaken at large facilities can help to inspire young people to study science and pursue a research career; of particular note is the EPS Young Minds (EPSYM) project which was described by its new leader Antigone Marino of the University of Naples Federico II. This program could be considered for emulation in the US by the APS.

Representing the US Particle Accelerator School and the Joint US-CERN-KEK- Russia Accelerator School, William Barletta explained that whether as locations for scientific mega-experiments or as giant tents over myriad small science experiments, the success of large scientific facilities depends on a confluence of four principal factors: 1) a continual influx of highly trained scientists and technologists to build and operate devices with unprecedented levels of performance; 2) a technically savvy user community, which can provide the science pull for new capability and capacity and can then deliver transformative scientific results; 3) well trained scientific executives who can inspire and lead highly creative staff and manage large technological risks; and 4) an engaged public which will be excited by and supportive of the science enterprise. In the face of a widespread lack of university training programs in the technology of accelerator-based science facilities, laboratories with a broad national and international charter have formed alliances with major research universities to provide the core education in science, technology and management skills needed for such laboratories to flourish and to provide rich programs of scientific research of broad benefit to society.

Round Table 3 described the opportunity for a worldwide collaboration of physics societies for the year 2015 as an International Year of Light under the auspices of UNESCO and the United Nations. The Year of Light would highlight how light technologies have revolutionized society through medicine and communications, entertainment and culture, and how they are major economic drivers and provide solutions to global challenges in energy and education both in industrialized and developing countries.

Though ASEPS3 was not explicitly a worldwide physics summit, it did open the door for a very broad engagement by physics societies to build global collaboration, to increase the scientific return on societal investment and to spread the benefits of forefront physics research to developing countries. These goals are appropriate for programs of strong multi-lateral cooperation of physics societies that exemplify our ideal of open science without secrecy and without borders.

Luisa Cifarelli of the University of Bologna, Italy, is Past-president of the European Physical Society, the Italian Physical Society, and is a member of the Executive Committee of the APS Forum on International Physics (FIP) and the APS Committee on International Scientific Affairs (CISA).

William Barletta is Director of the US Particle Accelerator School, Department of Physics, Massachusetts Institute of Technology. He is Past-Chair of the APS Forum on International Physics (FIP) and also serves on the APS Committee on International Scientific Affairs (CISA).

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To listen to the interview, click the following link: http://www.wpr.org/government-shutdown-threatens-scientific-research

Michael S. Lubell, APS director of public affairs, wrote an op-ed for *Roll Call* on Sept. 12 titled "Cutting Science Funding Starves Future Generations." The column points out that current federal science budgets are "undermining the foundation of future economic growth, which in no small measure depends on science, education and infrastructure."

To read the op-ed, click the following link: http://www.rollcall.com/news/cutting_science_funding_starves_future_generations_commentary-227532-1.html

POPA

POPA considered and approved a report titled *Renewing Licenses for the Nation's Nuclear Power Plants* at its October meeting. The report has been approved by the APS Executive Board and will be posted to the POPA Reports website in the coming weeks: http://www.aps.org/policy/reports/popa-reports/index.cfm

The proposed APS Statement on K-12 physics education remains under review and will be re-considered by the APS Executive Board and Council later this year following edits informed by APS member commentary. A second statement on undergraduate research has undergone Council commentary and will be sent to the APS Executive Board for review and approval later this year. APS Statements on the Civic Engagement of Scientists and on Joint Diversity are being reviewed for modification.

A subcommittee has been formed to vet a proposal for a joint international workshop on tactical nuclear weapons, with sister physics societies in Europe. The idea for an international workshop stemmed from a US workshop on the subject, held jointly by APS and the Center for Strategic and International Studies.

The Climate Change Statement Review Subcommittee continues its review of the APS Statement on Climate Change. A workshop is planned for early 2014.

A template for study proposals can be found online, along with a suggestion box for future POPA studies: http://www.aps.org/policy/reports/popa-reports/suggestions/index.cfm

For more information, log on to the APS Public Affairs website: http://www.aps.org/policy/

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all the difference," said Staffan Normark, Permanent Secretary of the Royal Swedish Academy of Sciences.

The Higgs field triggers the symmetry breakdown that gives elementary particles their mass. The more strongly an elementary particle binds to the underlying field, the greater its mass. The Higgs boson is the particle associated with that field.

"The boson by itself is something that is the experimental test of the existence of the whole mechanism and one had to wait," Englert said. "It took some time to first prove the consistency of our theory…During the '70s the Standard Model was built up and only after that could one look for a test because the Standard Model was wonderfully verified, except for the missing element, which was that boson, whose condensation is what gives the mass to particles and short range forces."

To isolate the particle experimentally, scientists constructed the world's largest and most powerful particle accelerator near Geneva. The LHC's 17-mile ring runs under both Switzerland and France, and accelerates protons to collision energies of up to 7 TeV. Scientists painstakingly scrutinized the remains of the collisions for any telltale signs of a decayed Higgs. After two years of operation, and more than 300 trillion individual collisions, the LHC's two detector collaborations, ATLAS and CMS, jointly announced their discovery of the Higgs boson at last July's press conference.

"The discovery of the Higgs boson has captured the imagination of physicists and the public alike," said APS President Michael Turner. "It is hard to find a cab driver anywhere in the world who when he knows you are physicist doesn't ask about the Higgs boson. This is a tremendous achievement, involving more than 10,000 physicists from around the world to build, operate and analyze data from the most complex and most expensive science experiment ever built."

The theory of what would ultimately be called the Higgs field was first proposed in three papers in *Physical Review Letters*, written by six people on three independent teams, all published in 1964. The researchers' theories explained the "broken symmetry" origin of particle masses, and also showed why photons, the particles that carry the electromagnetic force, have no mass while W and Z bosons, the purveyors of the weak nuclear force, can be massive. The Higgs mechanism effectively unified the weak and electromagnetic forces. These papers laid the groundwork for the later development of the Standard Model of particle physics.

Englert and his longtime collaborator, the late Robert Brout, also from the Université Libre de Bruxelles, authored the first of the 1964 papers. Higgs was the sole author of another, and the third was by Carl Hagen, now at the University of Rochester, Gerald Guralnik of Brown University, and Tom Kibble at Imperial College. All six were awarded APS's 2010 J.J. Sakurai Prize for Theoretical Particle Physics for their work. Five of the six traveled to snowbound Washington DC in February of 2010 to receive the Prize. Higgs was unable to attend, citing health concerns.

"It's unfortunate that the Nobel Prize is limited to only three recipients," said R. Sekhar Chivukula, the 2010 Chair of the APS Sakurai Prize Selection Committee, "because failing to recognize the work of Hagen, Guralnik, Kibble and Brout is a significant oversight. I'm glad that the APS could award a prestigious prize in a way that makes clear just how important they all were in establishing the foundations of contemporary particle physics."

After the awards were announced, Hagen said that the confirmation of the particle last July was the culmination of nearly 50 years of work.

"I am very happy to see the recognition of the Swedish Academy for this area of work and want to offer my congratulations to François Englert and Peter Higgs," Hagan said in a statement. "As my colleague Tom Kibble has said, it is no surprise that with the Nobel Prize unable to go to more than three people, the Academy felt unable to include my co-authors and me. But I am nonetheless very proud of the work we did, at how complete our explanation was, and how that has contributed to our understanding of how particles obtain mass."

FELLOWSHIP continued from page 4

er Corps, there is interest from the Department of Education in having a science policy fellow," Hodapp said. "This is a unique opportunity to come in at the ground floor when the Department of Education is just starting to think about STEM issues."

The deadline for the 2014 fellowship has passed and the first fellow should be announced later this Fall. For more information visit: http://www.aps.org/policy/fellowships/stem.cfm

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a department-wide seminar or a public lecture.

I'm still learning how to navigate this, as an academic. But I know that I don't want to be that speaker at a conference who loses half the audience because she didn't give enough background, and then throws in so many irrelevant details that the other half of the audience tunes out.

As I go forward, I will look back at my summer in the newsroom and remember how critical it was to think about the readers in order to write a compelling, informative, and accessible news story. And I'll ask myself two questions:

What does my audience know? And what will they find interesting?

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to think about any problem–it's a generalized problem-solving method that can be applied to the economic world as well as the physical world.

L: *Having studied math and physics myself, I always found that I would look at a business problem like a bifurcation tree and think about things 4 or 5 or 6 moves ahead. Do you have this as well, and if so, do you think you got this from studying physics?*

M: Yeah, in general you always want to try to think about the future, try to predict the future. You're going to generate some error between the series of steps you think will occur versus what actually does occur and you want to try to minimize the error. That's a way that I think about it. And I also think about it in terms of probability streams. There's a certain set of probabilities associated with certain outcomes and you want to make sure that you're always the house. So things won't always occur the way you think they'll occur, but if you calculate it out correctly over a series of decisions you will come out significantly ahead…

L: *So that's kind of how you're thinking on a day-to-day basis, would you say?*

M: Yeah, I think of the future as branching probability streams.

L: *Is there any downside to having studied physics or being a physicist in your position and in your industries?*

M: Definitely not. I encourage everyone to do it. The difficulty is that physics is usually so badly taught in high school and even in junior high…There's too much of the teaching of the tools and not enough of the "why the hell are we learning this in the first place?"

L: *When you hire people, what are some of the top qualities or characteristics, aside from the technical know-how, that you look for in an employee?*

M: In SpaceX, we're obviously trying to advance the state of rocket technology with the ultimate goal of establishing a self-sustaining civilization on Mars. In order to do that, we've got to hire people who are going to be really good at coming up with innovative solutions for all the elements of a rocket. We'll look for evidence of exceptional ability, [for example]. The grades are one assessment, but it's certainly possible for someone to game the system in college and pick the right classes and get a 4.0 and neglect everything else. So grades are one element that could suggest exceptional ability, but often more important is what someone has done in international competitions. If someone won a national science fair or created some amazing bit of electronics or software as a teenager, something like that shows initiative, innovation and exceptional technical capability. That's what I'm looking for on the engineering side.

L: *What advice would you offer physics-educated professionals and early career physicists who are thinking of leaving physics for entrepreneurship?*

M: [Think about] what is the thing that you want to do that you'll find fulfilling and is really useful to others, and then guide your life in that direction. In physics itself, there are only a relatively small number of people needed to advance the state of the art, particularly if it's contingent on completion of some large technical project, like the LHC. But even if someone has no intention of ultimately being a physicist, I still believe that the training of physics is excellent. So as they're going through their academic career I would recommend studying physics as a good base and then a broad range of engineering courses and then some degree of specialization in an engineering field where it fulfills someone's interest, and then arts and sciences courses, particularly history. And a few business courses are helpful so you at least know the terminology. You can probably do it with one accounting course, [although] I hate accounting. It's worth it to have some business courses but you don't need too many. And I wouldn't recommend an MBA. I'd say no MBA needed. An MBA is a bad idea.

L: *Why?*

M: It teaches people all sorts of wrong things.

L: *What do you mean?*

M: They don't teach people to think in MBA schools. And the top MBA schools are the worst. Because they actually teach people that you must be special, and it causes people to close down their feedback loop and not rigorously examine when they are wrong.

L: *But you must hire MBAs, right?*

M: I hire people *in spite of* an MBA, not because of one. If you look at the senior managers of my companies, you'll see very few MBAs there.

L: *Interesting. If you were sitting on an airplane and we were living in a vacuum and somebody said oh hi, what do you do? What would be your answer?*

M: I do engineering. I do aerospace engineering and automotive engineering. Most of my time is spent doing that**.**

L: *How much time do you spend on engineering problems as opposed to dealing with the business side of things?*

M: Most of my week [60%] is spent in engineering meetings with my teams. I have meetings with all the technical teams at Tesla and Space X every week. The last few months I have had to spend proportionally more time on some business activities, re-engineering the service and sales process at Tesla. Not my top favorite thing to do, but it needed to be done.

L: *Do you share technologies between the companies?*

M: We're trying to do more of that over time because otherwise it shouldn't all just flow through me. It's quite helpful to have the synthesis of rocket technology and automotive technology because I see things that people who are just in one of those industries don't see.

L: *Can you give me an example?*

M: Cars are really primitive, from a structural standpoint compared to rockets, because in order for a rocket to get to orbit you have to be incredibly mass efficient, so the first stage of our rocket is 95% propellant by mass fraction. That means only 5% of the first stage is engines, electronics, wiring, airframe, and everything else. Which is really a ludicrously low number. So I'm used to extreme mass optimization in the rocket arena, and then you look at most cars: Cars have all sorts of mass in places that don't do any good and often not enough in places that are important, and almost all cars are made of not very advanced steel. The Model S is the only all-aluminum car made in North America. Since it has a very heavy battery pack, we have to offset that mass with a much lighter rest-of-car. So in order for the Model S to get the range it has, we had to conserve non-pack mass and that meant going to an all-aluminum body and chassis. There's a lot more we can do on the Model S in terms of mass optimization but it was necessary to still be at a mass at the end of the day that's the same as a gasoline sedan even though you have this heavy battery pack.

L: *When do you think "ordinary" people will be able to afford space travel in the same way we go on cruises, for example?*

M: It depends on where in space [you're talking about]. If [it's] where the atmosphere is thin, that's actually relatively easy, because you just punt up and pull down and that's a 5-minute ride. If you want to go to an orbit, that's two orders of magnitude greater energy requirement and then you've got to weed off that energy on the way back, so that's a lot harder. I can see orbital travel ultimately getting to…maybe 100-200 thousand…and then the holy grail is to try to get the cost of going to Mars to under a half a million dollars. That's the critical economic activation energy needed to have a self-sustaining civilization on Mars.

A final comment: A lot of people in physics are concerned about expenditures on manned space flight because they are not sure what's the point. Generally I would agree: if we were just going to bounce around in low Earth orbit, it's questionable whether it's worth the expense. However, if one considers the objective to become a space-faring civilization and a multi-planet species, I think that physicists should support that because it increases the probable lifespan of humanity dramatically, and dramatically increases the scope and scale of civilization, which in turn is what will lead to greater enlightenment in physics and other arenas.

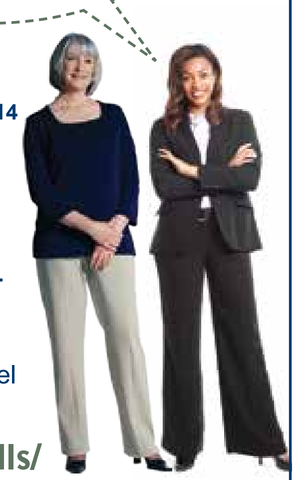
L: *Will physicists inherit the world?*

M: (Laughs) Absolutely.

Alaina G. Levine is a science writer and President of Quantum Success Solutions, a science career and professional development consulting enterprise. Her new book on networking strategies for scientists and engineers will be published by Wiley in 2014. She can be contacted through www.alainalevine.com or via twitter @AlainaGLevine.

ANNOUNCEMENT

Professional Skills Development Workshops for Women Physicists



"Improve your negotiation skills and learn to communicate your great ideas to colleagues."

March 2, 2014, Denver, CO
Application Deadline: December 6, 2013

April 4, 2014, Savannah, GA
Application Deadline: January 3, 2014

Who may apply: Women postdoctoral associates and women faculty in physics. Each workshop will have one session aimed at postdocs and one session aimed at women faculty.

First consideration will be given to applications received by the deadlines. Workshops will be limited in size for optimal benefits. Women of color are strongly encouraged to apply.

Participants are eligible to receive a stipend to help cover the cost of travel and up to two nights lodging.

Details: /www.aps.org/programs/women/workshops/skills/

SHUTDOWN continued from page 1

Defense Advanced Research Projects Agency stayed active as it was funded through multi-year grants. NIST and the National Institutes of Health closed down.

Before the shutdown ended, APS President Michael Turner told the Senate Committee on Commerce, Science and Transportation that these disruptions in research could hurt the US's global standing in science.

"[W]hile the game of political 'chicken' inside the Beltway drags on, the very basis of our economy's competitiveness is slowly being eroded," Turner said in his statement. "It is only a matter of time before our global lead in the sciences is irreparably harmed."

Past shutdowns offer some insight as to what problems different institutions faced. Since 1976, there have been seventeen "spending gaps," most lasting a week or less. The most recent, and longest, lasted 21 days, stretching from December of 1995 into early January 1996.

In that shutdown, National Science Foundation headquarters was almost completely empty, save for the Director, Neal Lane, a few other political appointees and security guards. Proposal reviews came to an abrupt halt, and new grants stopped being issued.

"The impact on the researchers on campus was not immediate," Lane said. "So long as there was money already there, their work could continue…had it lasted longer, the impact would have been more severe."

Siegfried Hecker was in charge of Los Alamos at that time. He said that for them, the shutdown was "essentially a non-event." However, when a budget was finally passed, the lab faced significant cuts late in the year and was forced to let about 1,200 people go.

"The issue was not so much the government shutdown, but really a budgetary process that had gone haywire," Hecker said.

Matt Hourihan, director of the AAAS's R&D Budget and Policy Program, echoed Hecker's sentiments. He said that though not everything is comparable to 17 years ago, researchers are again facing deep cuts to science spending. Sequestration has already reduced discretionary spending by about eight percent, and it's unclear if the current budget standoff will result in more cuts.

"Science is inherently a long-term activity, so a pause is not necessarily the end of the world," Hourihan said. "The bigger point of concern for me at least…is the fact that the shutdown is a symptom of a bigger problem."

Federal spending on science has been nearly flat since 2010 as a percent of total discretionary spending and down in actual adjusted dollars. Experts worry that this decline will likely continue. Congress has not passed a budget since 2009, and it seems unlikely to dramatically change course on science spending in the near future.

"[The shutdown] was a big disruption, but it's not the real long-term threat to competitiveness the same way a restricted budget environment is," Hourihan said.

The Back Page

At Los Alamos: Learning to Love the Bomb

By Jeremy Bernstein

After I got my PhD from Harvard in 1955, I needed a job and a friend made a suggestion: on the campus there was a relatively modest cyclotron, simple enough for graduate students to operate. There was a position open for a "house theorist." My friend recommended me and I got the job, but after two years my appointment was over and I had to look for a new job. I applied to the Institute for Advanced Study of Princeton and was accepted for autumn 1957. This left the summer.

The Livermore and Los Alamos weapons laboratories were actively recruiting. Ken Bainbridge, chair of the Harvard physics department, called me into his office and asked if I would like a summer job at Los Alamos. He said he would recommend me. Los Alamos for me had an almost mystic quality–and some extra money would come in handy when I got to Princeton. I spoke to a Los Alamos recruiter, who told me that I could have the job if I was able to get the relevant security clearance. In 1947 the Atomic Energy Commission introduced a Personnel Security Questionnaire to determine levels of clearance. The levels were "P," then "S," then "Q." A person with Q clearance was entitled to information about nuclear weapons on a "need to know" basis. I had to supply the FBI with a list of everywhere I'd lived for the last ten years. I was rather worried about a great-aunt, who was a subscriber to the *Daily Worker* and spoke in dark tones about the "bosses." Either they overlooked her or decided she was harmless because I got my clearance.

I arrived at the guard station at Los Alamos and was fitted out with credentials. I discovered that I was sharing an office with Ken Johnson, whom I had known since graduate school. It soon became clear that no one had any work for us, so we were free to do whatever we wanted. I had come with a problem of how to determine the parity of the pi zero using aspects of its two photon decay. I was stuck on the mathematics, so we decided to do it together. Ken was a great mathematician and he proved results with a high degree of generality. We wrote a paper and submitted it to Carson Mark, the director of the theoretical division, to see if we could publish it with a Los Alamos imprimatur. Mark was pleased: he wanted Los Alamos to have a reputation as something other than a bomb factory.

Of course, it was a bomb factory. Los Alamos and Livermore were churning out designs for devices small enough to fit into intercontinental missiles. These were being tested above ground in Nevada in a series that was called Operation Plumbbob. We used to have afternoon tea–something Oppenheimer had introduced during the war–and I'm sure that most of the people who attended were working on weapons.

Francis Low was a consultant to the controlled nuclear fusion program. I had met him briefly when he'd been a visiting professor at MIT; after the summer he was returning there permanently. He was a hero of mine. He and Murray Gell-Mann had made a study of quantum electrodynamics at short distances that introduced techniques which are still basic to quantum field theory. In the middle of August, Francis announced he was going to be away watching bomb tests in Nevada. Surprised, I asked if he had been working on weapons. He said no but that Carson Mark had invited him to observe a test. I asked if there was any chance I could go too. Francis said I would have to ask Carson, who told me I could come along provided I paid my way. On the morning of 30 August the three of us took off from the small airstrip at Los Alamos on a commuter flight to Albuquerque.

I was about to enter the "need to know" world. I decided that under no circumstances would I ask any questions. I had no legitimate need to know. I had no idea of our itinerary. I knew that we would have to get from Las Vegas to Mercury, Nevada, the location of the test site, some 65 miles north-west of Las Vegas. That nuclear weapons were being exploded above ground–dumping thousands of kilocuries of radiation into the atmosphere–so close to a major city shows the craziness of the time. After we landed at Las Vegas and were met by a small delegation of Los Alamos people in a government car, a casino was our first stop.

The casino must have had a lot of business from people at the test site because there was a light that was turned on if the test scheduled for the next morning was on. The light came on, and we drove to Mercury for a few hours' sleep. The tests were scheduled for 5.30 a.m. That morning

The Bomb

a device called Smoky was to be tested. Carson explained that it was a Livermore device. You could tell because they named their devices after mountains; Los Alamos devices were named after scientists. Galileo was in a tower being readied for a test in two days. We went to a concrete bunker to await the explosion. I was given some very dark glass to put over my own glasses. Even the reflection from the bunker walls could damage your eyes. I don't know how far away from the explosion we were but we were close enough to see the 700-foot tower that had the bomb on top of it.

"The horizon in front of me was in turmoil. In the center was a livid red-orange cloud."

A loudspeaker counted out the minutes until the explosion and then counted down the last sixty seconds. I had turned my back and covered my eyes with the dark glass but the bright flash still made me shut them. I counted to ten and then turned round.

The horizon in front of me was in turmoil. In the center was a livid red-orange cloud. The hugeness of it was what impressed me. I had had no idea of the sheer scale of a nuclear explosion. I felt a sharp and slightly painful click in my ears. This was the supersonic shock wave. Then came the sound: a sort of rolling thunder. The cloud had turned purple and black and hung in the air like a radioactive cobra about to strike. There was talk of taking cover, but it didn't move in our direction. I stood there mute. We went back to the dormitory to get a little more sleep.

Sometime around mid-morning we drove with Carson to the 500-foot tower where the next device, the Los Alamos Galileo, was going to be exploded. On the way there were spots in the desert where the sand had fused into glass. Signs were posted warning of high radioactivity from previous tests. We got to the base of the tower. You could ride most of the way to the top in an open elevator. From that point on there was only a rickety steel ladder. The desert looked a long way down. I had a moment of panic but then it occurred to me that at the top of the ladder there was a nuclear device with a yield comparable to the bomb that flattened Hiroshima. And I was worried about climbing a ladder?

The top was a flat space with just about enough room for Galileo and its attendants. It was a big device with various wires coming out and looked more like a diving bell than a bomb. There was a clicking noise from a vacuum pump. I had no idea why it was there and didn't ask. Carson spoke to the crew and we went back down the elevator. Carson then drove to a concrete blockhouse at the far edge of the site.

He walked in without knocking or ringing and we followed. Neatly arranged on shelves were the plutonium pits of a considerable number of atomic bombs, probably enough to destroy many cities. I stepped back towards the door. I had read enough about Hiroshima and Nagasaki to know what I was looking at. Carson picked up one of the pits, handed it to me, and told me not to drop it. It was warm to the touch–alpha particles–and about the size and weight of a bowling ball. I didn't know enough to ask the obvious question: why was it so light? A solid sphere of plutonium this size would have weighed a couple of hundred pounds. I'm sure that had I asked I wouldn't have got an answer. Even asking would have been viewed unfavorably. It was then that I noticed her.

At the other end of the building there was a large workbench where a man was filing something that looked to me like white putty. I had read enough to know that what looked like white putty was a high explosive which was going to be attached to the pit to cause the implosion of the plutonium sphere. Next to him a woman was knitting a green sweater. I don't mean to sound pretentious, but I at once thought of Eliot's "This is the way the world ends." What was she doing there? I didn't dare ask.

The next morning Galileo was tested. I now knew what to expect but was still overwhelmed. Then we returned to Los Alamos. None of us talked about the tests. Somehow I felt the experience had made me part of the secret world. If you like, I had learned to love the bomb.

Over the next years I came to realize how foolish I had been. The Plumbbob series, to which Smoky and Galileo belonged, were the biggest and longest series of tests ever done in the continental United States, 29 in all. The highest explosive yield was Hood, the test that took place on 5 July –the equivalent of 74 kilotons of TNT. The Nagasaki bomb was about 20 kilotons. Smoky was the second highest, with 44 kilotons equivalent. The series, during which the total yield was about 306 kilotons–something like a tenth of the yield of one hydrogen bomb–released about 58,300 kilocuries of radioiodine into the atmosphere. This fallout was distributed all over the United States and is estimated to have caused about 32,000 cases of thyroid cancer. Twelve hundred pigs were exposed to the explosions in blast-effect studies, and 18,000 servicemen also participated. Roughly 1200 watched the Smoky explosion from a distance of about 13 kilometers. A unit was flown to ground zero some 15 minutes later. They declared that it was safe to occupy so the rest were flown in twenty minutes after the explosion. The exercise was completed at 9:45 a.m. Some of these men later contracted leukemia.

The plutonium pit I was given to hold was so light because it was hollow. The weapons being tested that summer were "boosted": deuterium and tritium gas were injected into the cavity just before the explosion. I believe the vacuum pump I heard when we visited Galileo was connected to this. When the pit is imploded, and the density is increased enough to reach a supercritical mass, the fission chain reaction begins. When about 1 percent of the plutonium has been fissioned, the temperature is raised to the point where the fusion reactions of the deuterium and tritium take place. These produce a blast of very high-energy neutrons which boost the subsequent fission efficiency. That is what accounted for the large yields in some of the bombs tested that summer. There is no end to the ingenuity that was being applied to weapons design.

The last above-ground test by the United States took place in 1962, and the last above-ground test anywhere was conducted by China in 1980. This is certainly a good thing. But I have only one misgiving. No one has seen a nuclear explosion in more than thirty years and the number of people who have ever seen one is dwindling. For most people, nuclear weapons are an abstraction. Perhaps there should be one more explosion in the desert of Nevada to remind us.

Jeremy Bernstein is a physicist and author. He was for thirty five years a staff writer for The New Yorker *and now writes frequently for* the New York Review of Books.

This article is excerpted from "At Los Alamos: Learning to Love the Bomb" by Jeremy Bernstein, available from Now and Then at nowandthenreader.com. The unabridged version appeared originally in the December 20, 2012 issue of the London Review of Books (see www.lrb.co.uk).

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