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Happy 60th, CERN
pp. 4 and 8

Laura Greene Elected Vice President of APS for 2015

The APS general election has ended and the results are in: Laura Greene of the University of Illinois at Urbana-Champaign has been elected Vice President. She will serve one year as Vice President and then one year as President-Elect before serving as President of the Society in 2017.

Greene, a condensed matter physicist, has served on a number of APS boards and committees, including the Executive Board, Council, the Committee on Committees, the Nominating Committee, the Fellowship Committee and several prize committees; also, she helped found the APS Committee on Informing the Public and the Forum on Outreach and Engaging the Public. She is currently chair of the Division of Materials Physics. She has also served on numerous other governing bodies, including the Sloan Fellowship Selection Committee for Physics, the Condensed Matter Physics Grant Selection Committee of the Natural Sciences, and the Engineering Research Council of Canada. Most recently, she was elected to the board of directors of

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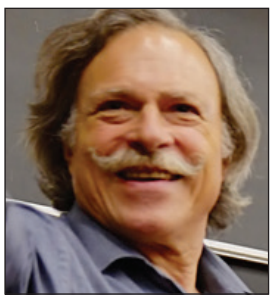
Laura Greene



Paul Chaikin

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Gail McLaughlin

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US Physics Olympians Bring Home Gold and Silver

By Michael Lucibella

The United States tied with four other nations to place fifth overall at this year's International Physics Olympiad. China, South Korea, and Taiwan tied for first place, with Thailand placing fourth overall. The national rankings are unofficial standings, and reflect the number of gold, silver, and bronze medals students on each team received in different categories.

Since 1967, the Olympiad has been an annual competition for high school students from around the world. The students vie to answer a series of theoretical and experimental physics questions. This year eighty-six nations sent "traveling teams" of five students for the June 13-21 competition in Astana, the capital of Kazakhstan.

The US traveling team was made up of Calvin Huang, Vikram Sundar, Kevin Fei, Mike Winer, and Alex Bourzutschky. They were selected from the full US team of nineteen that trained at the University of Maryland and the George Washington University earlier this summer. Huang, Sundar and Fei each won gold medals, and Winer and Bourzutschky won silver.

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Paul Stanley

The US International Physics Olympiad team. L to R: Paul Stanley, Calvin Huang, Alexander Bourzutschky, Vikram Sundar, Kevin Fei, Michael Winer, David Fallest.

Sao Paulo–Backbone of Brazilian Science

By Michael Lucibella

The eyes of the world were on Brazil as soccer teams from around the globe vied for the coveted World Cup. The very first game was played in São Paulo, the capital city of the state of São Paulo and the scientific capital of not only Brazil, but South America as well.

Of Brazil's 27 states, São Paulo is by far the most populous and industrialized, and it contributes far more to the economy than any other state. Home to 43 million people, roughly 22 percent of the country's total population, its economic output is fully a third of the country's GDP. "It's kind of like California," said Carlos Henrique de Brito Cruz, head of the top science funding agency of São Paulo.

In addition, São Paolo leads the country in science. The amount the state spends on research is nearly three times that of all the other Brazilian states combined. About 45 percent of all PhDs awarded in Brazil are in São Paulo, and more scientific articles are written in that state alone than in any other country in Latin America.

The biggest driver behind the research focus is the São Paulo Research Foundation (FAPESP). Founded in 1962, it's been the backbone of Brazilian science funding for more than half a century. The state's constitution sets aside one percent of all revenue towards research funding, to be administered by FAPESP. Brito Cruz said that having this requirement kept funding consistent and predictable, letting scientists plan for the future, and he added, "Research is one of the things that require medium and long term plans."

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São Paulo City, capital of São Paulo State, which leads the country in funding for science and number of science PhDs awarded.

It's a model that has started to be mirrored elsewhere in the country as well. After the fall of the military government in 1985, Brazil went through a re-democratization process, and around 1989 a number of states redrafted their constitutions. "When these states rewrote their state constitutions, they copied the part about funding agencies," Brito Cruz said.

But it will take time for them to catch up. São Paulo is currently home to 19 state and three federal research institutions, including the Brazilian Synchrotron Light Laboratory, which gets a planned upgrading soon.

The Brazilian economy as a whole has been maturing and stabilizing over the last two decades. Economists frequently cite it along with China, India and Russia as growing global economic powers. Brito Cruz noted that the "stabilization of the Brazilian economy in 1994 allowed the government budget to be more predictable and more rational…. With the control of inflation, federal and state budgets were able to improve their planning."

A contributing driver to this economic growth was the federal

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APS-Funded Outreach Groups to Unveil New Projects

Earlier this year, APS funded seven outreach groups through its Outreach Mini-Grants program. The teams have been hard at work, and, in the coming months, most projects should have their public debut. "It's a program where APS gives small grants up to ten thousand dollars to APS members interested in starting their own outreach programs," said Becky Thompson, the head of outreach at APS. "We want to make sure that APS members are involved in public outreach. It's important for scientists to engage the public."

Of the seven, six new groups received funding for projects ranging from nuclear science video games to gravitational wave classroom activities and a condensed matter film. One group originally selected last year to develop a cosmic ray smartphone app received an extension. "We want to make sure we are reaching a variety of audiences," Thompson said. "We're looking for things that have high impact, can reach a lot of people, or can reach fewer people on a very deep level."

The program first started in 2010 in conjunction with LaserFest, the celebration commemorating the 50th anniversary of the laser. That year 38 grants were awarded with support from the National Science Foundation (NSF), SPIE, and the Richard Lounsbery Foundation. Since then 25 additional grants have been awarded by APS.

This year the NSF awarded APS a new grant to help continue and broaden the program. "We got a grant for $200,000 over three years from NSF to expand the program,"

OUTREACH continued on page 7

Members in the Media

"When we just looked at the times–the boring question, basically–for some special problems, D-Wave was 10 times faster…. For other problems, D-Wave was 100 times slower."

***Matthias Troyer**, ETH Zürich, on his research testing the quantum computing claims of the D-Wave company,* The Washington Post*, June 19, 2014.*

"I said, the challenge is to do it without learning anything, and they said, what about what we call zero-knowledge proofs?... Personally, I just find it's a fascinating and counterintuitive statement, that I can prove something is true without revealing why something is true."

***Alexander Glaser**, Princeton University, on conceptually designing tests to look inside nuclear weapons without revealing their secret technology,* Los Angeles Times*, June 26, 2014.*

"When the driving force was resonant with the [atom] cloud's oscillation frequency, we achieved a sensitivity that is consistent with theoretical predictions and only a factor of four above the Standard Quantum Limit, the most sensitive measurement that can be made."

***Dan Stamper-Kurn**, University of California, Berkeley,* NBCNews.com*, July 1, 2014.*

"All we see is a blob in the sky, and inside this blob there is all sorts of stuff–various types of objects–that could be the source…. Now we know where to look."

***Gordon Thomson**, The University of Utah, on discovering a hotspot of cosmic rays in the sky,* The Christian Science Monitor*, July 9, 2014.*

"We can't know everything. We can't even know what 'everything' is or means. If there is a final truth out there, it's beyond us. Science works under strict boundaries, and as hard as we may try, we can't go beyond them. To know all answers, we need to start by knowing all questions. And that is simply impossible. Our view of the world will always be incomplete."

***Marcelo Gleiser**, Dartmouth College,* The Washington Post*, July 14, 2014.*

"It was more an afterthought than something central to the mission, but once they released the photos–it was part of the dawning of the environmental movement."

***Enrique Gomez**, Western Carolina University, on getting NASA to release the Apollo-era photos for public consumption,* USA Today*, July 18, 2014.*

"They have really done something very special.… It's been very enabling of our research and that's not a statement about dollars, that's a statement about community."

***Charles M. Marcus**, University of Copenhagen, on Microsoft underwriting research into quantum computing,* The New York Times*, June 23, 2014.*

"The overarching theme here is that, out there at the frontiers of discovery, it's very foggy."

***Michael Turner**, The University of Chicago, on the controversy surrounding the BICEP2 results*, The Washington Post*, July 23, 2014.*

"If this kind of thing happened all the time, it would give us a bad name."

***Katherine Freese**, University of Michigan, on the controversy surrounding the BICEP2 results,* The Washington Post*, July 23, 2014.*

"It's about finding a way to control that bridge between the nanoparticles.… This level of control opens up a wide range of potential practical applications."

***Ventsislav Valev**, Cambridge University, on using metamaterials to create a cloaking device,* CBSNews.com*, July 29, 2014.*

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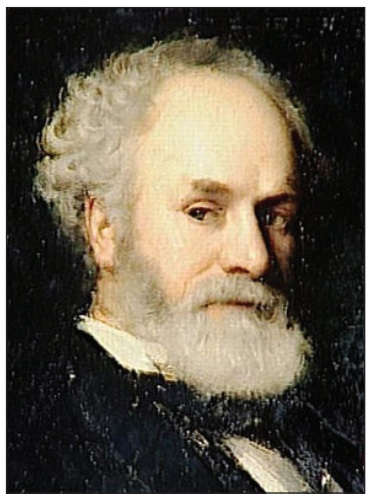
This Month in Physics History

August 18 and October 20, 1868: Discovery of Helium

Despite being the second most abundant element in the observable universe, helium is relatively rare on Earth, the product of the radioactive decay of elements like uranium. In fact, it is so rare that helium was discovered only in 1868, thanks to the efforts of two scientists in particular, one in England, and the other in France.

In 1859, Gustav Kirchoff realized it was possible to deduce the chemical composition of the sun and other stars by analyzing the spectra of the light they emit. Kirchoff used this method to discover cesium and rubidium. Astronomers were particularly interested in studying solar prominences: colorful flame-like bursts now known to be hot clouds of dense gas. The best way to make such observations, scientists believed, was during a solar eclipse.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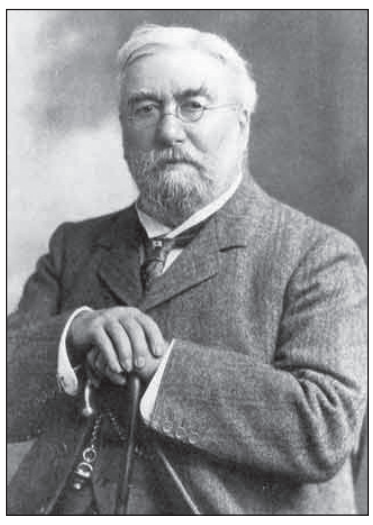
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Pierre Janssen (top) and Joseph Norman Lockyer (bottom), discovers of helium.

Born in Paris, Pierre Janssen suffered an accident as a child that left him permanently lame. He studied mathematics and physics at the University of Paris, eventually becoming a professor of architecture there in 1865. But his interests extended far beyond that specialty, and he found himself involved in numerous scientific expeditions relating to astronomy and geophysics. For instance, he traveled to Peru to study the magnetic equator, and to Italy and Switzerland to study the solar spectrum.

In 1868, Janssen traveled to Guntur, India, to observe the solar eclipse. He focused on the solar prominences and concluded they mostly comprise hydrogen gas, heated to extremely high temperatures. But on August 18, when he observed the sun's spectrum through his spectroscope, he noticed that the wavelength of the yellow line supposedly indicating the presence of sodium didn't actually match up to the wavelength for that element. In fact, it didn't match the wavelength of any known element to date. The line was bright enough, he thought, that it should be visible even without the aid of an eclipse, provided a means could be found to filter out all but that wavelength of visible light. That is how he came to invent the spectrohelioscope to better analyze the sun's spectrum.

Some 5,000 miles away, on October 20, 1868, the English astronomer Joseph Norman Lockyer also succeeded in observing the solar prominences in broad daylight. His paper detailing those observations arrived at the French Academy of Sciences on the same day as Janssen's paper, so both men received credit for the discovery of helium.

Initially it was a dubious honor: Many colleagues doubted this could be a new element and ridiculed their conclusions. Others thought helium could exist only in the sun. In 1882, the Italian physicist Luigi Palmieri was analyzing lava from Mount Vesuvius when he noticed that same telltale yellow spectral line in his data–the first indication of helium on Earth. It would be another 12 years before the Scottish chemist William Ramsey found further experimental evidence of this new element.

The son of a civil engineer and nephew of a well-known Scottish geologist, Ramsey earned his doctorate at the University of Tübingen in Germany and eventually joined the faculty of University College London, publishing several papers on nitrogen oxides. In 1894, inspired by a lecture by Lord Rayleigh, Ramsey successfully isolated a new gas with no chemical reactivity–the first inert gas, which he dubbed argon, after the Greek word for "lazy." Subsequently he discovered additional inert gases: neon, krypton, and xenon, eventually garnering the 1904 Nobel Prize in chemistry for his accomplishments.

In 1895, Ramsey was studying a chunk of uranium ore (cleveite), which he treated with mineral acids. He was hoping to isolate argon by separating nitrogen and oxygen from the sample with sulfuric acid. Instead, he noted the presence of an unusual gas locked inside the specimen–appearing in a spectroscope as a "glorious yellow effulgence," according to Lockyer, to whom Ramsey had sent his sample for verification. Its spectrum matched that of the proposed new element observed in the sun's chromosphere.

After running tests to ensure that the line was indeed a new element, as opposed to a new form of hydrogen, Ramsey's work appeared in the *Proceedings of the Royal Society of London* later that year, and Swedish chemists Per Teodor Cleve and Abraham Langlet successfully isolated the gas from cleveite. Lockyer dubbed the new element helium, after the Greek word for the sun (*helios*).

Janssen, meanwhile, did not remain idle in the years following his seminal observations. He traveled all over the world to witness more solar eclipses in 1870, 1875, 1883 and 1905. For the 1870 eclipse in Algiers, he escaped Paris–then under siege at the height of the Franco-Prussian War–in a hot-air bal-

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Trial Balloon on Helium Purchasing Plan Launched

By Michael Lucibella

APS is partnering with the American Chemical Society (ACS) and the U.S. Department of Defense (DoD) procurement agency to secure lower helium prices for researchers. The three groups are working on setting up a group-purchasing plan for scientists with federal grants so scientists can pool their market influence.

"Academic users don't have any real purchasing power when it comes to liquid helium," said Mark Elsesser, a policy analyst at APS. "The idea is to pool the academic users…and have an agency broker the helium on their behalf."

Helium is an important component in many experiments, and in liquid form is often used to chill experiments to near absolute zero temperatures. However, recent federal action will cause helium prices to climb significantly. To help protect scientists at small labs, APS and ACS are partnering with the Defense Logistics Agency (DLA), the organization that procures weapons, repair parts, and other supplies for DoD.

"It turns out that they have the rights and abilities to procure supplies for anybody with a federal contract," Elsesser said.

DLA already buys enough helium for DoD to compete with industry in negotiating low helium prices. Once the full program is up and running, scientists with a federal contract or grant can sign up to buy helium from DLA for lower rates than would be otherwise available to them on their own.

Altogether, scientists use only about two to three percent of the helium consumed in the United States annually, while most of it goes for industrial manufacturing and MRI machines. Big scientific institutions like Fermilab or Brookhaven have the large purchasing power to negotiate competitive rates from helium suppliers, but smaller institutions don't wield the same influence.

"The people who are most vulnerable are the bench-top scientists who have one or two helium cryostats," said Moses Chan, a low-temperature researcher at Penn State University. "Those are the people who sometimes have to pay the very, very high prices."

The consortium is in the process of organizing a small yearlong pilot program with DLA that is likely to include about 10 to 15 academic groups. The idea is to get a diverse lineup of users to see which researchers DLA can best serve.

"It's going to be a new program, a new trial, so there could be some growing pains," Elsesser said. "The program is not going to be for everybody."

The Bureau of Land Management (BLM), which oversees the US helium reserve, has supplied 40 percent of domestic helium for years. Because of legislation passed in 1996, it has been selling its supply at below-market rates, which helped cause a helium shortage over the last couple of years.

Legislation passed last year allowed BLM to sell its supply at rates in line with the market. This helped correct many of the shortages, but over the long term, helium costs will continue to rise.

The group-purchasing program would complement the existing program that lets federally funded scientists buy discounted helium from commercial suppliers that buy from BLM. Scientists in the program complained about the paperwork involved, and also said that deliveries were sometimes unreliable and that costs kept creeping higher. The new group-purchasing program is meant to open up another avenue for federally funded researchers to buy discounted helium, one with more stringent supply line and cost controls.

The consortium is just beginning its search for users, and hopes to have groups chosen for the pilot program by the beginning of next year, with shipments starting a few months after that. If all goes well, the full program should come online sometime in 2016.

Elsesser is accepting applications from those interested in participating in the pilot program until September 12 and plans to select the initial group by October. If all goes according to plan, the first helium deliveries from DLA should begin in May of next year.

Researchers interested in applying to participate in the program should contact Mark Elsesser (elsesser@aps.org). More details can be found on the program's website (http://www.aps.org/policy/issues/energy/helium/purchaseprogram.cfm.)

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loon. He also witnessed the transit of Venus in Japan in 1874, and again in Algeria in 1882, with the aim of capturing on film the exact moment when the transit began. He invented an instrument called the clockwork revolver to do so, capable of taking a series of 48 exposures in 72 seconds using the daguerreotype photographic process. The resulting images were sufficiently good to encourage other astronomers to adopt his method for future transits.

In 1893, he constructed an observatory on Mount Blanc, rightly determining that one could gain a considerable advantage at higher altitudes, where the atmosphere was thinner. By then 69, he nonetheless made the climb and spent several days making observations. He even made two cameo appearances in early films by the famed Lumière brothers. Janssen died on December 23, 1907, just three years after his more than 6000 solar photographs were collected and published in the *Atlas de Photographies Solaires.*

Profiles In Versatility

Biometrics as a pathway to human rights

By Alaina G. Levine

For as long as he can remember, Joseph Atick knew what he desired to do with his life. "I wanted to harness nature in the service of mankind," he says. Physics and mathematics provided an elegant solution, because "there is something about the rigor of math that connects you with reality, and I wasn't interested in being separate from reality. In physics, there is no room for fudging. It's as platonic as it can be."

Atick is one of the foremost authorities in biometrics, the use of computer technology to identify individuals. He has spent his career studying the brain and how we see, motivated by a childhood mishap that injured his eyesight. Considered a pioneer in facial recognition and identity technologies, today he concentrates on the appropriate and fair application of his technological breakthroughs through public policy and diplomacy consulting. He circumnavigates the globe on behalf of the World Bank and the United Nations to collaborate with governments to ensure that identification systems are adopted in such a way that they safeguard individual human rights and privacy.

Atick pursued his purpose early. At the age of eight, he established a small laboratory under the family house where he conducted experiments in Newtonian mechanics. He viewed his ability to be able to predict how inanimate objects behave as a "source of power," he explains. "I was seduced by it and became more interested in explaining nature than playing football." By 15, he had written a textbook on mathematical methods for modern physics. And at 16, he audaciously called the chairman of the Stanford University physics department and asked if he could be admitted as a graduate student, despite the fact that he had dropped out of high school to learn on his own and had not even attended an undergraduate institution. "I know you may hear from crackpots all the time," he recalls saying. "But please allow me to explain the particulars of my case."

As it turned out, Stanford nuclear physics professor Stanley Hanna already knew about the prodigy and had shared an anecdote about him with the chairman just a few weeks prior to the call. "I was surprised he didn't hang up on me, but Hanna said 'I've heard about you. I know your book. When can you come and meet with me to discuss this?'"

Since Atick didn't have a driver's license or a credit card, he persuaded his mom to do the "favor" of accompanying him to Stanford from Miami, where they were living, so he could meet with faculty and the dean. He was offered a non-degree spot in the graduate program, which he was assured would be converted to a degree-granting opportunity if he could prove himself, both in physics and other subjects that one typically learns as an undergraduate, such as geography, languages, and literature.

For a kid born in Jerusalem who was also a poet, he breezed through the qualifier, taking the top spot amongst his "peers." "It was a relief after the qualifier since there was this recognition that I was in the program fair and square," he notes. He got busy on his thesis, earned a master's at 17, joined the theoretical physics group at SLAC conducting research on particle physics, and under the aegis of Leonard Susskind, was awarded a doctorate in mathematical physics around the time he was finally able to legally imbibe and gamble.

Joseph Atick

The Institute for Advanced Study took note, and recruited Atick to pursue explorations into string theory, but something about the subject was not to his liking. "While I was honored and excited by what was going on there, I felt I was taking one step away from reality," he says. "At Stanford, at least they were smashing things and testing theories, but at Princeton I began to question why we were doing this research. Aren't we supposed to gain insights into nature to help mankind?"

String theory didn't hold the answer, although Atick published quite a few seminal papers on the topic. On the other hand, neuroscience and computational biology, in their nascent stages at the time, not only captured his imagination, but also held the potential to more quickly aid him in his mission. A year after arriving at the Institute, he switched and began working in earnest on what became known later as computational neuroscience. He attracted a lot of attention in his newly adopted field, and soon Atick landed at Rockefeller University, which had invited him to head the computational neuroscience laboratory, an offer he accepted at the tender age of 27. Although he worked closely with the neuroscientists and biologists, his home department was physics.

"The week after I made associate professor, I resigned," he says. "I wanted to reach that level to prove to myself that I could do it," but once he had excelled there, he feared becoming trapped in complacency. However, Rockefeller's president initially wouldn't accept his resignation, and insisted he keep Atick's resignation letter on hold for a year, should he decide to return. "I begged him to shut the door on that opportunity, because I didn't want temptations. I did not want a bridge to the past," he recalls. "And I walked out and founded a company in information theory and the brain."

And that was all it took. From there, Atick's enterprise, which originally focused on how the brain handles patterns, and whose early clients were financial institutions, soon took on a life of its own, as it expanded to pattern recognition of humans. His company, Visionics Corporation, had an "open door policy for hiring physicists," he shares, and was one of the earliest enterprises devoted to facial pattern recognition and biometrics. It went through various mergers and acquisitions and name changes, and when he sold it in 2010, it had reached 1400 employees.

His foray into human population identification management was clearly a commercial success, but Atick had his sights set on something bigger. "Identification is an important part of international development," he says. "Digital identification is necessary for the efficient delivery of government services, and for helping people participate in a modern society and claim their fair share of rights and entitlements without fraud and discrimination."

In certain parts of the world, where borders are porous and virtually invisible, populations move back and forth from one country to another for services and for voting. As a result, economic and election fraud are rampant. "With no real mechanism for accounting for your people, you cannot have a realizable democracy," he implores. In fact, "I would claim that without reliable identification, it is difficult to exercise basic human rights."

Around 40% of the people in the world don't have birth certificates, he says, so biometric technologies that identify a person by iris, face or fingerprints "[become] a clear administrative mechanism for making the delivery of services more efficient and for establishing the uniqueness of individuals." With rigorous digital identification programs in place, entitled services and opportunities can be delivered, such as the ability to apply for government aid, open a bank account, obtain healthcare, receive a passport and vote.

As Chairman and Founder of Identity Counsel International, Atick assists organizations such as the World Bank and the UN with these issues, dividing his

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CERN: 60 Years of Collaboration

By Michael Lucibella

Europe's premier physics lab is turning 60 in September. Its discovery of the Higgs Boson in 2012 was only the most recent highlight of its six-decade history.

At the same time, by bringing together 21 member countries and 7 observer nations, the European Organization for Nuclear Research (CERN) set an example of a successful international collaboration. Other big international physics projects like the International Linear Collider (ILC), the International Thermonuclear Experimental Reactor (ITER), and the Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME) have all borrowed elements of CERN's governing structure. "The governance model is one of the things that really makes CERN work," said James Gillies, Head of Communication for CERN. "There are several more [such collaborations] now, and they've based their models on CERN."

CERN was first conceptualized in the late 1940s as Europe was still recovering from World War II. Fascism and war had depleted most of the continent's resources and many of the top scientists had fled to the United States. "The war had stopped, but it was a continent that had suffered quite a long period of turmoil," Gillies said.

French physicist Louis de Broglie first proposed a multi-national European lab in 1949. After years of lobbying spearheaded by Isador Rabi, a Nobel laureate and the U.S. envoy to UNESCO, 12 European nations

CERN

Flags of member nations at CERN.

came together to sign the convention officially forming CERN in 1954. "The physicists needed CERN to work in order to be able to participate in frontline particle physics–so they felt compelled to make it work," said Christopher Llewellyn Smith, who was director of CERN from 1994 to 1999.

At the time of CERN's founding, the United States was emerging onto the global scene as a major leader in scientific research. European physicists wanted to compete, but no single country could seriously compete with the emerging superpower. "If Europe wanted to do high energy physics, the only way is by having governments collaborating with each other because it's such an expensive field," said John Krige, a historian at Georgia Institute of Technology who specializes in the history of CERN. "Pooling resources is the best way.… That's the only way they're going to be able to afford it."

Being a fundamental physics lab inherently played a big role in pushing competing nations to work together. "The goal is the same, and it's very clear that it is fundamental research," said Maria Spiropulu, a physicist at Caltech and vice-chair of the APS Forum on International Physics. "That alleviates a lot of the conflict…because we're all going towards the same fundamental goal and the same dream."

However, a shared mission alone can't sustain a laboratory for sixty years, and CERN's administration is designed to be somewhat flexible and accommodate the member states' scientists and politicians as much as possible. The ultimate authority for the laboratory rests in CERN's governing council.

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INSIDE THE Beltway

Increased Populism Could Undermine Support for Science

by Michael S. Lubell, APS Director of Public Affairs

Voters are fed up with Washington gridlock. But given their grouchiness, they'd be fed up with Washington even without any gridlock. And that's a problem for scientific research, which depends so heavily on the federal dollar and a public that accepts federal spending as a social good.

A *Washington Post*-ABC News poll released August 5 revealed how contemptuous Americans are of their government and their elected officials. In that survey, 51 percent of the respondents said they were ready to ditch their members of Congress in the November election–a percentage not seen for more than two decades.

Of course, unless their representatives face primary challenges, most voters won't find they have an acceptable alternative, since gerrymandering has rendered meaningful opposition in the general election almost meaningless.

Washington isn't the only institution that's producing public bile. Anything big seems to do the job quite well: from Wall Street's mega profits to business moguls' mega paychecks.

Today at the extremes of both parties, politicians are mouthing a populist mantra. The Tea Party wing of the Republican Party has been at it since 2010. And this June, David Brat, riding the wave of populism, upset House Majority Leader Eric Cantor (R-VA-7th), a Wall Street ally, in the Republican primary, despite being outspent 20 to 1. On his way to a stunning double-digit victory Brat sounded the populist clarion when he told Virginians, "Dollars don't vote. You do."

Among Democrats, Sen. Elizabeth Warren (D-Mass.) has been leading the populist choir ever since she was elected in 2012. Campaigning for Democratic senatorial candidate Natalie Tennant in West Virginia this July, Warren captivated her audience when she said, "Citibank, Goldman Sachs, all those other guys on Wall Street, they've got plenty of folks in the United States Senate willing to work on their side. We need more people…willing to work on the side of America's families."

When opposite sides of the political spectrum start to use the same rhetoric, you know a perfect storm is in the making.

In such an atmosphere, scientists will have to make themselves more publicly accessible and learn to keep their outbreaks of arrogance permanently under wraps. Otherwise, they will run the risk of being written off by an increasingly cranky public. In a tempest of populism, being part of a detached elite is simply not a winning strategy.

Two recent policy debates serve to underscore the depth of anti-Washington sentiment among populist lawmakers, as well as the rift between them and establishment office holders. They are the Highway Trust Fund, which is nearly broke, and the Export-Import Bank, whose charter will expire this September.

The Trust Fund is in trouble principally for two reasons: the 18.4 cents per gallon federal gas tax has not been raised since 1993, and cars have become more fuel-efficient.

Refilling the fund's financial tank is difficult, if not impossible, as long as raising taxes of any kind

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Public Outreach Corner

Welcome to the APS Public Outreach Corner!
The APS Public Outreach department is committed to exciting and engaging the public with physics. In every other issue of *APS News*, we will bring you highlights from APS outreach activities.

Mini-Grant Program
The successful Outreach Mini-Grant program will have more funds to distribute thanks to an NSF award. APS will award grants up to $10,000 to projects designed to engage and excite the general public. In the past, roughly five proposals have been funded annually, but thanks to additional funds provided from NSF we will be able to fund eight to ten proposals in this round. Proposals are due on December 14, 2014. Visit the APS home page (aps.org) in early September for the official Request for Proposals.

Comic-Con
On July 22nd APS Outreach made its fifth trip to Comic-Con International, the world's largest pop culture convention. We spent five days handing out roughly two tons of our popular comic book series, *Spectra*, about a young girl who discovers she's a human laser, and must use her powers to fight the forces of evil. We had many returning fans and booth groupies who were excited to see our newest issue, *Spectra's Quantum Leap*. You can read about the team's Comic-Con adventures on the Physics Buzz blog (physicsbuzz.physicscentral.com) and can read the comics on PhysicsCentral.com.

SpectraSnapp App
We are happy to announce that our popular SpectraSnapp iPhone app will be available for Android phones and tablets on September 1. SpectraSnapp uses a simple phone attachment to turn your camera into a spectrometer. This app has been used by K-12 teachers, lab instructors, and kids to learn about light and spectra. Check back at www.physicscentral.com to get the app.

PhysicsCentral
PhysicsCentral, the APS outreach website with fun physics for every age, passed a milestone this month, hitting over 200,000 "likes" on Facebook. We are excited that our traffic continues to increase, now hitting an average of 100,000 hits a month with over 175,000 pageviews. PhysicsCentral has everything from at-home experiments for kids to a blog enjoyed by the general public and physicists alike. This month's posts included a very popular review of Star Trek technology and how today's technology measures up. It is also home to our comic books, the PhysicsQuest program, and our popular Science off the Sphere video series featuring astronaut Don Pettit. Follow us on Facebook or Twitter and keep up to date on our newest content.

Michael Lucibella

APS Outreach team at the 2015 Comic Con in San Diego.

Diversity Corner

APS Bridge Program Request for Proposals
Information on the 2014 APS Bridge Program (APS-BP) Request for Proposals (RFP) for new Bridge Sites is now available at http://www.apsbridgeprogram.org/institutions/bridge/rfp.cfm

The primary goal of the APS-BP is to increase the number of underrepresented minorities who are awarded PhDs in physics. The deadline for submitting an initial proposal is October 3, 2014. In the 2013-2014 RFP solicitation, we received and reviewed ten initial proposals, and of these, seven advanced to the full proposal submission process. Two of these, California State University, Long Beach and Florida State University, were selected to become Bridge Sites.

A webinar on the APS Bridge Program RFP will be held on September 5 at 12:00 pm ET. Information on registering for the webinar is available at the URL in the first paragraph above.

Update Your Department's Female-Friendly Graduate Program Survey
The Committee on the Status of Women in Physics (CSWP) has facilitated the collection of responses to a series of questions about graduate programs in physics that should be helpful to those interested in assessing the climate for women at various graduate schools. You can find department responses to a short series of questions at: http://www.aps.org/programs/women/female-friendly/index.cfm

All responses are self-reported by department chairs (or their assignees). To update your responses, please contact women@aps.org

How does your institution compare nationally?
APS created an institution comparison site to allow US institutions to see how they compare nationally in terms of producing physics degrees and encouraging diversity among these degrees. Check it out here: http://www.aps.org/programs/education/statistics/compare.cfm

Professional Skills Development Workshop at the DFD Meeting
APS, with support from the National Science Foundation, will host a Professional Skills Development Workshop for Women Physicists at the Division of Fluid Dynamics Meeting in San Francisco, CA, on November 22, 2014. Email women@aps.org for details on workshop registration. For more information on the workshop, please visit: http://www.aps.org/programs/women/workshops/skills/

Climate Site Visits
The APS has had a long-standing interest in improving the climate in physics departments for women and underrepresented minorities. CSWP and the Committee on Minorities both sponsor site visit programs.

For more information on the Climate for Women in Physics Site Visit Program, visit: http://www.aps.org/programs/women/sitevisits/index.cfm

For more information on the Climate for Minorities in Physics Site Visit Program, visit: http://www.aps.org/programs/minorities/sitevisits.cfm

Save the Date for 2015 PhysTEC Conference: Travel Grants Available for MSI Faculty
The Physics Teacher Education Coalition (PhysTEC) Conference is the nation's largest meeting dedicated to physics teacher education. The 2015 PhysTEC Conference will be held February 5-7, 2015 at the Marriott Seattle Waterfront in Seattle, WA. The conference will focus on Thriving Programs and will feature a pre-conference Learning Assistant Workshop on February 5, a post-conference workshop on Building Thriving Programs on February 7-8, and a joint poster session on February 6. Faculty from minority-serving institutions are eligible to apply for travel grants. More information can be found at: www.phystec.org/conferences/2015

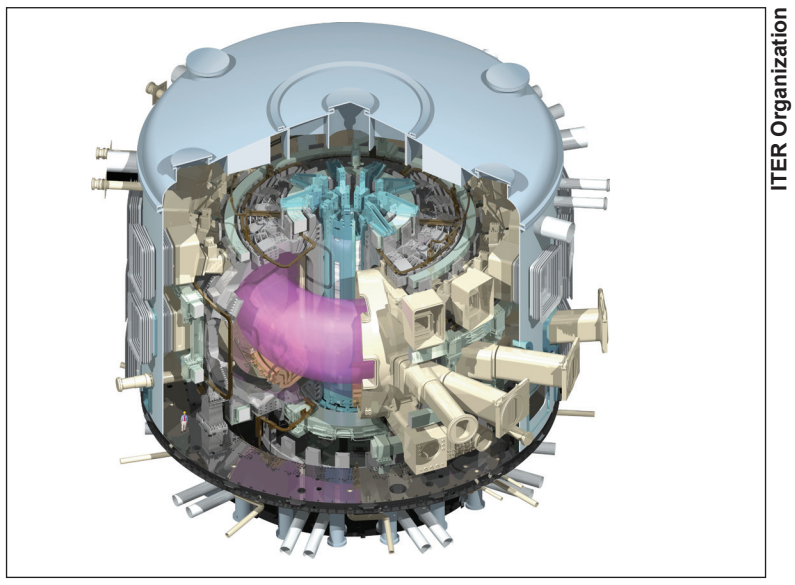
Women and Minority Speakers Lists
APS offers lists of women, minority and physics education research speakers who are available to give talks in departments or to general audiences. If you are looking for a diverse speaker for your colloquium series, we invite you to use our speakers lists at www.aps.org/programs/speakers/. There are also travel grants available to bring minority speakers to physics departments to give talks; for information, visit: www.aps.org/programs/minorities/speakers/travel-grants.cfm

Women and minority physicists can sign up to give talks, or modify their existing listing, at https://www.aps.org/programs/speakers/enroll.cfm

Congress Divided Over Future of U.S. ITER Contributions

By Michael Lucibella

The U.S. Congress is divided over the future of U.S. contributions to the world's largest fusion experiment, the International Thermonuclear Experimental Reactor (ITER), located in the south of France. The Senate Appropriations subcommittee on energy and water development voted on June 17 to zero out funding for the troubled ITER project, while the House passed a version of the same bill that would increase its funding. However the president has threatened to veto the House's bill for other reasons and the Senate has pulled its bill from consideration, leaving the future funding of the U.S. contribution to ITER uncertain.



ITER Organization

Cutaway illustration of the planned ITER tokamak

ITER is building a thirty-meter tall tokamak in Cadarache, France. The aim of the international collaboration is to achieve ignition, the point where more energy is generated by its fusion reactions than is put into running it. The project is a major stepping-stone towards generating clean fusion energy, but it's been troubled for years by serious budget overruns and long delays. According to a recent U.S. General Accounting Office report, the project's completion date is 20 years behind schedule, and the U.S. contribution has swelled by nearly $3 billion.

Senate Appropriations Committee members on both sides of the aisle have long been critical of U.S. contributions to the program. "We've withdrawn funding for the program," said Sen. Lamar Alexander (R-Tenn.). "It hasn't shown the progress it should. An audit by distinguished scientists told us that." In addition, Sen. Dianne Feinstein (D-Calif.) has also been one of the program's harshest critics. The Senate committee attempted to zero out funding for the program last year as well, but it was restored when the House and Senate bills were reconciled.

On the flip side, this year's Energy and Water bill that passed the House on June 10 authorized the Department of Energy (DoE) to contribute $225 million to the project in direct cash and construction of parts. This is $75 million above what the White House asked for in its budget request, and matches the funding level used as a baseline by DoE to project costs. A lower budget would likely increase costs in the long run and further delay the project.

However, the House bill did not give ITER a totally free pass. It included language stipulating the project would receive U.S. funds only after its governing council implements management reforms laid out in an independent internal assessment carried out late last year. These recommendations include reducing the bureaucracy of the project, developing a realistic project schedule, and making the director general more accountable.

Support for ITER in the House also flows from both sides of the aisle. At the July 11 meeting of the House Subcommittee on Energy, both Republicans and Democrats were generally supportive of continuing to fund ITER.

"Fusion holds the promise of providing a practically limitless source of clean energy to the world," said Rep. Eric Swalwell (D-Calif.) "The support of fusion energy research is something that is critical in this day and age."

Representative Lamar Smith (R-Texas) echoed Swalwell's support of the clean energy goals of the project.

"The Obama Administration has chosen to underfund ITER in its fiscal year 2015 request," Smith said. "Depriving the U.S. ITER program of the funds it needs to accomplish its goals is not good policy."

The president said that if presented with the Energy and Water bill in its current form, he would veto it because it does not fund other clean energy technologies like wind and solar. The Senate is unlikely to resubmit its version before the November elections.

APS Bridge Program Annual Conference

By Bushraa Khatib

The APS Bridge Program (APS-BP) held its annual Conference from June 25-27, 2014 at the American Center for Physics in College Park, MD. APS-BP aims to increase the number of underrepresented minority (URM) students who receive PhDs in physics. So far, the program has selected four bridge sites, and recruited two cohorts of students, since securing National Science Foundation funding in 2012.

Ken Cole

Attendees at the APS Bridge Program Conference held in June at the American Center for Physics.

Sixty-eight people attended the Conference, including representatives from APS, the American Institute of Physics, bridge programs, and colleges and universities across the US. Representatives from the newly selected Bridge Sites–California State University Long Beach and Florida State University–as well as currently funded sites–University of South Florida and The Ohio State University–came to the Conference to explore issues and network with recently selected Bridge Fellows.

This year's Conference focused on the role of the master's degree in advancing URMs in physics. Anthony Johnson, University of Maryland Baltimore County, and Edward Helm, Louisiana State University, began the Conference with plenary talks addressing the history of APS involvement in improving diversity in physics and the use of nontraditional variables in graduate admissions processes, respectively.

Theodore Hodapp, Director of APS Education & Diversity and of the Bridge Program, presented an overview of where the Bridge Program currently stands, including student successes, recruiting strategies, lessons learned, and future directions. In the Program's second year, 11 students were placed as Bridge Fellows at APS sites, and four were placed into non-APS bridge programs; an additional 10 underrepresented minority students, from those who initially didn't gain spots in graduate school, are now entering physics graduate programs. Hodapp commented, "The Bridge Program is on the verge of helping erase, in only its second year, the gap in URM participation in graduate education in physics."

In her plenary talk, Sheila Lange, University of Washington, discussed results from an analysis of the Survey of Earned Doctorates that indicates URM students

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the American Association for the Advancement of Science. In her candidate statement, Greene said: "Sustained and increased funding for fundamental and applied research can be engendered by public engagement: As politicians vote supporting their constituents, APS must take a leadership role in promoting that engagement. Our technological challenges for the 21st century exist on a global scale, and enhancing our partnerships with industry and international exchanges will facilitate our tapping into vast, undiscovered, human resources."

Current President-Elect Samuel Aronson of Brookhaven National Laboratory will move up and assume the presidency in January 2015, when current President Malcolm Beasley of Stanford University steps down. At the same time, Homer Neal from the University of Michigan will advance from Vice President to President-Elect.

Paul Chaikin of New York University was elected as the Chair-Elect of the Nominating Committee. He is a condensed matter experimentalist and helped found NYU's Center for Soft Matter Research. He has also served on several APS prize and nominating committees and recently chaired the APS Forum on Outreach and Engaging the Public. In his candidate statement, Chaikin said: "The goals of the APS should be to foster awareness in government, business and society as a whole of the contributions that have and will be made by scientific investigation and discovery, so that both the most daring and fundamental as well as the most useful research will be supported. Further, we should aim to lift the level of analytic and scientific reasoning in the country and its policy makers."

Eliezer Rabinovici, a quantum field theory and string theory researcher from Hebrew University in Jerusalem, was elected to be an International Councilor. He is the Israeli scientific delegate to the CERN council and has worked for twenty years to help build the SESAME synchrotron light source in Jordan. He is also a member of the Scientific Council of the Joint Institute for Nuclear Research, located in Russia, and a former member of the High Energy Physics Board of the European Physical Society. In his candidate statement, Rabinovici said: "Science in general and physics in particular has made significant progress by successfully combining the individual spirit with global collective efforts.… The acquiring of new knowledge and the satisfying of our human curiosity requires both big science and small science. It requires global cooperation while understanding and respecting our national and personal identities."

Gail McLaughlin, a theoretical nuclear physicist at North Carolina State University, was elected to be a General Councilor. She is chair of the Advisory Committee for the Institute for Nuclear Theory, located at the University of Washington in Seattle. She has also served on the APS Program Committee, the Executive Committee and on the Fellowship Committee of the Division of Nuclear Physics and the Nominating Committee for the Division of Astrophysics. In her candidate statement, McLaughlin said: "Support for basic sciences is facing significant challenges, and physicists need to find ways to effectively communicate the excitement of doing science, and the benefits of basic science to the economic well-being of the nation. We have to convey this message to both the public at large, and to policy makers in the federal and state governments."

BIOMETRICS continued from page 3

time between New York, Paris, and lately, Africa.

One of his major successes has been the implementation of a national multi-biometrics system in India, which uses a combination of technologies to "resolve one human out of a billion," he notes.

Today, 95% of his time is spent on policy, because "technology is a commodity now," he says. "I help build strategies for responsible identification management to accelerate national development." Of course, privacy is at the forefront of his mind. "The negative side of any technology always exists, so the very first set of questions I ask when I go into a country is related to their constitution, data security, and respect for human rights," he says. "Putting powerful technology in the hands of dictators is something we never want to do, and as a consequence we go into a country and ensure the appropriate safeguards are in place, in the first place."

The physicist recognizes the double-edge of his biometric innovations. "A knife can be used to harm someone, and yet we need it to eat," he concedes. "I am the first person to call for a ban on biometrics until freedom and liberty are guaranteed. The last thing I want to do is go to my grave thinking that I have enabled a police state instead of liberating people." To further this objective, he co-founded the International Biometrics & Identification Association in 1998, which "promotes effective and appropriate use of technology to determine identity and enhance security, privacy, productivity, and convenience for individuals, organizations, and governments worldwide, including biometrics, one of the technologies playing an increasingly important role in identity management."

"Having been trained as a physicist is an enormous asset," he shares. His scientific mastery provides a critical foundation upon which to advise on technology usage with credibility and "you have the capacity to look at multidimensional problems," of which policy is one example. "If I had to do it again, I would do it exactly the same way–I would start with physics because it arms me with tools that allow me to tackle any problem that comes my way with confidence."

As for the future, Atick is tantalized by where the technology is headed, especially in the age of mobility. We can expect more and varied multi-biometric systems to be employed that identify people by their voice, facial structure, eyeballs, finger- and handprints, and even the maps of their veins, he says, all of which can serve humanity for the better. "My dream is to have a world without borders, and technology can enable that."

Alaina G. Levine is the author of "Networking for Nerds" (Wiley, 2014) and President of Quantum Success Solutions, a science career and professional development consulting enterprise. She can be contacted through www.alainalevine.com, or followed on twitter @AlainaGLevine.

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remains a political non-starter. But every office holder knows how George H.W. Bush and Bill Clinton were skewered when they boosted taxes, particularly after promising not to do so. And both suffered serious political setbacks as a result: Bush lost his White House re-election bid in 1992, and Clinton triggered his party's loss of the House in 1994.

So this time around, Congress did just about what you would expect: It punted, using one-shot budget gimmicks to provide the Trust Fund with a short-term lease on life. But before it did, Tea Party Republicans Sen. Mike Lee of Utah and Rep. Tom Graves of Georgia floated the idea of eliminating the Trust Fund entirely and letting the states figure out how to manage highways on their own. In years past, their proposal would have generated little more than a Washington hiccup, but Lee and Graves managed to grab some Capitol Hill attention by capitalizing on tanking public trust in the federal government and growing populist sentiment.

The battle over the Export-Import Bank is a bit different, but the same mindset is driving anti-government zealots to terminate the bank's life. The Ex-Im Bank battle pits the business community, which sees the bank as a beneficial boost to American competitiveness on the global stage, against the populists, who see it as just another public plum prime for business picking.

Established in 1934, the Bank backstops private credit for American companies engaged in exporting goods and services. And it has always had strong backing from the U.S. Chamber of Commerce and the National Association of Manufacturers (NAM), two business organizations that traditionally have had deep ties to Republican leadership. But in the Ex-Im Bank case, Kevin McCarthy (R-Calif. 23rd), the new House majority leader, and Jeb Hensarling (R-Tex. 5th), chair of the House Financial Services Committee, have both said they want to put a permanent padlock on the bank's doors.

Cutting the federal government down to size may be the new 21st century populist mantra, but it is nothing new for the conservative Republican Study Committee (RSC), that recently saw its chairman, Steve Scalise (R-La. 1st), elected House Majority Whip, the no. 3 GOP post McCarthy formerly held.

The RSC has long had ties to conservative think tanks, like the Heritage Foundation and the libertarian Cato Institute, which historically have questioned federal support of science. Their argument is simple: The only reason industry has backed away from investing in long-term research is that the private sector thinks the federal government is more than willing to pick up the tab.

Of course, high-tech CEOs emphatically reject that claim. But if the U.S. Chamber and NAM lose their battle over the Ex-Im Bank, American business leaders are likely to find that Congress will tune them out on other issues, as well, including their advocacy for science

So, it will be up to the science community to take its case to the public. Otherwise it will find itself with far fewer friends in high places–or any place, for that matter.

MEDALS continued from page 1

Both the theory and experimental questions covered a broad range of physics topics. "Problem one was a smorgasbord collection of three smaller problems: a particle sliding in a hoop, a bubble oscillating in a vacuum, and a tricky [inductor-resistor] circuit," said Paul Stanley of Beloit College, the team's academic director. "Problem two was an application of the van der Waals equation to calculate bulk properties of water. Problem three was a mathematically oriented approach to plasma physics." He added that the experimental question concerned the transmission of light through uncommon materials.

When not competing, the students went on several field trips to sites around Astana, including a recreated 18th century Kazakh village at Burabay, the Arlan Resort Area, and a trip out to a nearby lake to participate in a number of local cultural ceremonies. The five US students stayed in the dormitory at the recently founded Nazarbayev University.

The US team is organized and run by the American Association of Physics Teachers. The American Physical Society helps sponsor the team.

BRIDGE continued from page 5

take very different pathways to doctoral degrees compared to white and Asian American students. The survey looked at a random sample of doctorates earned in science and engineering fields from 1998-2001. The analysis showed that URM students are significantly more likely to earn a master's degree en route to the doctorate, and earn BS, MS, and PhD degrees at three different institutions. The APS Bridge Program is now planning to help connect underrepresented minority students who have received a master's degree to find a good match with a doctoral program.

To bring a broad perspective of scholarship to improving degree attainment, this year's Conference featured David Meketon, University of Pennsylvania, as a plenary speaker to address "The Psychology of Achievement." Meketon discussed self-control, "true grit," motivation and other psychological factors relevant to student success in physics and elsewhere.

Geoff Potvin, Florida International University, presented a comparison of graduate admission practices at doctoral- and master's-degree-granting institutions. The APS Bridge Program conducted two surveys on the recent admissions practices at these two types of institutions. Departments responded to questions on criteria used, relative importance of these criteria, and other questions. Notable trends indicated by the data include the following: (1) Graduate Record Exam (GRE) cutoffs are used explicitly or implicitly by a sizable number of doctoral- and master's-degree-granting institutions, despite the Educational Testing Service's advice against using the GRE as a cutoff measure; (2) Many doctoral programs consider the GRE physics subject test highly important, but many institutions (both doctoral and master's) are not using it at all; (3) Master's–and doctoral–granting–programs have expressed the concern that not enough URM students apply to their programs. The data raise further questions on admissions practices, including whether or not programs need to think more explicitly about the compositions of their annual cohorts, and how much effort is really being made to identify and attract a larger, more diverse pool of graduate students.

Several panel sessions featured representatives from both master's- and PhD-granting institutions who provided varying perspectives on the role the master's degree plays in improving diversity in physics. A student panel featured physicists who followed various career and educational paths after earning their master's degrees, providing insights, advice, and reflections on what the degree enabled them to accomplish.

Parallel workshops on mentoring for students and faculty in attendance were well received by participants. Faculty participated in a brief introduction to the ten-week Physics Research Mentor Training Seminar, led by Renee Michelle Goertzen, APS Education Programs Manager. The full seminar is designed to provide training to physics faculty who are in mentorship roles. Brian Beckford, APS Bridge Program Manager, and Arlene Modeste Knowles, APS Career and Diversity Administrator, facilitated the student version of this workshop to help students identify goals and expectations for the mentor-mentee relationship.

The Conference also featured speakers who discussed GRE bootcamps and cultivating relationships with other institutions.

The presentations are available at http://apsbridgeprogram.org/conferences/summer14/agenda.cfm

ANNOUNCEMENTS

The new MAS

The Mid-Atlantic Section (MAS) is a new APS unit that serves the District of Columbia, Delaware, Maryland, New Jersey, Pennsylvania, and West Virginia. Members of the mid-Atlantic region are invited to submit abstracts to the focus sessions.

Plenary Speakers

- **William Phillips, NIST and University of Maryland**
  Nobel Laureate 1997
  "Why condensed matter physicists should pay attention to atomic physics"
- **Eva Andrei, Rutgers University**
  "Graphene and the Magic of Physics in Two Dimensions"
- **Abhay Ashtekar, Penn State University**
  "The Very Early Universe: Origin of Space, Time and the Large Scale Structure"
- **Kate Kirby, Executive Officer of the American Physical Society**
  TBA
- **Maura McLaughlin, West Virginia University**
  "Pulsar Timing Arrays as Galactic Scale Gravitational Wave Observatories"
- **Dan Vergano, National Geographic**
  "A Brave New World: Science News in the Age of Social Media"

Abstract Deadline: 08/29/2014

Focus Sessions

- Applied Physics
- Astrophysics and Astronomy
- Atomic, Molecular and Optical Physics
- Biophysics and Medical Physics
- Condensed Matter Physics/Nanoscience
- Gravitation & Cosmology
- Nuclear Physics
- Particle Physics
- Physics Education
- Space Physics
- Statistical and Nonlinear Physics

Registration

Faculty/Staff $60
Graduate Students/Postdocs $40
Undergraduate Students $20
Retired $20

http://sites.psu.edu/midatlanticaps/

APS Outreach Mini-Grants

APS will award grants up to $10,000 to projects designed to engage and excite the general public. **Proposals are due on December 14th.**

Visit the APS homepage (aps.org) **in early September** for the official Request for Proposals.

CERN continued from page 4

Each member state gets two seats on the council, one reserved for a scientist and the other reserved for an administrator. "The governing structure was pretty hands-off," Llewellyn Smith said. "There was never a tendency to micromanage; they let the CERN management just get on with it."

Countries contribute to a central fund for the infrastructure of the lab as a whole. However, while the infrastructure of the lab comes from the pooled fund, the experiments do not. This means that while the Large Hadron Collider (LHC) was built by CERN using the money contributed to the central fund, the four giant detector experiments were funded, designed, and built by independent collaborations of nations. This way, if one falls behind, it doesn't necessarily mean the entire project will suffer.

Most of the countries that contribute to the organization have been strategic about where the funding for the lab comes from in their domestic budgets. "For some governments, the infrastructure of CERN is funded from the foreign policy budget, not the science budget," Krige said. "This means that it doesn't touch the science budget." He added that Britain is one of the few countries to use money from its science ministry. Doing so pitted scientists against each other over whether to support the international program or domestic research. "That led to incredible fights in Britain on how much it can afford for CERN," Krige said.

It's a fight that has been playing out in the United States over ITER. Funding for the U.S. contribution to the giant fusion reactor comes directly from the Department of Energy's Office of Science, often at the expense of domestic programs.

Of all the current international physics projects under development now, ITER receives the most comparisons to CERN, but the fusion project is years behind schedule and projected to be billions of dollars over budget. "It tried to [carry out] the dream where there is an equal division of the responsibilities," Spiropulu said. "The politics became more important than the project."

The construction of the reactor was split up among the 35 contributing nations. Different nations picked different components to build based largely on national interests, rather than efficiency. At the same time, ITER's central management gave the project little flexibility to adapt easily to design changes and delay.

"ITER is being built in a way that is closer to the way the LHC experiments were built than the way the collider itself was built," Llewellyn Smith said. In addition, because the fusion reactor is essentially a single giant experiment, all the components need to be in place and ready before it fires up. "A major problem [with] one of the members will immediately impact the project as a whole," said Michel Classens, Head of Communication for ITER. "Little by little all of the parts of the reactor will arrive here."

However the project that is most similar to CERN, both in terms of organization and intent, is SESAME. The project to build a synchrotron light source in Jordan has brought together nations normally hostile to one another, including Israel, Iran and the Palestinian Authority [see *APS News*, Back Page, April 2014].

"SESAME is modeled on CERN conceptually," said Llewellyn Smith, who is also president of the project's council. "The SESAME statutes are modeled on the CERN Convention, as is the governance structure. They have worked very well in the circumstances." He added that both collaborations aim to bring leading science facilities to regions where these were lacking and to foster international cooperation in the process.

The ILC is in the very early stages of development. It too is using CERN as a guide. "For something like a new international collaboration, this serves as a well-made model that all we have to do is tweak," said Barry Barish, director of the global design effort for the ILC, and former APS President. "The process for the ILC is much more like the experiments at CERN."

He added that one of the big differences between the ILC and ITER is that the governing structure and construction agreements are being decided earlier in the process, before a final site has been chosen. "What it has enabled by forming the same kind of CERN-like collaborations at an early stage is the ability to make decisions both technical and scientific," Barish said. "The hope is that we all own it, and as it moves forward, the problems that are inevitable can be dealt with."

OUTREACH continued from page 1

Thompson said. "We're very excited that NSF is so supportive of an outreach proposal such as this."

Nicolas Yunes and his team from Montana State University are working with the head of his school's film program to put together a planetarium show about gravitational waves. "We wanted to make it more plot-driven but still be informative…. Gravitational waves will allow us to hear the universe for the very first time," Yunes said. "We have what all the waves look like and can convert them on a computer so we can listen to them." Once finished, the team plans to distribute their show to other planetariums for free in order to reach as broad an audience as possible.

Alexander Boxer wants to build a miniature golf course to teach the fundamentals of force and motion to kids and adults. He plans on building on the traditional mini-golf course by incorporating accelerometers, video capture and screen readouts to demonstrate in real time the forces players exert on the golf ball. "A key part of this project is that it's kind of high tech. Every time you hit the ball, things are going to be measured," Boxer said. "It's a fun way to introduce people to new concepts and keep their attention.... With the APS grant, we're trying to build one demonstration hole that we think can be mobile," Boxer said.

Lesley Greene, an associate producing director at the Kitchen Theater Company in Ithaca, New York, is producing "Physics Fair," the theater's original show. It's a musical about a middle school girl who is organizing her school's science fair.

"Songs are just such a great way to remember things that otherwise don't stick with you," Greene said. "There are certainly high-school-aged kids who know elements because of the Tom Lehrer song."

In addition to featuring original songs about science, Greene linked up with scientists from the Cornell Laboratory for Accelerator-based Sciences and Education. Together they are using their outreach experience to create eye-catching physics demos for the science fair projects in the musical. "Basically they find everyday objects and do amazing things," Greene said.

BRAZIL continued from page 1

government's effort to spur industrial research. Starting in about 1999, the government created a number of "sector funds," which divert a small, fixed amount of the revenues of an industry towards applied research. "It's not really a tax, it's called a contribution," Brito Cruz said. "You inject additional money into the funding stream for Brazil." All together there are about a dozen such sector funds that help underwrite innovation in different industries.

"Today, both government and industry see research as an important element for the creation of development," Brito Cruz said. "Industry became more and more aware of the value of innovation."

But the changing political winds have made many in industry nervous about the future. Two consecutive leftist administrations have imposed additional regulations on various industries, cutting into profit margins and by extension research budgets. Brito Cruz adds, "The dark side of the present situation is that recent governments in Brazil have had an attitude that is somewhat hostile to industry."

However, he is still upbeat about the general direction of scientific research both in Sao Paulo and Brazil as a whole: "I'm optimistic about the future. Every country sees difficulties now and again."

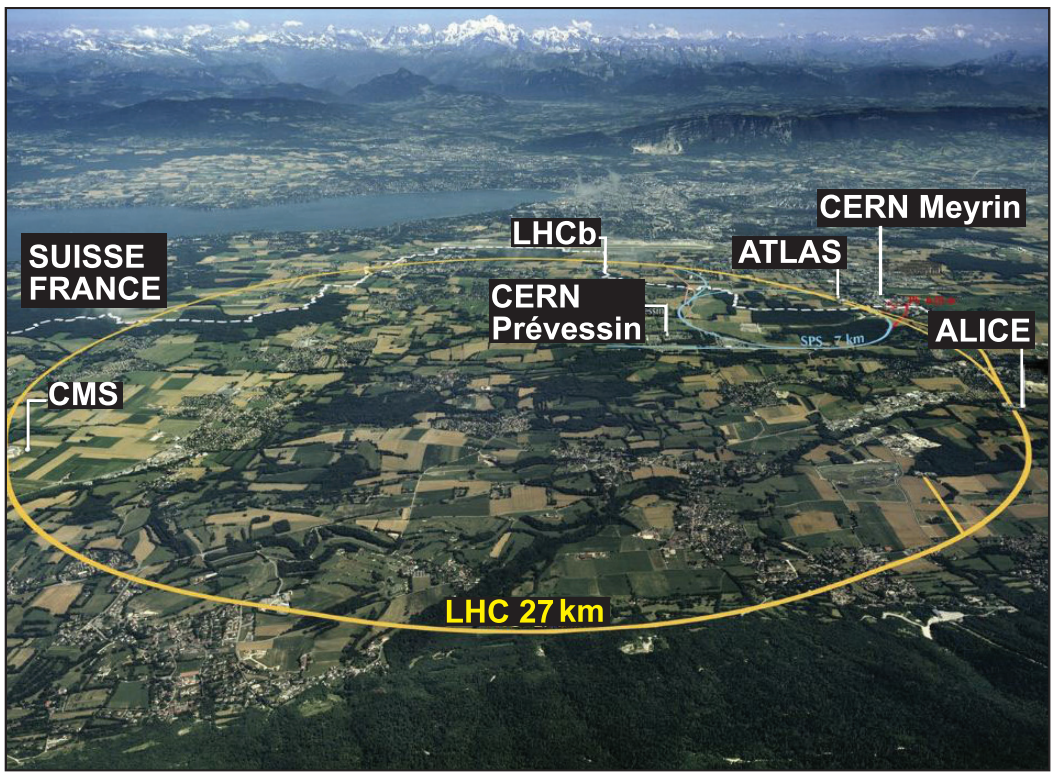
The Back Page

CERN–Six Decades of Science, Innovation, Cooperation, and Inspiration

By Chris Quigg

This month, the European Laboratory for Particle Physics, which straddles the Swiss-French border northwest of Geneva, celebrates its sixtieth birthday. CERN is the preeminent particle-physics institution in the world, currently emphasizing the study of collisions of protons and heavy nuclei at very high energies and the exploration of physics on the electroweak scale (energies where electromagnetism and the weak nuclear force merge). With brilliant accomplishments in research, innovation, and education, and a sustained history of cooperation among people from different countries and cultures, CERN ranks as one of the signal achievements of the postwar European Project. For physicists the world over, the laboratory is a source of pride and inspiration.

CERN is a very large, and highly cosmopolitan, research institution, with 2500 staff members, 600 Fellows and apprentices, and nearly 12,000 "associated members," representing more than 110 countries. The 2014 budget is 1.1 billion Swiss francs ($1.2B). The United States has the largest participation among Observer states, with 1765 scientists drawn from 112 institutes. The European Commission and UNESCO also have Observer status, and in 2012 CERN became an Observer to the United Nations General Assembly.



CERN

The big picture - CERN from the air, with the Alps in the background.

The Creation of CERN

Recognizing the diminished state of European science at the end of the Second World War and the urgent need to rebuild trust among citizens of the continent, a visionary group of leading physicists conceived a European laboratory for subatomic research. Louis de Broglie carried their proposal to the European Cultural Conference held in Lausanne in December 1949. The notion gained momentum six months later at a UNESCO conference in Florence, thanks to a resolution introduced by I. I. Rabi that authorized UNESCO to "assist and encourage the formation of regional research laboratories in order to increase international scientific collaboration."

By the end of 1951, UNESCO had authorized the creation of the European Council for Nuclear Research/Conseil Européen pour la Recherche Nucléaire. In short order, eleven nations signed an agreement establishing the Council and planting the seed for CERN. In 1952, the provisional council selected Geneva as the laboratory site. In mid-1953, representatives of twelve founding member states–Belgium, Denmark, France, the Federal Republic of Germany, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom, and Yugoslavia–signed the convention establishing the organization, subject to ratification. Approval by the governments was complete on 29 September 1954, and CERN was born.

CERN Milestones

CERN's research program is built upon particle accelerators, and it is by continuous innovation and systematic improvements that the lab has attained its world-leading status for the high-energy collisions of hadrons. The Proton Synchrotron (PS), commissioned in 1959, was one of the earliest alternating-gradient (strong focusing) synchrotrons. To this day, it is an essential part of the accelerator chain, delivering 28-GeV protons to its successor, the Super Proton Synchrotron (SPS). An outstanding achievement of the PS era was the 1973 discovery of interactions signaling the weak neutral current, a new form of radioactivity, in Gargamelle, a 4.8-m-long heavy-freon (CF_3Br) bubble chamber. During the heyday of the PS, CERN pioneered colliding beams of protons in the Intersecting Storage Rings, which came into operation in 1971, eventually lifting the center-of-mass energy frontier to 63 GeV. The ISR subsequently was the test bed for Simon van der Meer's ideas to produce dense beams by stochastic cooling.

The SPS, a "big machine" of its day, is a proton synchrotron 7 km in circumference accelerating beams up to 450 GeV that has been feeding a wide variety of fixed-target experiments for many years. The SPS was highly productive in many areas, notably neutrino physics, where it contributed to establishing quantum chromodynamics as the theory of strong interactions. Reconfigured as a proton-antiproton collider, it yielded the discovery of the *W* and *Z* bosons, the force particles of the weak interactions, in 1983, a decisive step toward validating the electroweak theory that was honored by the Nobel Prize to Carlo Rubbia and van der Meer.

The next great step was the construction of the Large Electron-Positron collider (LEP) in a 27-km tunnel that extends under the Jura mountains at a depth of 100 m. Beginning in 1989, LEP operated first as a *Z* factory with energies near 91 GeV, compiling a very detailed dossier on the weak neutral current. LEP moved on to higher energies where experiments validated the electroweak gauge symmetry in *W*-pair production and searched for the Higgs boson.

LEP ceded its place in the tunnel to the extraordinary Large Hadron Collider (LHC) and its complement of superb detectors, which began data-taking in earnest in 2011 for proton-proton collisions at 7 TeV. More than 10,000 people have participated in the design, construction, and execution of the LHC and the experiments it hosts. Many hundreds of studies covering a sweeping range of investigations have been reported in the journals. The ATLAS and CMS experiments have already reaped their first immense reward–the discovery of the Higgs boson. We can only imagine what surprises may await in 2015 and beyond, when the energy increases from 8 TeV toward the 14-TeV design energy and the number of events recorded grows by an order of magnitude.

CERN Today

A visitor arriving at CERN instantly feels a vibrant atmosphere of energy, optimism, confidence, and youth. The CERN cafeteria has been, for as long as I have known it, a place where you could meet anyone and discuss any sort of idea. It bustles with formal and informal gatherings, from highly technical discussions to sensitive diplomatic negotiations.

The laboratory sets for itself four aspirations: research, innovation, education, and bringing people together. The LHC program, which will run beyond 2030, is the core research activity. Beyond the central theme of proton-proton interactions, the LHC enables the study of heavy-ion collisions (Pb-Pb and proton-Pb). The lab is also the leading center of antihydrogen experiments, and hosts rare kaon decay experiments, rare-isotope studies, efforts for neutrino experiments, and more. Its theoretical physics group, which boasts a distinguished history, is the nexus of European theory and draws visitors from the entire world.

Complementing the laboratory's long line of advancements in the enabling technologies for accelerators, CERN has led the conception and development of novel detectors applied first to particle-physics experiments and later to medical diagnostics and other applications. Georges Charpak's invention of the multiwire proportional chamber, recognized by the Nobel Prize, heralded a revolution in experimental technique in which electronic signals supplanted photographic images. In information technology, CERN is famous as the birthplace of the World Wide Web and has been a leading force in the development of grid computing.

Many young scientists and engineers have had formative experiences as CERN Fellows. Some 2500 students are conducting PhD research at the LHC. Many of them will take jobs in industry, commerce, and government, or migrate to other scientific disciplines. The laboratory has for many years hosted a summer student program for recent graduates that blends lectures and practical experience. CERN jointly organizes advanced summer schools in particle physics in Europe and Latin America and collaborates with Fermilab on the Hadron Collider Physics Summer School. Schools in Accelerator Science and Computing are also regular features. Increasingly, CERN is engaging with teachers and school groups.

CERN's status as an international organization gives it great latitude to welcome scientists and students from many lands, largely insulated from the vicissitudes of relations among governments. It is thus positioned to be a laboratory for the world. Going well beyond the original impulse to create a haven in which scientists from the European states could make common cause, CERN now hosts collaborations between scientists whose governments may be at loggerheads, or not even recognize the other's right to exist. In the long run, uniting people and giving them the chance to accomplish something wonderful together can be a powerful force for world peace.

CERN in the Future

While a long life remains for the Large Hadron Collider–with a series of upgrades to the machine and detectors, to be sure–CERN has an obligation to itself and to the science to look further ahead by considering what instruments and exotic technologies will be needed to answer emerging questions. The Future Circular Collider study is looking into the scientific merit and practical aspects of a very large tunnel, perhaps 80 to 100 km around, that could hold a hadron collider with at least five times the energy of the LHC and possibly an electron-positron Higgs-boson factory as an intermediate step.

Particle physics and accelerator science have long been highly international undertakings, and are becoming more so. CERN, already a center for the world, is engaging with international partners to a greater degree than ever before. This year, Israel became the first non-European member state. The International Linear Collider and CERN's Compact Linear Collider have joined forces in a Linear Collider Collaboration. The recent revision of the European Strategy for Particle Physics, for which the CERN Council is the steward, foresees possible contributions to an International Linear Collider in Japan and engagement in long-baseline neutrino-oscillation experiments in Japan or the United States. The overtures to the Latin American community show great promise. I hope that, before the lab's next significant birthday, the United States will form an even closer association with CERN.

A Personal Word

I visited CERN for the first time more than four decades ago, as a fresh PhD. I was instantly made to feel welcome and was delighted to meet a new set of people whose experiences differed from mine and who thought about physics in different ways. Every visit is still a revelation. Uniting people to do science doesn't make us all the same, but it can make us better scientists, and better people.

To the visionaries who imagined what CERN could become, to those who made it so, to the people and governments whose support made it possible, go my thanks and admiration. To my friends at CERN today, Happy Birthday! We have work to do together.

*CERN's 60th anniversary brochure is available online at http://j.mp/1odGyse.

Author note: Chris Quigg is a theoretical physicist at Fermilab, and the author of Gauge Theories of the Strong, Weak, and Electromagnetic Interactions *(Princeton University Press, 2013). He regards CERN as his second scientific home.*