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APS physics

Nominees Sought for Nicholson Medal

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AIP Reorganizes its Publishing Operations

By Michael Lucibella

In February, the American Institute of Physics established a new wholly owned, but managerially independent, limited liability company to oversee publishing all of its research journals. The move comes amidst a broader restructuring effort by AIP to modernize its governance, and better respond to the changing publishing market.

"The AIP gets nearly all of its funding from publishing," said Fred Dylla, the Executive Director of AIP. "It's very important that the publishing be run as efficiently as possible."

AIP is an umbrella organization, whose members are other societies, among the largest of which is APS. APS is the publisher of the *Physical Review* family of journals, including *Physical Review Letters*, *Physical Review X* and *Reviews of Modern Physics*, whereas AIP publishes a portfolio of 17 journals, many of which concentrate on applied areas of physics, as well as journals of several of its member societies.

Several APS divisions and topical groups correspond closely with areas covered by AIP journals, including *The Journal of Chemical Physics*, *Physics of Fluids*, *Physics of Plasmas*, and *Review of Scientific Instruments.* AIP also publishes *Journal of Applied Physics* and *Applied Physics Letters.*

The newly formed AIP Publishing LLC is designed to be leaner and more adaptable. "Pub-

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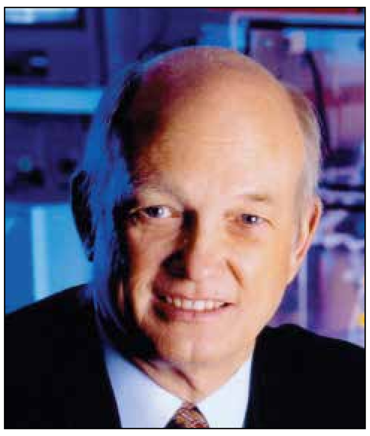
Brinkman Looks Back on Good Science and Tough Decisions

William F. Brinkman stepped down last month as the Director of the Office of Science in the U.S. Department of Energy, the leading funder of physical science in the federal government. He had held this post since June of 2009, prior to which he was a Senior Research Physicist at Princeton, and before that Vice President for Research at Bell Laboratories. He also served as APS President in 2002.

As he left office, Brinkman took time to share some thoughts with Michael Lucibella of *APS News.*

What can you say were the highlights of your tenure as the Director of the Office of Science?

Well, several things. I think we moved ITER [the International Thermonuclear Experimental Reactor] forward very successfully, we moved the free electron laser to completion and it's working. Those were very important accomplishments. NSLS II [National Synchrotron Light Source II] is moving forward. A lot of good science came out of things like the biofuel centers and the EFRCs [Energy Frontier Research Centers] I think they were very innovative and have produced a lot of very good science, whether it was on lignins [an organic compound that could be a renewable fuel source] or on breaking down cellulose and that kind of thing, but also on new types of solar cells with silicon pillars. A lot of good science came out and I feel pretty good about that. In addition, we've managed to build as good a staff as we've had in a long time. So I'm very pleased with that too, I think the people that I am leaving behind are very good.



How has the Office of Science changed under your watch?

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APS Launches New Prize and New Award With Nominations Due by July First

This year APS is launching the Herman Feshbach Prize, named for a leading nuclear theorist who enjoyed a long and distinguished career at MIT. The Feshbach Prize in nuclear theory will complement the Tom W. Bonner Prize, given primarily for nuclear experimental physics.

Nominations for the first cycle of the Prize are currently being sought. They can be submitted online at http://www.aps.org/programs/honors/prizes/feshbach.cfm. The nomination deadline is July 1; the first recipient(s) will be determined by the APS Executive Board in September upon recommendation of the selection committee, and the first Prize will be presented at the 2014 April Meeting in Savannah.

Also debuting this year is the Reichert Award for Excellence in Advanced Laboratory Instruction. The addition of this Award to the APS portfolio is designed to recognize outstanding achievement in teaching, sustaining and enhancing an advanced undergraduate laboratory course or courses. The Award was established through the generosity of Jonathan Reichert and Barbara Wolff-Reichert, for whom the development of advanced laboratory instruction has been a long-time passion. More information about the Award, and instructions for submitting nominations, can be found at http://www.aps.org/programs/honors/awards/lab.cfm. The nomination deadline is July 1.

March & April Meeting Talks Online

Full video capture of two major sessions at the March Meeting has been posted on the APS website. Both the Kavli Foundation Session: Physics for Real World Problems, and the Nobel Prize Session featuring talks by David Wineland and Serge Haroche can be accessed at http://www.aps.org/meetings/march/index.cfm. At the same site there are also interviews, special features and live coverage of the meeting, produced by APS-TV.

Video from the April Meeting, including all the plenary sessions, is also available at http://www.aps.org/meetings/april/index.cfm.

Attendees Flock to Annual PhysTEC Conference

By Bushraa Khatib

This year's annual conference of the Physics Teacher Education Coalition (PhysTEC) was held March 16-17 in Baltimore, Maryland as a satellite meeting of the annual APS March Meeting. Over 75 universities and colleges were represented by 119 attendees.

The conference began with an opening plenary by Richard Steinberg, Program Director of Science Education at City College of New York. Steinberg, a professor of physics and education, presented his experiences during a sabbatical year in which he taught physics in a New York City public high school. He described his transition from introductory college physics instructor to teacher education program participant, which involved taking courses that he himself had previously taught, and shared both frustrating and positive experiences with his students. Steinberg said his experiences as a high school teacher give him more credibility as a professor, and reinforce his methods of teaching physics by inquiry.

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March Meeting Prize and Award Recipients

Photo by Ken Cole

At the ceremonial session at the March Meeting in Baltimore, APS President Michael Turner presented prizes and awards to 26 individuals; in addition, one award was presented by the American Institute of Physics (AIP). After the ceremony, the recipients gathered for a group photo; three who unfortunately could not attend are pictured in the insets. In the photo, front row (l to r): Timothy Sanchez, Wilson Ho, Daniel Fisher, Costas Soukoulis, John Pendry, David Smith, Luc Berger, James Chelikowsky, John Slonczewski. Middle row (l to r): Mark Pinto, Brooks Pate, Jean-Luc Brédas, Robert Birgeneau (AIP), Mario Affatigato, Daniel Neumark, Tetsuji Miwa, Michio Jimbo, Margaret Geller, David Yllanes. Back row (l to r): John Woollam, Mahesh Mahanthappa, Stephen Cheng, Nergis Mavalvala, David McClelland, APS President Michael Turner. Insets (l to r): Yuliya Dovzhenko, Geraldine Richmond, Roman Schnabel.

Parsing the Data About Women in Physics

By Calla Cofield

At a press conference at the APS March Meeting, Louis Amaral from Northwestern University presented results from a paper in which he and colleagues carefully examine what factors may influence publication rates among women in STEM fields. Roxanne Hughes of the National High Magnetic Field Laboratory presented results from her study of the effectiveness of a program targeted at providing more opportunities to female physics undergraduates.

Women Publish Less Than Men

A simple count of publication numbers by gender shows fewer publications from women in STEM compared to their male colleagues.

Researchers at Northwestern University and Universitat Rovira i Virgili in Catalonia, Spain decided to ask the more dynamic question of whether or not male scientists were actually outperforming their female counterparts. Their results were published in December 2012 in the journal *PLoS One*. The team created an equation for publication rate that incorporated variables such as the stage the person is at in his/her career, and the number of publications from the entire field or discipline in that year.

They also considered that some

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Members in the Media

"It is the consensus of the Voyager science team that Voyager 1 has not yet left the solar system or reached interstellar space… In December 2012, the Voyager science team reported that Voyager 1 is within a new region called 'the magnetic highway' where energetic particles changed dramatically. A change in the direction of the magnetic field is the last critical indicator of reaching interstellar space, and that change of direction has not yet been observed."
***Edward Stone**, Caltech,* CBSNews.com, *March 20, 2013.*

"Just as DNA determines many individual characteristics, the map from the space probe shows the seeds from which our current universe grew."
***Marc Kamionkowski**, Johns Hopkins University, about the recent detailed map of the cosmic microwave background made by the European Space Agency's Planck space telescope,* The Washington Post, *March 21, 2013.*

"The standard cosmological model looks even stronger today than yesterday… The universe remains simple and strange."
***David Spergel**, Princeton University, on the new map of the CMB,* The New York Times, *March 21, 2013.*

"We envision that one day small robots with legs will be sent on to Mars and other planets to help humans with extraterrestrial exploration."
***Chen Li**, University of California Berkeley,* The San Francisco Chronicle, *March 21, 2013.*

"It was basically just this random mess of collisions, which is essentially how you want to think about the gas in the air that we breathe."
***Jesse Silverberg**, Cornell, on the physics of mosh pits,* National Public Radio, *March 22, 2013.*

"We hope that this will provide a lens into looking at other extreme situations such as riots and protests and escape panic."
***Matthew Bierbaum**, Cornell, on the physics of mosh pits,* National Public Radio, *March 22, 2013.*

"Is that really nothing?… There's no space and there's no time. But what about physical laws, what about mathematical entities? What about consciousness? All the things that are non-spatial and non-temporal."
***Lawrence Krauss**, Arizona State University, on whether nothing is just the absence of something,* NBCNews.com, *March 24, 2013.*

"This is a different time… It makes sense to have a brain activity map now because the maturation of an array of nanotechnologies can be brought to bear on the problem."
***Michael Roukes**, Caltech, on the announcement by President Obama of a new initiative to map the human brain,* The New York Times, *April 2, 2013.*

"It took us 18 years to build this experiment. We want to do it very accurately."
***Samuel C. C. Ting**, MIT, when announcing the ISS's Alpha Magnetic Spectrometer hinted at the presence of dark matter,* The Washington Post, *April 3, 2013.*

"What you have probably seen from the data is a significant new measurement… Unfortunately, the data wasn't that conclusive."
***Richard Gaitskell**, Brown University, on whether data from the ISS's Alpha Magnetic Spectrometer hinted at the presence of dark matter,* The Los Angeles Times, *April 3, 2013.*

"I would bet against dark matter being the origin of these particles at this time."
***Dan Hooper**, Fermilab, on the Alpha Magnetic Spectrometer data,* National Public Radio, *April 3, 2013.*

This Month in Physics History

May 11, 1962: Feynman's "Brownian Ratchet"

In 1948, Sir Arthur Eddington famously described the second law of thermodynamics as holding "the supreme position among the laws of nature," lamenting that if one devised a theory found to violate that second law, "There is nothing for it but to collapse in deepest humiliation." That hasn't kept physicists from proposing the occasional speculative thought experiment on how one might violate the second law, thereby deepening our understanding in the process.

The most famous is "Maxwell's demon," first proposed by James Clerk Maxwell in the 19th century in a December 1867 letter to Scottish mathematician Peter Guthrie Tait. Maxwell envisioned a container of gas molecules in thermal equilibrium. An insulated wall divides the container into two chambers. An entity (the "demon") opens a door in the dividing wall periodically to allow molecules moving faster than average to flow through in only one direction. Over time, this creates a temperature differential between the two chambers capable of being harnessed for work. Given the statistical nature of the second law, the demon appears to defeat the increase in entropy.


Richard Feynman

Nearly one hundred years later, Richard Feynman revisited the concept with his own thermodynamically-inspired thought experiment that appeared to violate the second law. Feynman grew up in Far Rockaway, Queens, and loved to solve puzzles from a very young age. When he was in high school, a student would often come to him in the morning with a geometry problem, and Feynman would work on it until he figured it out. Over the course of the day, other students would present him with the same problem, and he'd solve it for them immediately, earning a reputation as a "super-genius." His entire career in physics was about solving ever-more-complicated puzzles.

Feynman joined the Manhattan Project in the early 1940s, while still a graduate student, evincing a mischievous penchant for breaching the Los Alamos security systems just for fun. He taught himself the art of safe-cracking and picked the locks on vaults containing the most sensitive secrets to building an atomic bomb. He never took anything. He just left taunting notes behind bemoaning the project's lax security. In his later years, he developed passions for painting and playing the bongos.

In the 1960s, Feynman was a physics professor at the California Institute of Technology, and found himself involved in a three-year project designed to improve the instruction of Caltech's undergraduate students. The result was a classic series of lectures that eventually found their way into published form: *The Feynman Lectures on Physics.* The tome has since sold well over 1.5 million copies in English alone, and continues to inspire budding young physicists today.

During one of those Caltech lectures, on May 11, 1962, Feynman described a "Brownian ratchet" device based on earlier work in 1912, by a Polish physicist named Marian Smoluchowski. Smoluchowski proposed a machine capable of extracting useful work from heat in a system at thermal equilibrium. It features a small paddle wheel immersed in a fluid and a ratchet connected by an axle. The molecules in the fluid exhibit random Brownian motion and those collisions cause the paddle to turn. The key is that a pawl prevents its rotation in the opposite direction, so the paddle will continue to turn in just one direction, and can be harnessed to perform some kind of work.

Feynman's updated version of Smoluchowski's thought experiment was to demonstrate to his undergraduates that the ratchet will *not* rotate continuously in one direction. The pawl will also exhibit Brownian motion, jiggling up and down in such a way that occasionally the ratchet tooth will slip backward rather than forward. In fact, Feynman performed the first quantitative analysis of the device and concluded that over time the machine will ratchet backward as much as it moves forward, thereby canceling any possibility for extracting work, and most likely losing energy in the long run with no external energy source to keep it running. The only way to extract work from the system would be to find some way to create a temperature differential between the air on either side of the device–the same basic principle as a steam engine.

Feynman's thought experiment has continued to interest physicists over the decades, even extending it to scenarios involving multiple ratchets. Eventually it led to developing the concept of Brownian motors: nanoscale machines capable of extracting useful work not from thermal noise, but from microscopic sources of nonequilibrium, such as chemical potentials.

In 2010, physicists at the University of Twente successfully demonstrated a machine based on the Brownian ratchet, using 2000 bouncing beads whose bouncing motion rotates a paddle inside the machine, to generate a small net excess of energy. In order to ensure that the paddle turned in one direction only, the Twente researchers covered one side of each vane on the paddle. This caused the beads to lose more energy whenever they hit the taped side.

It is a highly inefficient system; much of the energy is lost to heat and sound, and it doesn't violate the second law. But it could shed light into the movement of biological molecules like RNA polymerase and protein kinesin. At those size scales, such molecules travel through the body along "tracks" in cells via a ratcheting mechanism–a phenomenon called back interaction. The Twente apparatus models that motion on a macroscale.

So while Eddington was technically correct in

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INSIDE THE BELTWAY

Guns, Salsa and Butter

by Michael S. Lubell, APS Director of Public Affairs

What do gun control and immigration reform have to do with science budgets? Your reflexive response is probably little or none. But let me put on my optimist's hat, which admittedly has seen little wear in the last few years, and pose a political dynamic that could tie them together.

I'll begin with the context. Two sound bites capture the moment: polarization and deafness. The first needs little elaboration. You see it whenever you tune into Fox News or MSNBC, the echo chambers of the right and the left.

But if you really want analytical evidence, you can find it in Nate Silver's *New York Times* blog, "Five Thirty Eight." In his Dec. 28, 2012 posting, Silver documents the dramatic shrinkage of competitive House races during the course of the last 20 years. In 1992, he notes there were 103, but in 2012, only 35.

Today, a House Republican is far more likely to lose incumbency to a primary challenger from the right than to a centrist Democrat in a general election. And although the average Democrat does not feel quite as exposed to a primary from the left, the lingering existential threat deters significant movement toward a collaborative center.

If you're seeking the cause of the disjoint electoral map, you need look no further than the combination of district gerrymandering and geographic sorting out of the two major parties.

But enough about polarization: let's turn to deafness. Well before the 2012 election, Congress's approval rating was tanking, although Republicans had a slight advantage in the race to the bottom.

But the polling data did little to reduce the hyper-partisanship that was tying Washington up in dysfunctional knots. For reasons I just described, incumbents on both sides of the aisle simply had no incentive to compromise. They remained deaf to a growing public drumbeat for a return to effective government.

Gerrymandering did not afford a divided electorate–disaffected though it might be–much opportunity to spank House members standing for re-election for their lack of productivity and partisan intransigence. But the presidential and senatorial races provided another forum, and Democrats, with their slightly higher favorability, capitalized on the advantage, retaining the White House and adding two seats in the Senate.

Since the last election, a number of prominent Republicans have begun to question their party's strategy of uncompromising adherence to staunchly conservative principles in the face of a growing public clamor for compromise. Whether the GOP will modify its stolid stance remains a matter of speculation, but simply the possibility of a posture change is providing fulsome fodder for the likes of Rush Limbaugh on the right and Rachel Maddow on the left.

Guns and salsa may give us a glimpse of the future. Here's why.

In April, conservative Republican Senator Pat Toomey of Pennsylvania and moderate Democrat Joe Manchin of West Virginia collaborated on gun control legislation that garnered the nod of 50 Democrats, 16 Republicans and 2 Independents on a motion to allow the bill to reach the Senate floor. A threatened filibuster vaporized completely. And even though the billed failed on the floor, bipartisanship–which only a few months earlier had been a poison political pill–assumed an aura of respectability.

Such budding propriety might gain further traction if the fully bipartisan "Senate Gang of Eight" succeeds in crafting a comprehensive immigration reform bill that addresses the festering sore of 11 million undocumented immigrants, many of them who entered our nation illegally from Mexico. Although partisanship could still derail the legislation, the current Senate air augurs well for its success. And if it bipartisan achievement becomes the 2013 buzzword, science could be a major beneficiary.

On April 10, President Obama released his budget request for fiscal year 2014. It was more than nine weeks late, but for science enthusiasts it was worth the wait. The presidential budget proposed not only restoration of the recent across-the-board sequestrations, but also significant increases for most research programs. In the hyper-partisan world of the last two years, that proposal would be declared dead on arrival by the Republican House leadership.

But only two months before the president submitted his request, House Majority Leader Eric Cantor of Virginia had told an American Enterprise Institute audience, "…there is an appropriate role and a necessary role for the federal government to ensure funding for basic medical research." Amplifying on the theme, he said, "Scientific breakthroughs are the result of, and have helped contribute to, America's being the world's capital of innovation and opportunity in nearly every field."

If "bipartisanship" disappears from the Washington dictionary of expletives, if Republicans take their cue from Eric Cantor and if Democrats embrace the president's call to scientific arms, 2013 could become a watershed year for an enterprise that has been dying of fiscal thirst far too long.

Delivering the message that "Science Matters" to elected officials and, more importantly, to the public at large must become a priority for every scientist. A window is beginning to open. Let's not close it.

Science Diplomacy

While in Baltimore for the March Meeting, President Yee Hsiung and Vice-President Fu-Jen Kao of the Physical Society of the Republic of China (PSROC) visited APS Headquarters at the American Center for Physics in nearby College Park, Maryland. They received a tour of the building, including the Niels Bohr Library & Archives and the Center for History of Physics of the American Institute of Physics, and met with APS leaders to discuss possible areas of cooperation. In the photo are (l to r), PSROC President Yee Hsiung, PSROC Vice-President Fu-Jen Kao, APS Director of International Affairs Amy Flatten, and APS Associate Executive Officer Alan Chodos. Photo by Adam Negussie/ APS Staff

A Year of Progress for LGBT+ in Physics

By Calla Cofield

At last year's March Meeting in Boston, the APS hosted the first session at a major physics conference to focus on issues facing LGBT+ persons in physics. That session drew over 100 audience members. At this year's March Meeting, organizers of the volunteer-based group LGBT+Physics hosted an evening roundtable discussion session attended by roughly 40 people. At the session, the organizers reported on progress that has been made in the last 12 months to address some of the issues brought up in last year's session.

Both the 2012 session and the 2013 roundtable discussion were organized by members of the Networking Subgroup of LGBT+Physics. The group partnered with members of the organization oSTEM, which is an organization that supports career development of LGBT+ students in the STEM fields.

LGBT stands for lesbian, gay, bi-sexual, and transgender, while the plus sign includes other sexual orientations or gender identities including intersexed, queer, questioning, asexual or pansexual. Some organizations also list heterosexual and cisgender (anyone who identifies with the gender they were born with) to indicate the inclusion of all sexual orientations and gender identities.

At the 2012 APS session on LGBT+ issues, organizers asked attendees to fill out a survey asking them about their experiences in physics and what actions they wanted to see taken to improve support for and visibility of LGBT+ persons in physics. The results of that survey were published on the website arXiv.org in a paper titled "Gender and Sexual Diversity Issues in Physics: The Audience Speaks." In early March, the LGBT+Physics group published a "Best Practices Guide" on its website (lgbtphysicists.org, which the group identifies as the first website for LGBT+ physicists). The guide makes recommendations for "how to make the physics workplace more inclusive for LGBT+ scientists," and is aimed mainly at academia. It offers specific recommendations at the individual, department and university level. These include actions that can be adopted immediately, such as using inclusive language and adding sexual orientation and gender identity to non-discrimination policies. The guide goes on to offer long-term suggestions, such as increasing networking opportunities for LGBT+ persons.

The guide's suggestions aim to improve the general "climate" for LGBT+ persons in physics, which can be influenced by how accepted and supported those persons feel by their colleagues and their institution. Similar issues face women and racial and ethnic minorities in physics. Research has shown that a negative climate toward minority groups can negatively impact individuals, which can lead to larger negative consequences for the department and the institution.

A second major step was the creation of an "out list" for physics, where LGBT+ members of the physics community may publicly identify themselves as such. There is also a list for ally physicists (persons who openly support the LGBT+ community but do not identify as LGBT+ themselves). There is an out list for professional astronomers hosted by the University of California Santa Barbara website, and some universities have made their own public out lists.

Tim Atherton, one of the roundtable session organizers and an associate professor in the physics and astronomy department at Tufts University, said in an email, "We hear again and again from people that perhaps the biggest problem is the lack of visibility of LGBT+ people and their allies in physics. The out list and ally lists are our attempt to directly address that. These lists help create a better climate by helping to alleviate the isolation that all minorities feel and also recognizing the important contributions of LGBT+ people to Physics. We'd

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Organic-Based Flow Batteries Could Enable Renewables

By Michael Lucibella

Scientists at Harvard are developing an inexpensive, organic-based battery that could change how the nation generates electricity. At the March Meeting, researchers reported their initial results developing batteries that store charge using quinones, carbon-based molecules found frequently in nature.

They hope that with further development, their battery design could be scaled up to industrial levels, and help make solar and wind energy more economically viable.

Michael Aziz is the head of a team, sponsored by the Department of Energy's ARPA-E program, that is developing the new batteries. Team members are starting work on a design of new "flow batteries," which rely on quinones suspended in water, rather than existing designs that use expensive vanadium or dangerous chlorine.

The batteries work like fuel cells. Two large tanks of liquid circulate through a central cell stack divided by a thin membrane. One fluid in the flow battery is positively charged, while the other is negative, much like the electrolytes in a traditional battery. The thin membrane in the cell

Photo by Brian Huskinson

Aziz's table-tob device at the Harvard School of Engineering and Applied Sciences successfully demonstrated that quinones can store a charge, the first step towards building future flow batteries.

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Letters

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

A Noether Letter

I was pleased to read your celebration of Emmy Noether and her famous theorem in "This Month in Physics History" in the March *APS News*. Her theorem does not seem to have received the fame commensurate with its fundamental importance, as you point out. I would like to relate an anecdote about her and mention the crucial importance her theorem made to my work.

When running for Common Council in Summit, New Jersey, in 1980, I was going door-to-door introducing myself and requesting support. From the voter list I carried, I noticed I was at the home of a Noether family. When the man who answered the door exhibited a noticeable German accent and mentioned that he was a physical chemist, it was enough for me to break in by asking, "Are you related to Emmy Noether?" Flabbergasted, he said, "Yes, she was my aunt! How do you know of her?" I replied there was a whole chapter in my book about her theorem and my use of it, and he couldn't then stop telling me of Emmy's professional travails, much as recounted in the "Physics History" piece. Finally, I hurried on, hoping I had garnered a vote by a very unconventional connection.

My use of Noether's theorem was deriving from a single Lagrangian all long wavelength dynamical equations (electromagnetic, acoustic, optic, and later spin) and all constitutive relations, linear and nonlinear, of an arbitrary crystal. Key to the Lagrangian is constructing the most general stored energy of a crystal consistent with the conservation laws. Using the invariance arguments of Noether's theorem permits this, and also allowed me to present for the first time the general conservation law of pseudo (or quasi or crystal) momentum. Later this allowed me to resolve the Abraham-Minkowski controversy definitively (they were both seriously wrong) by a derivation from fundamental principles [*Phys. Rev.* A44, 3985 (1991)]. That work also identified from fundamental arguments for the first time that the well known quantity hk is a sum of real and pseudo momentum per photon (thus a new name wave momentum). The formalism seems to have been off-putting to its recognition.

Donald F. Nelson
Worcester MA

Wall Street is a Poor Use of Physicists' Talents

The commentary by James Owen Weatherall, Fisics and Phynance, offers a spirited defense of the migration of physicists to Wall Street hedge funds and investment banking firms but his article misses the mark. He starts by discussing the accusation that the rarefied financial instruments created by "quants" have actually destabilized the markets but then quickly digresses into why physicists are good at predicting market behavior or pricing options. However, Wall Street doesn't create anything of intrinsic value, it simply serves as a marketplace. The question is, are physicists needed to make the marketplace operate more efficiently? That is, is innovation being stifled because the marketplace is inefficient? I know of no evidence to support this claim. What then would be the best use of our highly trained physicists? I would argue that it would be to employ them in solving the most pressing problems of our day, such as understanding global climate change/disruption, developing clean energy sources, and developing the next generation of electronic devices. The problem is one of priorities. As a nation, we invest tremendous time, effort, and money in training these young scientists but our tax policies and government regulations do not stimulate development and innovation in climate modeling, clean energy, or spintronics. As a result, our young scientists are faced with a choice of limited employment opportunities at relatively poor salaries or ....Wall Street. You do the math.

Donald J. Hirsh
Ewing, NJ

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Although I am amused at the imaginative play on words with "Fisics" and "Phynance," I am not thrilled that *APS News* is discussing tricky dicky financial models for the benefit of a few greedy vultures at the expense of everyone else and our Nation. A discussed example is hedge fund managers, who gamble with other people's money in an artificially contrived system where they are guaranteed to make huge personal fortunes while everyone else, businesses and our Nation lose.

In this system, there is no positive benefit to society or our Nation. And these hedge fund managers are given special tax breaks to further support their greed. There is no sense of accountability or fairness in this system. Wall Street should NOT be just another gambling joint. All this is addition to outright frauds, deceit and theft as in the mortgage debacle.

The strength of the USA was built on companies that invented, designed, engineered, produced and manufactured useful products such as cars, steel, oil, engines, coal, railroads, electrical power systems, electric motors, transformers, pumps, electric control systems, radios, telegraphs, etc., etc., etc. Wall Street is now just a contrived artificial system for personal profit with no useful contribution to society.

Chuck Gallo
Lake Elmo, MN

James Owen Weatherall replies:

There are several different questions one might raise regarding the role of physics and physicists in finance. One question concerns whether physicists' talents serve the greatest good in finance, as opposed to in other fields. Another concerns whether modern finance–physicists notwithstanding–is corrupt or otherwise flawed. With regard to the first, I agree that basic science should have better support both from government and industry, and that physicists may be more productive working in fields other than finance. And as for the second, I have no interest in defending Wall Street excesses. My article and my recent book, however, focus on a third, entirely orthogonal issue, which concerns how to understand the intellectual contributions that physicists have made to financial practice. I believe one can explore the models physicists have developed in finance while remaining entirely agnostic about the moral status of the financial industry writ large. And I believe it is important to do so: Wall Street is here to stay, warts and all; the important question regarding mathematical models is whether we can use them safely and effectively.

Still, let me make just two remarks concerning the other questions. The first is that university physics departments have no difficulty finding excellent candidates for tenure track and research positions. I do not think it is fair to say that Wall Street is syphoning off talent from physics. Instead, young physicists face a lamentably depressed job market. And ironically in this age of shrinking federal research budgets, two of the most significant sources of new science funding today–the Templeton Foundation and the Simons Foundation–were built by philanthropists who made their fortunes through the financial industry. So it strikes me that the relationship between finance and basic research is more subtle than the letter writers suggest.

The second remark is that, as I understand things, the value of financial markets as a public good concerns their ability to transfer capital between those who have it and those who need it for entrepreneurship and innovation. One way in which this transfer can be encouraged is by developing methods for controlling risk, often through financial products that serve as hedges for otherwise dangerous investments. Physicists have been instrumental in developing such products, and in this sense physicists have made a contribution to finance that serves the public good. Of course, it does not follow that all such products are for the best, or that all practices based on such products are morally defensible.

Thoughts on how to think

On the Back Page (*APS News*, March, 2013), James Weatherall wonders why physicists are especially good at financial modeling. He believes that it is because "Physicists have a distinctive way of thinking about mathematical problems. They are experts in approximative thinking, in building toy models and effective theories. This sort of reasoning is just what is needed to take a problem that appears hopelessly complex and find the simplifying assumptions and idealizations necessary to make it tractable."

That sounds right to me. I question, however, whether such a "distinctive way of thinking" or even any thinking about how to think and what that means is ever expressly addressed during a physics student's education. I have to wonder if the only individuals who are able to become professional physicists are those who innately possess or otherwise independently acquire the right ways of thinking.

I came into physics out of an authoritarian religious and cultural upbringing. Late in my graduate studies I found myself questioning my very thought processes. Although I finally received a PhD, my awakening was too little, too late, and I was never able to have a career in physics.

To what extent is thinking about how to think part of a physics student's experience these days, and could the situation be improved?

Neal Reid
Oakville, Ontario

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disciplines require significantly larger research budgets than others. For example, data from the National Science Foundation shows that PIs in industrial engineering have an average yearly expenditure of $0.094 million, whereas PIs in molecular biology averaged $1.28 million per year.

When the group factored these elements into a new calculation of publication rates, they confirmed that in disciplines where expenditures are low, there is no "significant difference" in publication rates based on gender. The publication discrepancy is larger, however, in more costly disciplines.

As the paper notes, women in STEM fields have historically received "less institutional support and have had less access to research resources" than male colleagues. It now appears those discrepancies have a direct impact on publication rates.

Undergraduates Need More than Access

Roxanne Hughes, Director of the Center for Integrating Research at the National High Magnetic Field Laboratory, presented results from her 2012 study in the Journal of Women and Minorities in Science and Engineering on the effectiveness of a program called WSTEM, targeted at supporting female undergraduate students in STEM fields. The program included living in a dorm with other female STEM majors, and providing access to research opportunities and mentorships.

Among 26 female undergraduate students pursuing a STEM undergraduate degree at the university, 12 of them persisted while 14 left their STEM major. Six of the women who participated in the WSTEM program remained in the physics department, while six left.

Hughes says that, among participants in the WSTEM program, the split between women who persisted and those who left was almost identical to that among non-participants. This suggests that *access* to resources and opportunities within the STEM fields does not result in a significant increase in retention of female students. More in-depth analysis by Hughes found that the common factors among students who persisted in STEM fields were: specific STEM goals and aspirations (which may often be developed with mentors or more one-on-one interactions with professors), and strong social networks (either established formally by a program or informally).

"Sometimes … opening access doesn't change the underlying issues that are affecting women and underrepresented minorities persistence [in STEM fields]," said Hughes, noting that both students who persisted in STEM and those who left reported seeing signs of the "chilly climate," such as a lack of guidance, and a lack of help and advice from faculty. But, she notes, these are factors that can affect both males and females.

Hughes also noted that the federal government is investing in programs and policies that provide this kind of access to women and underrepresented minorities. She says those programs and policies should also include efforts to make students more aware of the opportunities available to them.

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his assertion that the second law may not be broken, ingenious physicists continue to demonstrate that perhaps it can be bent.

Further Reading:

Eshuis, P. et al. (2010) "Experimental Realization of a Rotational Ratchet in a Granular Gas," *Physical Review Letters* 104(24): 4.

Feynman, R.P. *The Feynman Lectures on Physics*, Vol. 1 (Chapter 46). Boston, MA: Addison-Wesley, 1963.

Von Smoluchowski, M. (1912) "Experimentell nachweisbare, der Ublichen Thermodynamik widersprechende Molekularphenomene," *Phys. Zeitshur* 13: 1069.

Diversity Corner

Registration Open for the APS Bridge Program Summer Meeting
The APS Bridge Program Summer Meeting will bring together experts to discuss efforts to increase the number of underrepresented minorities who receive PhDs in physics. The meeting will be held June 27-29, 2013 at the American Center for Physics in College Park, MD. Workshops, panel discussions, and presentations will address topics such as: mentoring, bridge program logistics, cultivating faculty/administrative support, and building a sense of community for students.

The conference is designed for faculty, administrators, and students from prospective and existing bridge program sites, as well as others who might be interested. Registration for the summer meeting is open at: http://www.apsbridgeprogram.org/conferences/summer13.cfm

2014 CUWiP Sites Announced
The Conferences for Undergraduate Women in Physics (CUWiP) will take place at eight sites around the country in 2014. More details about these conferences will be released in late summer 2013. The sites are:

Florida State University	Louisiana State University
Penn State University	Stony Brook University
University of Chicago	University of Maryland/NIST
University of Utah	U.C. Berkeley

Learn more about CUWiP at: www.aps.org/link/cuwip

Nominations for the CSWP Woman Physicist of the Month
In January 2012 the APS Committee on the Status of Women in Physics (CSWP) began a program to highlight exceptional female physicists. The CSWP Woman Physicist of the Month award recognizes female physicists who have positively impacted other individuals' lives and careers. Each CSWP Woman Physicist of the Month is featured on the Women in Physics website (www.WomenInPhysics.org), announced in the *Gazette*, and recognized at a reception at an APS national meeting.

Nomination is easy: email a three-paragraph statement explaining why the physicist you are nominating is worthy to women@aps.org.

Follow APS Diversity on Twitter
Curious to hear the latest happenings in physics and diversity? Follow @APSDiversity on Twitter.

Download the Women in Physics InSight Slide Show
Physics InSight is a series of slide shows designed to inform and excite undergraduates about physics. Download a slide show focused on women in physics at: http://www.aps.org/careers/insight/2011women.cfm

Spring 2013 *Gazette* is Available Online
The *Gazette* is the newsletter of the APS Committee on the Status of Women in Physics (CSWP) and the Committee on Minorities (COM). Items featured in the *Gazette* include updates on CSWP and COM activities and programs, book reviews, statistical reports, and articles on programs designed to increase the participation of women and minorities in science. Read it here: http://www.aps.org/programs/women/reports/gazette/

Join the *Gazette* mailing list by emailing your name and postal address to women@aps.org; you do not have to be an APS member to receive the *Gazette*.

Letters (continued)

Shocked...shocked

In his letter in the April 2013 issue of *APS News*, Jeffery Winkler expressed "shock" at APS Executive Officer Kate Kirby's statement in the February issue that "Encouraging women to pursue physics is a top priority for us." He then goes on to imply that by making that statement Kirby has decided a priori that the percentage of women in physics should be 50%. Nowhere in the February article did Kirby express such a position.

All that one really can imply by Kirby's statement is that perhaps the percentage of women in physics is lower than it could be. And the data seem to support that view. Currently women earn about 21% of bachelor's degrees in physics, and 17% of PhD degrees. These figures are lower than in the other hard sciences and mathematics.

Times change and people change. At one time the percentages of women in fields like law and medicine in the US were quite small. Now those percentages are roughly 50%.

Why shouldn't we encourage our daughters as well as our sons to take a look a physics as a possible career? It may be true that relatively few people are attracted to the discipline. However, there is nothing intrinsic about physics itself that should make it less attractive as a career to women than to men. On the other hand, if there are subtle (or not so subtle) biases against women working in physics on the part of the current cadre of physicists, young women thinking about physics as a career might find that off-putting.

Mark H. Shapiro
Fullerton, CA

Profiles in Versatility

Geophysicist Rocks at Helm of International Tsunami Information Center

By Alaina G. Levine

The day after Christmas 2004 began in a typical non-eventful manner for most of the planet. But in the early morning hours in Indonesia, an earthquake with a magnitude of 9.1-9.3 struck off the west coast of Sumatra. The resulting vicious tsunami was one of the worst disasters in recent human history, causing 230,000 deaths in 14 nations surrounding the Indian Ocean.

In Honolulu, Hawaii, Laura Kong, a geophysicist by training, received a phone call 30 minutes after the earthquake from the Pacific Tsunami Warning Center (PTWC), and sprang into action. As Director of the International Tsunami Information Center (ITIC), Kong possessed expertise that was desperately needed by countries that previously never would have even expected a tsunami. "Before this, most countries in the Indian Ocean didn't know what a tsunami was and what it could do," she says. Further compounding the problem, "back then there was no real time data in the Indian Ocean."

Kong and PTWC scientists on duty gathered what information they could from news reports as they urgently tried to contact Indonesian government officials. "In the chaos, all communication lines were down and no one answered the phone," she recalls. By 8 p.m. Hawaii time, about 5 hours after the earthquake, she was finally able to solidify information and data about what had occurred. And from that point on, her life was consumed by the catastrophe.

Laura Kong

For over a month, she and her colleagues consulted almost non-stop with government representatives from affected regions, sharing and collecting data, and offering advice and information about how to set up a reliable tsunami warning system.

"The 2004 Indian Ocean Tsunami was that rare moment in my professional career that changed everything," she says. "Prior to 2004, the tsunami warning and mitigation system was unknown. There were only a few very passionate, dedicated scientists and governments and very little research on tsunamis and tsunami warning systems. Very few governments made the hazard their top priority. But after December 26, all of their lives changed. Everyone wanted to know about tsunamis and what they could do prevent another catastrophe."

One of the most important outcomes was the creation and installation of an Indian Ocean warning system. "In 2004, the PTWC and ITIC were the only dedicated international tsunami centers in the world, but over the last seven years we've tried to transition information to Indian Ocean countries and other regions so they are responsible for their own training." The ITIC, a joint partnership between UNESCO and the U.S. National Weather Service/NOAA, serves the world, she notes. "Where there is a requirement, we help." Opportunities to assist range from simple data sharing, to more complex capacity building, training, and resource allocation for designing and installing warning and tsunami response and preparedness systems.

Kong's work ultimately affects policy discussions surrounding tsunami warning systems. She has helped brief government officials from around the globe as the new

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New System Could Send Entangled Photons into Space

By Michael Lucibella

A research team from Italy is developing a system that will let physicists beam quantum information to and from space. In a talk at the March Meeting, the team described a way to transmit an entangled photon, using a particular kind of polarized light, to an imperfectly aligned receiver akin to the orientation of a passing satellite.

Scientists have been investigating the "spooky" quantum properties of photons in hopes of setting up a long distance communication system. Among other advantages, it would be impossible for a nefarious third party to intercept and decrypt the message without alerting the sender and receiver.

In order for such a system to work, a link first needs to be set up between the two correspondents. One correspondent entangles two photons, and sends one still in its entangled state over a distance to the second correspondent. When the quantum state of one photon is measured, the wave function of the distant photon also collapses instantaneously. With some manipulation, scientists hope to be able to encode information into this collapse, possibly by entangling a third photon.

"We encode the quantum information in some degree of freedom of the photons, and send the photon from one partner to the other," said Fabio Sciarrino from Sapienza–Università di Roma. "The most common approach exploits the polarization of light."

Scientists have not quite gotten to the point where useful messages can be sent through such a system. However they have been making significant strides transmitting entangled photons over great distances. An experiment conducted in the Canary Islands set a new distance record in 2012, transmitting an entangled photon to another island 144 kilometers away. However, at some point the curvature of Earth will block the transmission's line of sight, thus requiring a satellite to relay the signal.

Orbiting spacecraft would run into a problem when trying to receive signals from the ground. The satellite's constantly changing position and orientation makes it nearly impossible for it to accurately receive traditional beams of polarized light. Most of the time the satellite's receiver would be out of alignment with the transmitter on the ground, distorting the transmission.

"If you have two satellites which are moving, one with respect to the other, it is non-trivial to align the horizontal axis of one satellite with the horizontal axis of the other satellite," Sciarrino said. "Our approach is to combine together two different degrees of freedom of light."

Sciarrino's solution was to use circularly polarized photons. "The phase of the beam is not a plane-wave. Instead it is a helix, rotating either clockwise, or counterclockwise," Sciarrino said.

To generate the circularly polarized photon, Sciarrino shined the light through a liquid crystal display, dubbed a "q-plate." He directed the beam at moving receivers, essentially mini-telescopes, to gauge how faithful the transmission was of the entangled photons.

Initial experiments carried out in his lab were encouraging. To follow up, Sciarrino partnered with a team from the Università degli Studi di Padova known for transmitting entangled photons over long distances. Tests so far at 100 meters have likewise yielded positive results, and Sciarrino said he hopes to push transmission distances up to a kilometer soon. The lowest satellites orbit at about 160 kilometers above Earth's surface.

At those distances other factors could potentially interfere with the transmission. The effects of atmospheric disturbances in particular are what Sciarrino and his team will soon be investigating. In addition, in the future the team will have to look at the relativistic effects of orbiting satellites, but Sciarrino said he didn't think that would be a difficult complication to surmount.

PhysTEC continued from page 1

Building on its involvement in the 2012 PhysTEC conference, the American Chemical Society (ACS) had a more prominent role this year as a conference cosponsor. Jacob Clark Blickenstaff, APS Teacher Education Program manager and a conference organizer, said, "I was very pleased with the partnership with the ACS and the inclusion of chemistry teacher educators in this conference." Featured workshops on chemistry included parallel sessions on the Chemistry Teacher Education Coalition, course design, and learning chemistry in cooperative groups.

Michael Marder's lunch plenary titled, "Nothing Makes Sense in Physics Education Except in the Light of Poverty," included data on the many factors that affect teacher preparation. Marder, the Associate Dean for Science and Mathematics at the University of Texas at Austin, emphasized that trends are more striking when data are disaggregated by lower income versus higher income students.

The conference featured a number of parallel sessions and workshops on topics including induction and mentoring, course reform, innovative practice, recruitment and retention, and sustaining reform.

Clark Blickenstaff noted that Catherine Good's talk on stereotype threat generated a great deal of interest in the community. Good, an Assistant Professor of Psychology at Baruch College, addressed stereotypes that affect the achievement of females and minorities in STEM disciplines, and described research-based interventions to help students overcome the impact of these negative stereotypes.

The conference closed with a panel session on the implications of the Next Generation Science Standards for teacher preparation. Panelists included Helen Quinn of SLAC, Melanie Cooper, Andy Jackson, and Ramon Lopez of the University of Texas at Arlington.

The PhysTEC conference is the nation's largest event focusing on physics teacher preparation, and is a major component of the PhysTEC project. The PhysTEC project, a partnership between APS and the American Association of Physics Teachers (AAPT), strives to improve and promote the education of future physics teachers. It does so primarily by selecting colleges and universities that can effectively use substantial project support to develop their physics teacher preparation programs into national models and make significant increases in the number of teachers they graduate.

To date, the project has supported 29 such sites, and recently announced the funding of four additional sites: University Central Florida, University of Cincinnati, Georgia State University and North Carolina State University. The number of teachers graduating each year from PhysTEC-funded institutions has greatly increased since the project began in 2001.

The 2014 PhysTEC Conference will be held May 19-20 in Austin, TX in conjunction with the UTeach Conference.

Galileo Would Have Been Proud

Photo by Renée Royal

As Aaron Osowiecki (standing, left) watches, Ashwani Kumar (standing, right) of Monmouth College measures the time it takes for a marble to roll down an inclined plane. Osowiecki and Jesse Southwick, both of Boston Latin School (founded when Galileo was still alive) gave a presentation at the PhysTEC Conference on "Ramps and Bungee Cords: Bringing It Together" that showed how students could "discover" conservation of energy by modeling their own data.

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What have you done to make that change happen?

I think there were a couple things that were important. One was we tried to reach out more to the applied areas and energy, much more strongly than we have in the past, and I think that has worked. We have a lot of interactions with the energy side of the house. We have what we call "Tech Teams," members from ARPA-E and from the various energy [associate director] levels. We have these groups working together to try to figure out what each program is doing and how they fit together. I think we were particularly successful with respect to batteries, where the tech team was the team that worked out the FOA [Funding Opportunity Announcement] for the batteries, and did this as a group across the three boundaries. This was very successful, and I think that that was one of the important changes. We've made a lot of changes administratively in the way we do business. We now have almost turned the whole business of applying for a grant into a totally electronic approach. We've sped up the process. A lot of things like that. We've worked hard at a lot of different aspects of running the organization well.

Was there anything you would have liked to have been able to accomplish that you weren't able to?

My biggest frustration had to do with two things. One of them was the fact that we couldn't seem to get enough money to do both ITER and the domestic program in fusion. That's hurt that field some. The other thing is, we're still struggling with the whole issue with what's going to happen at Fermilab and the shutting down of the Tevatron and making sure the US has a place in the whole international high energy physics milieu, and that's something that's really going to have to be worked on in the next year or two.

Do you think that America is losing some of its competitiveness in science?

One of the things that worries me is the very conservative fiscal attitude that's occurring in Washington. President Obama has been quite good about not cutting our program, but at the same time we were promised a doubling and none of that happened and it is unlikely to happen. What worries me is the rest of the world is building up their scientific budget substantially over the last few years. You look at Europe; there's a lot going on in Europe. You look at China; there's a lot going on there, South Korea too. Competitiveness is something I worry about a lot from a US standpoint. The X-ray free electron laser is great, it's leading the world, but there are four more that are going to be built in four different countries in the next years. So there's a lot happening out there.

What do you think will be the lasting effects of sequestration?

It's certainly going to delay a lot of programs and a fair number of grants are not going to be made and fulfilled, so it's going to have a real impact. It's $250 million worth of research that won't be done. It's that simple.

What about the recent travel restrictions that the administration has imposed? Do you think that's going to affect scientists' ability to do science?

Yes, very much so. It will affect the people trying to travel, and this whole conference thing has created a very large bureaucracy that I don't think is a very big benefit, and I think we're spending more on the bureaucracy than the savings we might accumulate from restricting conference attendance. So I don't see it as having been such a successful approach to science. Scientists have to travel, that's the thing that I tell people, scientists have to travel because that's what you do. You have to advertise the results, otherwise people won't pay attention to them. And you've got to go find out what other people are doing, because you want to be ahead of the field, not behind the field. There are very real reasons that scientists travel. I feel the same way about our program managers. Our program managers have to be able to travel, and we have certainly suffered a lot of restrictions on our end. Traveling is very important to science.

What do you think is going to be the future of nuclear physics and fusion physics. What do you see happening to those fields?

I think both of those fields are eventually going to be ok. We have to build the FRIB [Facility for Rare Isotope Beams] machine at Michigan State, and it's going to take a while. We don't really have enough money in the nuclear physics program to put that in with everything else, but we'll get there. Likewise in fusion, the way we set up the ITER budget will allow fusion's domestic program to get back on its feet in a year or two. I'm hoping that will work out and I think that's very, very important. We have been very strongly pushing a programmatic side of our science relevant to near-term energy programs and issues, so we pushed basic energy sciences and computing and biological and environmental sciences, and maybe we've gone a little bit too far, and we have to pull back and help out fusion and [High Energy Physics] and the physics of the future.

Are you generally optimistic about the direction of science that the country is going in? What do you see coming up on the horizon?

It's a very interesting time because there is probably nothing more important to mankind than the climate issue. But a lot of the response to that is often applied research. We have to be careful, it seems to me, that even though that's extremely important, we have to watch out that we don't do in our basic research. That's a very real risk as we go forward. I personally came to work in Washington because I thought the climate situation was sufficiently bad that we really needed to try to do some things. I think Steve Chu was reasonably successful in starting a bunch of things that mattered from a climate point of view. But boy, we are a long way from where we need to be.

What kind of advice would you offer to your successor?

My successor has to make the best of the issues that we just talked about. They are not easy issues, and he or she will have to figure out how to move forward.

AIP continued from page 1

lishing is a fast moving business," Dylla said. "It was felt to be very important to get the publishing right."

AIP Publishing will have its own governing board of about 12 people with a half-dozen experts of varying backgrounds, many fewer than the 40-person board of AIP. The new board plans to meet four times a year, rather than twice.

Despite the new governance structure, the intention is to keep the day-to-day operations of the journals unchanged. AIP Publishing is retaining the same offices and much of the same staff as when publishing was directly under AIP. *Physics Today* will remain editorially under AIP, while its physical publishing will be done by the LLC.

"It was an AIP Governing Board decision that created this entity, and it is very similarly organized to what AIP publishing used to be," said Marsha Lester, a chemistry professor at the University of Pennsylvania, and editor of *The Journal of Chemical Physics*. "The primary difference is that [the LLC] has its own board of directors."

The CEO of the new company is John Haynes, who was previously vice president for publishing at AIP.

"[T]he creation of AIP Publishing LLC places the organization in an excellent, strategic position to deliver even more benefit to global researchers whilst continuing to provide great value to library customers worldwide," Haynes said in a statement.

The reorganization comes as part of a major rethinking of AIP operations laid out in a 2008 self-assessment and a 2010 governance review.

"It had become clear to our Governing Board that it had been 80 years since AIP as a whole really looked at its governance," Dylla said.

The assessments criticized the complexity of its system for decision-making, and its large, 40-person Governing Board.

"When a meeting is that big, and it meets so infrequently, it's hard for the management and the governance to be a closely knit team," Dylla said.

Now that the publishing operation has been streamlined, the board is refocusing on reassessing and restructuring the governance of the rest of the Institute's operations. In addition to *Physics Today*, AIP runs the Niels Bohr Library & Archives and the Center for History of Physics, as well as the Statistical Research Center. It is active in government and media relations, and also administers the Society of Physics Students for undergraduates, and the Sigma Pi Sigma honor society.

Commenting on the establishment of AIP Publishing LLC, Bill Appleton, a professor emeritus at the University of Florida and editor of *Applied Physics Reviews* said "The main concern I have personally is that AIP and APS have been very closely coupled over the years and from a scientific point of view that is extremely beneficial. I don't think this will have any effect on that, but it would be too bad if it did."

Bruno Nachtergaele, a physics professor at the University of California, Davis and editor of *Journal of Mathematical Physics*, said that he thinks the new setup will help the journals respond to changes in the market faster.

"I'm certainly optimistic about the journal and I don't think the new company will affect it greatly," Nachtergaele, said. "I don't see anything negative at this time."

ANNOUNCEMENTS

Call for Nominations

APS Nicholson Medal for Human Outreach

The **Nicholson Medal for Human Outreach** is awarded to a physicist who either through teaching, research, or science related activities,

1. has demonstrated a particularly giving and caring relationship as a mentor to students or colleagues, or has succeeded in motivating interest in physics through inspiring educational works, or
2. has created special opportunities that inspire the scientific development of students or junior colleagues, or has developed programs for students at any level that facilitated positive career choices in physics, or
3. has successfully stimulated the interest and involvement of the general public on the progress in physics.

Nominations are active for up three years. **Nomination deadline - July 1, 2013**

Further Information: www.aps.org/programs/honors/awards/nicholson.cfm

APS Bridge Program Summer Meeting

June 27-29, 2013
American Center for Physics
College Park, MD

The APS Bridge Program Summer Meeting will bring together experts to discuss efforts to increase the number of underrepresented minorities who receive PhDs in physics. Workshops, panel discussions, and presentations will address topics such as:

- mentoring
- bridge program logistics
- cultivating faculty/administrative support
- building a sense of community for students

Conference designed for faculty, administrators, and students from prospective and existing bridge program sites, as well as interested graduate programs.

www.APSBridgeProgram.org

APS physics BRIDGE PROGRAM

Reviews of Modern Physics

Cold atoms in cavity-generated dynamical optical potentials

Helmut Ritsch, Peter Domokos, Ferdinand Brennecke, and Tilman Esslinger

When an atomic particle is placed inside a high-finesse electromagnetic cavity and is coupled to its radiation field, a rich nonlinear dynamics arises. This review describes recent advances in this research field, from both the theoretical and experimental points of view. At the single atom level, it presents novel cooling schemes that are applicable to any polarizable particle. It also addresses the situation where many atoms are simultaneously present in the cavity, in which case spectacular collective phenomena can occur, from superradiant light scattering to the formation of supersolids.

▶ **http://link.aps.org/doi/10.1103/RevModPhys.85.553**

http://rmp.aps.org

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warning system has been developed. In fact, the favorite part of her job is the opportunity to help nations with capacity building, she says. "We can impact how well countries are able to respond, and build a network and sense of confidence in the people responsible, and this ultimately will save lives," she says.

Kong did not envision an international career in science diplomacy when she received her bachelor's degree in geology with a minor in physics and mathematics from Brown University. In fact she was more focused on oceanography research. She pursued a doctorate in marine seismology through the MIT/Woods Hole Oceanographic Institution Joint Program in Oceanography and spent her graduate school years on sea-going vessels. "I crossed the Atlantic, Pacific, the equator, and the poles," she recalls.

But after receiving her PhD in 1990, Kong turned her attention to government. Following a postdoc at the University of Tokyo, she pursued public service opportunities at the Pacific Tsunami Warning Center, the USGS Hawaiian Volcano Observatory, and even the Federal Highway Administration, where she analyzed the environmental impacts of highway construction. She joined the ITIC in 2001.

Much of her day-to-day work is dedicated to appropriately communicating complex scientific information about tsunamis to governments and individuals who are laymen. One of the "hardest challenges about conveying scientific information to the public is to be able to put very technical information into a format that the public can take action on. For tsunami warnings, everything happens very quickly," she clarifies. "There is a premium on clear information that is not confusing–that if a wave is coming, get out of the way. But to get everyone to understand and act immediately is challenging."

Another problem Kong and her PTWC colleagues face is that during any given tsunami emergency, like the 2004 Tsunami, they probably do not have all the information immediately. "We have to react within an hour and most of the time we don't have enough data to say we're 100% correct." And yet, they have to issue statements and suggestions for government leaders to convey to their own people in a way that cannot be misinterpreted by anyone in the chain, she reveals.

"At minute three [of an event], as a scientist you don't actually know what happened," she describes. "But our public officials want to know what happened *now*. And once a scientist says something, it seems to become gospel." It can be magnified with very little data, she continues, so part of her challenge is to ensure that information is communicated in both a timely and easily understood manner. "The more you do this, the easier it gets." To that end, she helped author a standard operating procedure for crisis warning communications.

"If your astrophysics research project is over years, you have the luxury to plan," she says. "Here you don't have time to think. It will be over before you have time to think. Clear, concise communication is the most critical if you only have minutes."

In 2011, Kong's team again was put to the test when the March 11 earthquake and resulting tsunami hit the east coast of Japan. "Japan has the best tsunami preparedness in the world," she confirms. "Yet in the course of two to three hours, 20,000 people died." The lesson, she notes, is that even with the most cutting edge technology that Japan possessed, "local tsunamis are hard to respond to successfully. The best strategy is education of local populations before. Unfortunately, the sad part is that even if you know, people are probably still going to perish if they get caught in a wave. It's sobering to think that it can happen to Japan in a snap of a finger."

Kong confirms that her physics background has given her a strategic avenue for deciphering these unique scientific, communications and policy puzzles. "I would say that while my geophysics expertise has been essential to advise governments, perhaps more important is that my science training has taught me to approach problems in a logical, level-headed way, something especially important during a fast-evolving tsunami emergency."

And she wouldn't change the way her career has blossomed. "I went to school, I thought, to do research, but what I am doing now is very different–it requires that scientific background to put things together to make sense," she says. And her advice for physicists interested in taking the road less traveled? "Learn how to think, take in all information available, try to assess and move forward. All that physics work *will* help you in the future."

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stack only allows positive ions to pass through, blocking electrons and creating a current that flows through whatever device is connected to the battery. To recharge, the process reverses as electrons collect in the negative reservoir.

Researchers have been focusing on flow batteries because the amount of charge they can hold is limited only by the size of their tanks, making them ideal to store electricity generated from wind and solar power. In addition they should be able to be discharged and recharged indefinitely.

"You store the energy outside the hardware in big storage tanks," Aziz said. "You can scale up these tanks of chemicals to be arbitrarily large."

The problem that most renewable energy sources run into is their intermittency. Consumers' demand for electricity varies throughout the day, being lowest during the middle of the night, higher during the workday, and having a big spike around six in the evening.

A solar plant's output spikes around noon and tapers off in the evening. Wind power is even more sporadic. Gas and oil plants have the advantage that they can adjust their output up and down to match the changing demand.

"Nature gives us these renewable carbon-free power sources when she chooses to, rather than when we need it," Aziz said. "If we could have the ability to store large enough amounts of electrical energy at low enough cost, then we could make wind and solar dispatchable."

The ARPA-E grant started in February, and the team is still in the initial phases of testing which quinones work best. So far, preliminary experiments using a benzoquinone have yielded promising results, but many more tests are still needed.

At the March Meeting, Aziz and his team showed that they have been able to make flow batteries that let up to 50 milliwatts flow through a square centimeter of the cell stack's membrane. He said that while encouraging, that number needs to be an order of magnitude greater before they can start to commercialize it.

"Exactly how to scale this up is not clear right now and there can be a lot of hiccups along the way," Aziz said. "But if you wrote me a check for everything I needed, I think well within a decade we'd have this working."

Although the idea of flow batteries has been around for decades, they have received renewed attention in recent years as renewable energy has gotten more popular.

Most existing designs use vanadium compounds as their electrolytes. The high cost of the metal has, however, kept the cost of the batteries high and limited their adoption. Other versions of the battery using hydrogen and chlorine have also been shown to work, but the dangers of these chemicals will likely hamper their adoption.

"These are non-toxic chemicals…. You eat them in your vegetables, so it's possible to think about putting them in your basement," Aziz said. "The liquid is water, so it's not going to catch on fire."

Aziz did caution that female cockroaches use quinones as pheromones to attract a mate. "So if we end up using this molecule in a flow battery, we probably won't recommend it for energy storage in the kitchen."

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like everyone to join!"

Atherton also stressed that LGBT+ physics is looking for more volunteers, and that some of the group organizers are allies and not LGBT+ themselves.

During the session at the 2012 March Meeting, speakers pointed out that the APS Policy on Equal Professional Opportunity, adopted by Council in 1994, includes protection for persons based on sexual orientation, but does not explicitly mention gender identity. APS Director of Education and Diversity Ted Hodapp, who was in attendance, responded by saying that APS would like its members to initiate such changes to policy. At this year's roundtable discussion leaders handed out copies of a petition that calls on the APS to adjust the policy. Participants were encouraged to take the petitions back to their home institutions to gather signatures, which are being compiled by LGBT+Physics organizer Elena Long.

Atherton noted that the session was also organized with the help of APS's Career & Diversity Programs Administrator Arlene Knowles, and the Committee on the Status of Women in Physics and the Committee on Minorities. In addition, APS Executive Officer Kate Kirby sat in on part of the session, and remarked that she was impressed with the work of the organizers. In a statement to the attendees she added that, "I am committed to making APS an inclusive and diverse organization."

The Back Page

Raising the Bar in Physics Graduate Education

By Meg Urry

It has been clear for quite a while that physicists can't get away with educating only white men. Since 2001 there have been more foreign citizens in our PhD programs than US citizens. We've broadened our admissions to keep quality high, to keep our physics programs strong. Of course, these foreign students are often European or Asian men, so in some sense, our embrace of diversity has not changed the face of physics very dramatically. For graduate physics education in the 21st century, we will have to expand our "big tent" to include more diverse participants if we hope to keep quality at the highest possible level.

As the population becomes more diverse, it also becomes increasingly difficult to justify the selection effects that result in an overwhelmingly white, male student population in our graduate classrooms. Women remain below 10% of active physicists, and no more than 20% in the youngest, most diverse ranks. The latest AIP data, from 2008, show women receiving 18% of the physics PhDs granted in US institutions. People of color represent a much smaller fraction; for example, fewer than 3% of US citizens receiving PhDs are African-American and Hispanic. For comparison, together African-Americans (12.6%) and Hispanic Americans (16.4%) represent more than a quarter of the US population. By 2043, according to the U.S. Census Bureau, our country will be majority minority.

I am suggesting graduate education must diversify not just because of fairness or equal opportunity, although that certainly ought to concern us, but because it's vital for physics.

Why Diversity is Vital for Physics

The first statement of the problem is simple: if we for any reason exclude from our laboratories and classrooms more than 60% of the population (roughly, half being women, a quarter being racial minorities), we are limiting the bright minds who could bring their talents to bear on some really tough problems. Absent compelling evidence that those excluded are less capable, this is not smart.

But there is an even better argument for increasing diversity and inclusion, based on research on the roots of innovation: in discovery fields there is a competitive advantage to greater diversity among practitioners. As Sheila Tobias pointed out to me 20 years ago, great civilizations have often arisen at the intersection of trade routes, where people of different societies encountered new ways of thinking. That is, the conflict of ideas stimulates new and better ideas.

More concretely, research shows that diverse groups are more creative and develop solutions to problems that are judged–by people unaware of the origin of the ideas–to be better. Much of this research has been done in a business context rather than an academic or intellectual one. However, (a) business organizations hire many physicists, and (b) business organizations are probably more aware than slowly changing academic physics departments of the influence of workplace culture on performance. So I believe this research is highly relevant to what we do.

A typical experiment is to create small groups that are, or are not, diverse in gender, race, class, or other variable(s). Each group works independently on a set problem. For example, in their article on "Ethnic Diversity and Creativity in Small Groups," McLeod, Lobel and Cox[1] posed a simple problem related to tourism and asked experimental subjects to brainstorm answers. Experts from the travel industry then graded the responses, not knowing which groups produced each idea; they judged ideas from ethnically diverse groups to be "of higher quality–more effective and feasible–than the ideas produced by the homogeneous groups."

Experimenters also report more strife in diverse groups. It's much easier to talk to and work with someone who is just like you. But talking to yourself about a difficult problem doesn't add as much value as talking to someone with a different perspective.

Many experiments, with different boundary conditions, collectively find that:

1. Diverse groups experience more conflict.
2. If diversity is welcomed (i.e., well managed), diverse ideas lead to better solutions.
3. If diversity is unwelcome, diverse groups fail.

What is behind these results? As McLeod et al. (1996) explained, heterogeneous groups hold a variety of perspectives. This means different ideas come into play, and perhaps the conflict between ideas challenges the group to improve its reasoning. It may also stimulate creativity. So diverse backgrounds lead to different views and in the best case, to a beneficial refinement and resolution of those conflicting ideas.

The claim that differences among people cause them to think differently is quite controversial–for example, there are reams of articles debating whether women inherently think differently than men. Without entering that debate, I think it is clear that the experiences of men and women in physics are different, as are the experiences of ethnic minorities and majorities. That is, how we approach problems, how we think about solving them, how we engage and mentor students, how we work with colleagues–in short, how we do our jobs as physicists–is informed by our individual histories. These tend to have been different for men and women, for different economic classes, for racial groups, and so on. So we have a lot to teach one another.

Perhaps we do best when we work with people who annoy us! I try to remember this when someone is really irritating me. "Hmmm," I think (I hope), "I could probably learn a lot from this person."

Not all conflict or diversity is beneficial. If minorities are seen as outsiders, their voices are not heard and their ideas do not hold. This is worse than had the group been homogeneous because there is the burden of conflict without the attendant benefit.

In a nutshell: more conflict plus more ideas leads to chaos (if conflict rules) or superior performance (if conflict is managed). Which situation do we want for physics?

Why Diversity Improves A Graduate Student's Experience and Performance

In graduate education, our goal is to train bright, young people to be outstanding physicists. It is always easiest to mentor someone who is exactly like you because if you can get inside their head, you know what advice they need to hear. For example, is it good to encourage a student (positive reinforcement) or to challenge them (criticism)? My father was a professor of chemistry with a reputation for toughness. His three daughters are scientists yet none of the four women graduate students who worked with him finished a PhD (although at least one went on to a very successful career at Bell Labs, with strong backing from my dad).

Think of this issue as "impedance matching" with your students. My father treated his students as he wanted to be treated. That means that when they were going through a tough or indecisive patch, he pressed harder. This had worked well for him when he was a student. But he didn't realize that others–like me or my sisters–might react differently in a similar situation. I remember vividly when my older sister (now a biology professor and textbook author) and I told him that that kind of approach would have meant the end of our graduate careers. We both knew we would have quit if challenged that way by our advisors. "No, no," he insisted, "you are both too good to quit." But we pushed back, and I like to think he learned something that day, unfortunately too late for his women students.

So, my dad (who was a great guy with a big heart) was a wonderful advisor for students with his confidence, his sense of belonging, his style of learning. He would have been a disaster as my advisor. What would happen if all professors in a department were like my dad? Or all of them were like me? It's not good for the students.

Another way in which diversity is a benefit stems from the increasing role of teams in modern science. Today it is rare for a "rugged individual" with sharp elbows to make the big contributions. The Large Hadron Collider collaboration has upward of 5000 members and the Hubble Space Telescope is used by thousands of astronomers world-wide. Even smaller-scale "desktop" physics is typically done by collaborative groups.

Business, too, depends heavily on groups working smoothly together. Yet, much like physicists, they still hold tight to the idea of the top performer, the miracle man, the great (male) leader–even when research shows women are better team players and leaders than men.

Many physicists still cling to the image of Einstein, toiling alone in the customs office, having brilliant insights all by himself. But that is not how science happens today–and it wasn't really ever that way, even in Einstein's time. Working together well is critical.

Many institutions have made a lot of progress in diversifying. When I started in physics it was very rare to see women faculty; more than half of physics departments had no women on their faculty. Now, it is rare to find a department of any size without at least one woman faculty member, and many departments have done much better. There are also prominent physics leaders of color, though far fewer. But these success stories must be seen as exceptions rather than the rule. Typically they faced higher obstacles and thus probably had to perform at a higher level to succeed.

My contention (no real data) is that top men and women succeed. The difference is one step down, where men can pass through the evaluation filters and women and minorities generally cannot. We will have achieved equity when women of slightly-less-than-world-changing ability succeed as easily as men of similar ability.

Final Words

We are fortunate to work in an important, exciting field that we love. Let's also remember that we are ideally suited to better the world. I'll end with one final anecdote:

Two weeks into the fall term, shortly after I became department chair, one of the incoming graduate students asked to meet with me. She was thinking of leaving graduate school, she said, because she wanted to "help others." She had spent the summer working for a non-governmental agency in South America, and felt that was much more valuable work for the rest of humanity than solving the fluid equation.

For a quick moment, I saw her point–saw how it looked to her–and realized that we are teaching students that what we do is an intellectual exercise, gratifying to ourselves and other weird creatures like us but not ultimately useful to others.

This is wrong. As the provost at a large Midwestern university once said to me (he was an economist and son of a physicist), "Physicists are a lot like economists. They think they are the smartest people on the planet; they think that if they have not addressed a problem, it has not been solved; and they think there is no problem they could not solve." Sounds about right. So let's put our money where our mouths are: let's teach our students that they can solve the problems of the world, that physics tools are useful and that analytic thinking is essential. Look at climate change; biological systems; even finance. Physicists are there in the thick of it, for better and worse. There is nothing we can't try to do. We have the training to do as much as, or more than, anyone else to address the challenges facing this nation and the world. So let's find students who reflect the constituency and interests and concerns of the world, and equip them to make the world a better place.

Meg Urry is the Israel Munson Professor of Physics and Astronomy, and Chair of the Physics Department, at Yale University. This article is adapted from her keynote address at the APS Conference on Graduate Education on January 31.

1. McLeod, Poppy; Lobel, Sharon; Cox, Taylor (1996). "Ethnic Diversity and Creativity in Small Groups." *Small Group Research* 2(27): 248-264. <http://hdl.handle.net/2027.42/68515>

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