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Spring Prizes & Awards
See Insert

Gala Laser Celebration Sparkles in the Snow

By Michael Lucibella

APS and the Optical Society of America held a gala event at the Smithsonian Museum of American History to kick off the year's physics outreach program LaserFest. Energy Secretary and Nobel Laureate Steven Chu delivered the keynote address, highlighting the history of the laser, and laser innovations over time.

"Lasers are everywhere in society. Many times society doesn't know how deeply embedded they are," Chu said, "The first fifty years have been great, hopefully the next fifty years will be even better." Chu won the Nobel Prize in 1997 for optically trapping and cooling atoms using lasers.

LaserFest is a yearlong series of events celebrating fifty years of laser innovations and applications. APS has joined with the OSA, SPIE, and IEEE Photonics to put together events throughout the year aimed at making the public aware of the importance of lasers in modern society and honoring the physicists and engineers who made it all possible.

Photo by Ken Cole

Enjoying the celebration are (left to right) Optical Society Chief Executive Officer Elizabeth Rogan, Secretary of Energy Steven Chu, and APS Executive Officer Kate Kirby.

For the kickoff event, the museum's Flag Hall was transformed into a blue and white LaserFest extravaganza. A giant LaserFest logo was projected onto the wall above the hall's newly installed sculpture of Old Glory. At the center of the floor was a three-foot tall silver and red cake sculpture in the shape of Maiman's original ruby laser.

To keep the celebration of lasers going, the Museum of American History will feature a display case on the first floor of the museum containing artifacts that trace the history of laser innovations and applications. The exhibit was developed to underscore the many different ways that lasers are used. In it, an old style laserdisc player and laserdisc copy of Disney's "Fantasia" showed how lasers are an integral part of many consumer products. Next to them, a laser

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Kavli Plenary Session Examines STEM Education

By Calla Cofield and Gabriel Popkin

On Saturday, February 13, the APS "April" Meeting featured a plenary session entitled "Re-Energizing America's Focus in STEM Education," which was funded by the Kavli Foundation and organized jointly by the APS, the American Association of Physics Teachers (AAPT), the National Society of Black Physicists, and the National Society of Hispanic Physicists. Speakers included Linda Slakey of the National Science Foundation (NSF), Shirley Malcom of the American Association for the Advancement of Science (AAAS), and Robert P. Moses of the Algebra Project.

Slakey, the Acting Executive Officer of the Education and Human Resources Directorate at the NSF, opened the session with her talk titled "Catalyzing Widespread Implementation of Good Teaching Practices."

At the high school level, the key challenge to implementing good teaching practices is simply that, as Slakey put it, we don't have physicists teaching physics. Without teachers who are deeply conversant with the subject, students are not receiving the feedback they need to their questions, or finding professional role models.

On the other hand, college level education suffers because for the most part it does not incorporate a growing understanding of how students learn STEM subjects.

"Many of our colleagues have a deeply held misconception that lecturing is the most effective way to teach," said Slakey, "when in fact there is a lot of evidence to the contrary." Slakey said she looks largely to member societies like the APS

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Blockbuster Meeting Set for Portland

The APS March Meeting, the largest physics meeting of the year, will take place at the Oregon Convention Center and the Hilton Portland and Executive Tower Hotel in Portland, Oregon from March 15–19. Meeting attendees will present over 7,000 research papers in a wide variety of fields including condensed matter, computational physics, chemical and biological physics, new materials, polymers and fluids. A number of sessions will also look to explore the role of physics in different segments of society including its role in industry, national security, human dynamics, sustainable energy, and energy storage.

This year's meeting coincides with the fiftieth anniversary of the construction of the first working laser. To mark this important milestone, APS has partnered with the Optical Society of America, SPIE, and IEEE Photonics to put on LaserFest, a yearlong celebration of laser innovations and applications. LaserFest events at the March Meeting will focus on the importance of lasers in society, including session B5 "Five Legacies from the Laser," and J8 "LaserFest: Laser Education and Outreach," as well as the LaserFest booth.

Among the meeting highlights are:

Nobel Prize Lecture

One of the 2009 Physics Nobel Laureates, George E. Smith, will reprise his Nobel Prize Lecture on Wednesday, March 17, at 5:45 p.m. The title of his talk is "The Invention and Early History of the CCD."

The World's Fastest Transistors. The quest for faster computer speeds has pushed transistor technology ever smaller, regularly doubling average processing speeds about every eighteen months. Today millions of micro-sized transistors are able to fit on a single computer chip the size of a fingernail. Silicon has for decades formed the basis for this computing revolution, but experts predict that the technology is rapidly approaching its limits. Researchers looking to the future expect that transistors made of graphene, single atom thin carbon sheets, will be the material that forms the basis of future transistors. Thus far researchers have run into difficulty getting graphene to create an effective band gap that prevents current from flowing when a circuit is turned off. However, physicists at IBM research labs think that stacking layers of graphene on top

MEETING continued on page 6

RHIC Sets Temperature Record

At the "April" meeting, physicists from Brookhaven National Lab announced that they measured the hottest temperature ever recorded, thus recreating an exotic form of matter that hasn't existed since microseconds after the Big Bang. This is the first time that physicists were able to positively confirm the creation of the much sought after quark-gluon plasma.

"The RHIC at Brookhaven created matter that seems to be at a temperature of 4 trillion degrees Celsius. This is the hottest matter ever created in a laboratory," said Steven Vigdor, Associate Laboratory Director for Nuclear Particle Physics at the Lab, "We're talking about

RHIC continued on page 4

Record Snow Doesn't Faze Meeting Attendees

The record amounts of snow falling on Washington DC just days earlier had little effect on the joint APS "April" Meeting and AAPT Winter Meeting held in the city.

The two snowstorms, locally dubbed "Snowmageddon" and "Snowverkill," walloped the DC region with over 38 inches of the white stuff in just six days. This made it the snowiest winter in the nation's capital, closing the federal government for an unprecedented four and a half days.

But even with the snowstorms and a further dusting on Monday, the joint APS/AAPT meeting went on almost as expected. The snow did slightly delay the start of an affiliated conference of the Physics Teacher Education Coalition (PTEC) and force cancellation of Friday's Professional Skills Development Workshop and High School Teachers Day. Continued efforts by the local department of transportation to remove snow drifts snarled traffic all around the city throughout the weekend of the meeting.

However, nearly all of the scheduled sessions and events from Saturday forward went ahead with only minimal interruption. Preliminary attendance numbers available at press time indicate that the number of people forced to cancel their plans to attend the meeting was surprisingly small.

Photo by Michael Lucibella

Most meeting attendees said that overall the snow had little impact on them.

"I don't think it's really affected [the meeting] too much. We're from Michigan so we're pretty used to this," said Aaron Siebold at the Andrews University Physics Enterprises Booth, "We were kind of surprised at how they didn't know how to clear the streets around here."

Donald Koetke from Valparaiso University reflected this sentiment, "You've got to be very careful when you're out walking, but we got in with no problem."

Others, however, were more averse to the wintery conditions.

"I'm from Texas and we don't do snow," said Toni Sauncy, president of the Society of Physics Students, "I brought a gigantic grizzly coat because I was afraid of the snow, and I didn't leave the hotel for three days."

Industrial Applications Prize Set for Round Two

APS will select the second recipient of its new Prize for the Industrial Applications of Physics this year. Preliminary nominations, consisting of a letter of at most 1000 words, plus one additional optional letter of support, are due this April 1. The selection committee will then choose a number of finalists from among the preliminary nominations, and these will be asked to submit a more complete nomination. The recipient(s), recommended by the selection committee from among the finalists, will be approved by the APS Executive Board at its September meeting.

The preliminary nominations are designed to make it as simple as possible to submit nominations, in recognition of the fact that many industrial physicists are at smaller companies, and may not have time and resources comparable to their academic colleagues. As the prize website states, "the Prize will be awarded for innovative, leading-edge ap-

PRIZE continued on page 7

Members in the Media

"The Midwest is just too flat and we wanted to be somewhere in the West,"

Glen Wagoner, *on why he retired to Colorado,* The Denver Post*, January 24, 2010.*

"Fusion energy could provide a long-term solution to the planet's energy needs without contributing to global warming,"

Michael Mauel*, Columbia University,* MSNBC.com*, January 28, 2010.*

"The reason why time travel affects us on a visceral level is because it touches on this idea of destiny versus choice."

Sean Carroll*, Caltech,* MSNBC.com*, February 2, 2010.*

"Two years at 7 TeV is not that much better than seven years at 2 TeV, which we already have in the can. But we will make the most of whatever they give us."

Joe Lykken*, Fermilab, on the slow restart of the LHC,* The New York Times*, February 4, 2010.*

"We are studying the physics of viruses, not the biology of viruses…By treating viruses as physical objects, we can identify physical properties and mechanisms of infection that are common to a variety of viruses, regardless of their biological makeup, which could lead to the development of broad spectrum antiviral drugs."

Alex Evilevitch*, Carnegie Mellon,* UPI*, February 8, 2010.*

"It takes a lot of effort, makes a lot of noise, and doesn't produce much. But there's potential there, and everybody's really excited."

Thomas LeCompte*, Argonne National Lab, comparing the LHC to a newborn child,* The Minnesota Post*, February 9, 2010.*

"I've accomplished a great deal…I just felt this was a good time to go."

Vernon Ehlers*, US House of Representatives, announcing his retirement,* Chicago Tribune*, February 10, 2010.*

"You need strong public support for research, especially in this free market economy, because it's clear that the private sector won't invest in long goals, they all want results at very short terms,"

Serge Haroche*, Laboratoire de Physique de l'École Normale Supérieure,* CNNinternational.com*, February 12, 2010.*

"The Relativistic Heavy Ion Collider was designed to re-create conditions in the infant universe…These (collision) temperatures are hot enough to melt protons,"

Steven Vigdor*, Brookhaven National Lab, on the creation of Quark-Gluon Plasma,* USA Today*, February 15, 2010.*

"It could be extremely rugged –you could roll it up, even perforate it, shoot holes in it with a gun, and it'd still operate, whereas normal crystalline silicon would just shatter like glass,"

Harry Atwater*, Caltech, on a new type of flexible solar cell he is developing,* MSNBC.com*, February 17, 2010.*

This Month in Physics History

March 21, 1768: Birth of Jean-Baptiste Joseph Fourier

The human ear splits incoming sound waves into their component frequencies through mechanical means by exploiting natural resonances: namely, different nerve endings in our ears are sensitive to different frequencies. But it is also possible to analyze a sound mathematically to determine its component frequencies. This can be done thanks to a method, devised by an 18th century French mathematician named Jean-Baptiste Joseph Fourier, known as a Fourier transform.

Born on March 21, 1768, Fourier was the son of a tailor in the village of Auxerre. Orphaned by age 10, the young Joseph received an early rudimentary education at a local convent, thanks to a recommendation by the local bishop, and he proved such an apt pupil he went on to study at the École Royale Militaire of Auxerre. There he fell in love with mathematics. By 1790 Fourier was teaching at his alma mater.

Jean-Baptiste Joseph Fourier

Revolution was brewing in France. Fourier was sympathetic at first to the cause, drawn by "the natural ideas of equality," and a hope "of establishing among us a free government exempt from kings and priests." He joined his local Revolutionary Committee, but soon regretted it, as the ultra-violent Reign of Terror gripped France and thousands of nobles and intellectuals fell victim to the guillotine.

Fourier made the mistake of defending the stance of his own Auxerre faction before a rival sect while on a trip to Orléans. In July 1794, he was arrested and imprisoned for the views he'd expressed on that trip, and found himself facing the guillotine. But with the death of Maximilien Robespierre, the Revolution lost steam and Fourier and his fellow prisoners were freed. Fourier was selected for a new teacher-training school to help rebuild France, where he studied under three of the most prominent French mathematicians: Joseph-Louis Lagrange, Pierre-Simon Laplace, and Gaspard Monge. By September 1795, Fourier was teaching at the prestigious École Polytechnique.

A few years after his academic appointment, he joined Napoleon's army as a scientific advisor when Napoleon invaded Egypt, engaging in archaeological expeditions and helping found the Cairo Institute as Napoleon's military fortunes waxed and waned. By 1801, Fourier was back in France, teaching, until Napoleon appointed him prefect in Grenoble. He promptly stirred up a mathematical controversy with his conclusions about his experiments on the propagation of heat.

The culprit was an equation describing how heat traveled through certain materials as a wave. He based his reasoning in part on Newton's law of cooling: the flow of heat between two adjacent molecules is proportional to the difference of their temperatures. Fourier concluded that every wave-like "signal," no matter how complex, can be represented by adding together many different waves. In other words, complicated periodic functions–whether continuous or discontinuous–can be expanded and written out as simple waves mathematically represented by sines and cosines.

Fourier completed his memoir, *On the Propagation of Heat in Solid Bodies*, in 1807 and read it to the Paris Institute on December 21 of that year. The reception was mixed. Both Lagrange and Laplace objected to the notion of what we now call Fourier series: the expansions of functions as trigonometrical series. Along with another scientist, Jean-Baptiste Biot, they also objected to Fourier's derivation of the equations of transfer of heat. (Biot had written an earlier paper on the topic in 1804, although that paper proved incorrect.)

Nonetheless, when the Paris Institute held a competition on the topic of how heat propagates in solid bodies in 1811, Fourier submitted his memoir for consideration. He won the prize, in part because only one other entry was received. The selection committee (which included Lagrange and Laplace) recorded their reservations in their report: "The manner in which the author arrives at these equations is not exempt of difficulties and… his analysis to integrate them still leaves something to be desired on the score of generality and even rigor."

Because of the controversy, Fourier's memoir was not published until 1822, after his election to the Académie des Sciences in 1817, and the same year he became the Académie's secretary. His work did contain flaws, but it also provided the basis for later work on trigonometric series and the theory of functions of a real variable, most notably the Fourier transform, an operation that turns one function of a real variable into another. It is widely used in digital signal processing, as well as in the physical study of wave motion and optics.

Fourier's other claim to fame is the discovery in 1824 of the "greenhouse effect": namely, that certain gases in Earth's atmosphere could trap heat from the sun instead of having it radiate back into space, thereby increasing the surface temperature of Earth. He was inspired by an earlier experiment with so-called "hot boxes" by Horace-Bénédict de Saussure, in which a wooden box lined with black cork was exposed to sunlight. De Saussure then inserted three small panes of glass into the cork, and noted that the temperature rose in those compartments closer to the center of the box.

However, de Saussure did not have a solid theory for this observed effect. Fourier rightly surmised that Earth gains energy from numerous sources, most notably solar radiation causing an increase in temperature, and that Earth also radiates energy via infrared radiation (which he called *chaleur obscure*, or "dark heat"), and that a balance must be maintained between heat gain and heat loss. He incorrectly assumed that a significant amount of radiation from interplanetary space contributed to the greenhouse effect, but grasped that the rate of infrared radiation increased with Earth's temperature. This latter insight was mathematically defined 50 years later with the Stefan-Boltzmann law, further refined by Planck's law 20 years after that.

Fourier continued to publish papers on mathematics until his death in 1830, when he tripped and fell down the stairs at home. His tomb is in the Père Lachaise Cemetery in Paris, decorated with an Egyptian motif in honor of his position as secretary of the Cairo Institute.

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Washington Dispatch

A bimonthly update from the APS Office of Public Affairs

ISSUE: Science Research Budgets

On February 1st, President Obama released his annual Budget Request for Fiscal Year 2011 (FY11). In light of fiscal and political realities, the request is extremely good for science.

In mid-January, President Obama announced a three-year freeze on most non-security discretionary spending. Science received one of the very few non-security waivers. Although the waiver keeps the physical sciences on pace with the Administration's prior ten-year doubling commitment, it means that science will have to defend its budgetary turf on Capitol Hill against advocates for other programs and agencies that fared less well in the presidential request.

The following summarizes the presidential request for the key science agencies:

National Science Foundation (NSF): Up 8% from FY10 enacted levels to $7.4 billion in FY11. The request keeps the Foundation on its ten-year doubling, as authorized by the America COMPETES Act (Public Law 110-69).

National Institute of Standards and Technology (NIST) Core: Up 7.3% from FY10 enacted levels to $709 million in FY11. The NIST Core budget comprises the Scientific & Technical Research and Services (STRS) and Construction of Research Facilities (CRS). The STRS request is $584.5 million, an increase of 13.5% from 2010; the CRS request is $124.8 million, a decrease of 15.1% from 2010. The request keeps the NIST Core program on its America COMPETES ten-year doubling path.

Department of Energy Office of Science (DOE SC): Up 4.4% from FY10 enacted levels to $5.1 billion in FY11. Adjusted for congressionally-directed projects (commonly referred to as "earmarks"), which are never included in presidential requests, DOE SC would receive a 6.1% increase over FY10 levels. In FY 11, the Energy Frontier Research Centers (EFRC) program would be expanded to capture emerging opportunities in new materials and basic research for energy. The DOE budget would continue funding for one SC Energy Innovation Hub, as well as two Energy Research Hubs. The presidential budget would also provide funding for one new Hub on batteries and energy storage.

Department of Energy Advanced Research Projects Agency-Energy (ARPA-E): The request contains $300 million to support transformational discoveries and accelerate solutions in the development of clean energy.

NASA Science: The FY11 request for NASA reflects a dramatic reorientation of the agency's budget. The FY11 budget would eliminate funding for Project Constellation, a program focused on developing a rocket system to return Americans to the Moon. The FY11 budget would replace Constellation with a research and development program to support future heavy-lift rockets that would eventually enable travel to Mars. The presidential budget would also provide NASA Science with a significant increase: 12%, or $537 million, over the FY10 enacted level, to $5.0 billion in FY11. Earth Science, up 27% to $1.8 billion, would be the primary beneficiary, in line with the Administration's emphasis on climate change research. Planetary Science would rise 11% to $1.5 billion, while Astrophysics and Heliophysics would both decline, 3% to $1.1 billion in the case of Astrophysics and 2% to $642 million in the case of Heliophysics.

Both chambers of Congress will begin work on FY11 appropriations shortly. Be sure to check the APS Washington Office's Blog, Physics Frontline (http://physicsfrontline.aps.org/), for the latest news on the FY11 Budget.

ISSUE: POPA Activities

POPA approved the release of the National Security Subcommittee's report titled *Technical Steps to Support Nuclear Arsenal Downsizing*. Public release of the report occurred at a press conference held mid-February and an electronic version is now available on the APS website.

The Energy Critical Elements Study, which will examine the scarcity of critical elements for new energy technologies, will hold its first meeting in April of 2010 at MIT. Study committee members include: Robert Jaffe, MIT; Jonathan Price, University of Nevada; Gerbrand Ceder, MIT; Rod Eggert, Colorado School of Mines; Thomas Graedel, Yale; Karl Gschneidner, Iowa State University; Murray Hitzman, Colorado School of Mines; Frances Houle; Alan Hurd, LANL; Alex King, Ames Laboratory; Delia Milliron, LBNL; Brian Skinner, Yale.

The Electric Grid Study, which seeks to examine the technical challenges and priorities for increasing the amount of renewable electricity on the grid, will hold its second workshop in late February, 2010.

If you have suggestions for a POPA study, please visit http://www.aps.org/policy/reports/popa-reports/suggestions/index.cfm and send in your ideas.

ISSUE: Media Update

New York Times columnist Tom Friedman wrote an op-ed titled, "(Steve) Jobs, Jobs, Jobs," on Jan. 23, calling for President Obama to focus on science and innovation to help jumpstart the economy.

Log on to the APS Web site (http://www.aps.org/public_affairs) for more information.

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Photo by Michael Lucibella

Flag Hall of the Museum of American History was redecorated for the LaserFest celebration.

range finder used to direct guided missiles showed how lasers have been integrated into the country's national defense. Historical artifacts include one of Theodore Maiman's original lasers.

Brent Glass, director of the Smithsonian Museum of American History, said that in total there were over three hundred items in the museum's laser collection.

Greeting guests in the downstairs hall off of the Constitution Avenue entrance stood a large timeline of the history of lasers, highlighting the physicists who made great contributions to the field.

Attendees braved a cold February night in Washington. Snow left over from the record-breaking storm the week before snarled traffic, slightly delaying the start of the event. Several invitees had to cancel because of lingering airport delays and adverse travel conditions. Even with the adverse conditions, nearly 300 people attended the event.

Photo by Ken Cole

The LaserFest celebration featured a large birthday cake in the shape of Maiman's original laser. At some point, however, hunger overtook the crowd and the cake was sacrificed.

"It was terrific. Everyone came out in the elements and celebrated the fiftieth anniversary and had a fun time," said Barbara Hutchison, the LaserFest project manager at OSA, adding also that the event was to "honor the contributions to the field, while looking towards the future and teaching the general public about the importance of science in everyday life, particularly lasers."

In total, five Nobel laureates attended the event. In addition to keynote speaker secretary Chu, Nicolaas Bloembergen, Roy J. Glauber, John Hall, and William Phillips were in attendance, all of whom either helped to develop lasers, or used them in their research. During his talk to the attendants, Secretary Chu pointed out that twelve Nobel Prizes in the last fifty years featured a laser in an important way.

"I thought despite change in scheduling thanks to the snow, it went very well," said James Roche, the LaserFest coordinator at APS. "Everyone enjoyed the reception, Steven Chu is a fantastic speaker, and OSA did a great job organizing the entire thing."

Photo by Ken Cole

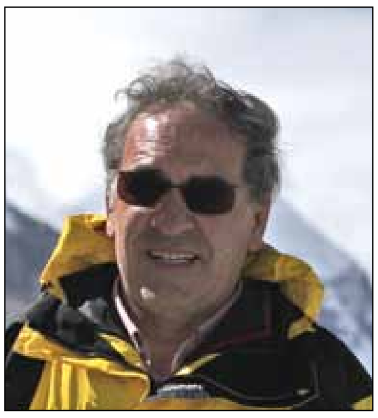
Laser pioneers Ali Javan, John Hall, and Erich Ippen share a moment at the LaserFest reception.

NIH Recruits Physicists to Battle Cancer

By Alaina G. Levine

The National Cancer Institute (NCI) is investing millions of dollars in a collaborative network of 12 Physical Science-Oncology Centers that will provide new insight into the war on cancer. The novel combatants? Physicists.

"This is the first time that biologists are asking physicists for concepts" and not just technological knowhow, notes Robert Austin, physics professor and Principal Investigator (PI) of the new Princeton University Physical Sciences-Oncology Center.



Robert Austin

Larry Nagahara, NCI Program Director for this initiative, agrees. Until now, he says, the NCI has relied on physicists mostly for the technology they can develop to support cancer research. For the first time, "rather than [provide] the technology, we actually want the [physicists] to ask the questions," he says, which will vary greatly from those asked by biologists.

"A physicist may ask…'what is the energy required for a cancer cell to metastasize?...What are the forces required for a cancer cell to move?'" suggests Nagahara. "Hopefully [this] will shed light on how cancer develops as a disease."

Each center, which received approximately $15 million in October 2009 for a period of five years, was created with "spectacular foresight and imagination," says Paul Davies, professor of physics and head of Arizona State University's Physical Sciences-Oncology Center. "The purpose…is to break with tradition in cancer research which has been dominated by cell biologists and geneticists…and to borrow from the style of thinking that physical scientists bring to bear on complex problems and open up a new front on the war on cancer."

Several fields of physics are

CANCER continued on page 5

Letters

Gravity Probe B Funding Source Clarified

It was good to see the Feb 2010 *APS News* identify Gravity Probe B as "One of the Top Ten Physics Newsmakers of the Decade".

As you report, the data analysis continues with increasingly accurate results. The final announcement will be in October 2010. However, your article contains one error of fact. Our current funding is not from the Saudi royal family but from the primary Saudi Arabian research institution KACST (King Abdulaziz City for Science and Technology) as part of a wide-ranging cooperative agreement between KACST and Stanford University.

Francis Everitt
Stanford, CA
PI of Gravity Probe B

Watch Your Language!

While Michael Lubell's analysis of the danger to big government and crony capitalists posed by the Tea Party movement ("Vox Populi," February 2010 *APS News*) is largely correct, his language is anything but. The term "Tea-Baggers" is an obscene sexual slur whose application to Tea Partiers, infamously popularized by CNN's Anderson Cooper, was intended partly as an inside joke and partly as a sophomoric taunt. (Those who would verify this by Googling should be warned that the results may not be safe for work.) Such talk has no place in civil society, much less in the pages of the *APS News*.

Matthew McMahon
Germantown, MD

Sinister Tale Elaborates on History Column

The article about Heaviside [This Month in Physics History, *APS News*, February 2010] reminded me of a lunch at MIT some fifty years ago at which Norbert Wiener was present and at which he was asked about the novel he had recently written (*The Tempter*, Random House, New York, 1959).

It was in fact based on the story of Heaviside, Pupin, and AT&T and painted a somewhat Machiavellian picture of the latter. As described in the *APS News* article, Heaviside was not commercial and had no interest in patenting his idea on loading of cables (for long-distance transmission). The value was recognized by AT&T, but there was no dealing with Heaviside. As recounted by Wiener, AT&T then proceeded to feed information to Michael (Mihajlo) Pupin so that the latter would re-invent and patent Heaviside's ideas. AT&T then set up a small company that infringed on Pupin's "invention." This was subsequently tested in the courts, and AT&T thus acquired final rights.

Henry Stroke
New York, NY

Need to Engage More People in Science

Virginia Corless's Back Page article [*APS News*, February 2010], "Theater Deepens the Vision of Physics," was moving. Her use of the word "deepen" I think was very powerful, suggesting that expanding physics onto the stage will not only broaden and popularize it, but that it should further the science.

Virginia's recounting of various scientific plays made clear what a beautiful and human struggle the history of science has been and continues to be. Most of today's science is funded by the public, but most of its results are not published openly for public evaluation. As we who share the responsibility and desire to "convince people that the science of the world we live in belongs to them," let's think of ways to engage more people in the scientific process, not just the reporting of results. To truly share the "democracy of seeing" that Boyle spoke of, we cannot simply beef up science PR, but engage the broader community in the critical thinking inherent to the process of discovery. Theater too of course is best met with a participatory and discerning audience, else it falls from art into distraction or propaganda.

I was initially confused by the actress's fearful response to the troupe's discussion of Weinberg's closing text and the mysterious fate of our "forever expanding or bouncing universe." Picturing myself part of their discussion brought back memories of similar conversations I've had with people close to me who share a mutual wonder of the forces and matter that influence and surround us, and which we have sometimes learned, through years of collective imagining and experimentation, to harness, mold, and simply but barely understand. When the actress curled up in a frightened ball I was thrown–my emotional responses to these thoughts and discussions have mostly been wonder and awe, even joy. Of course I have also been frightened at the enormity and perceived uncontrollability of our universe–but we should turn that fear and the fear of others into a faithfulness and joy in the process of science, and acknowledgement of how little we actually know, and how much more left there is to be learned.

Jesse Collins
Somerville, MA

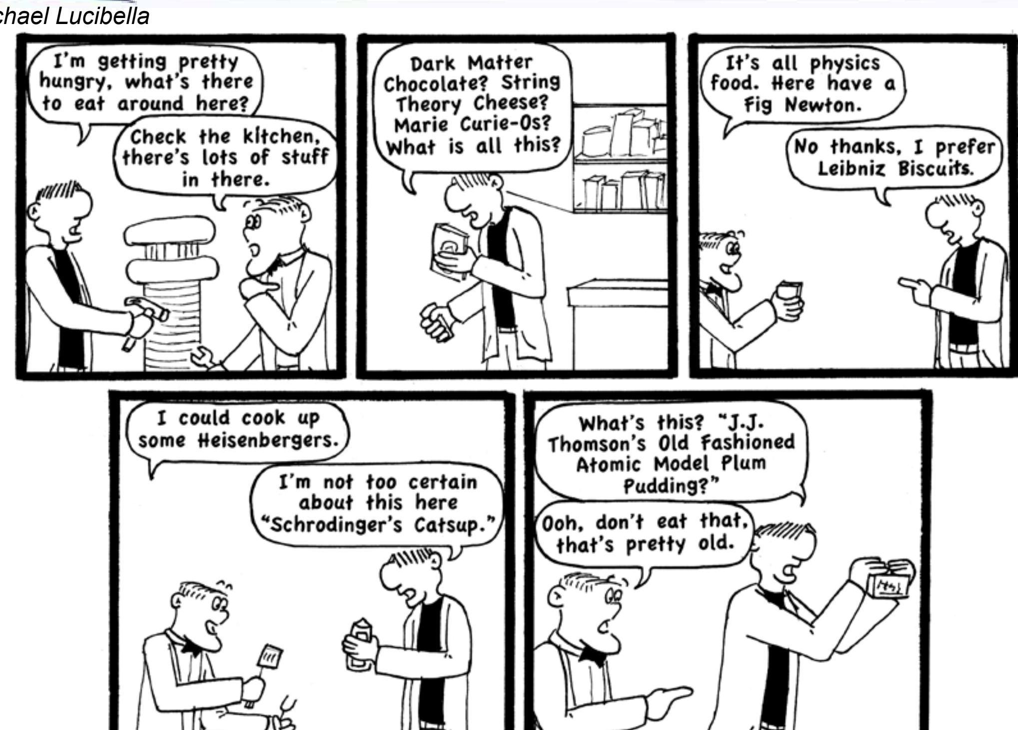
Stoppard's Arcadia has Physics Theme

I very much enjoyed Virginia Corless's Back Page, "Theatre Deepens the Vision of Physics," in the February *APS News*. But I don't think Michael Frayn's Copenhagen was "first on the scene," as she says, among recent plays with physics-related themes. Tom Stoppard's Arcadia, written a few years earlier, deals with chaos theory as one of its major themes, though, as you might expect from a Stoppard play, it has several other interlocking themes as well. It has been one of my favorite plays since I saw a high school production that my son was involved in about 10 years ago, and I highly recommend it to other physicists.

Michael Gerver
Raanana, Israel

zero gravity

By Michael Lucibella



Human Spaceflight Provides Needed Inspiration

Retired director of Lockheed Martin Norman Augustine, who chaired NASA's Review of U.S. Human Spaceflight Plans Committee, spoke candidly at the April Meeting about the future prospects of human spaceflight.

"The NASA administration needs the authority to manage NASA," Augustine said, adding he felt that increasing bureaucracy at NASA meant they're told by Congress to, "Manage NASA, but don't lay anybody off or close any facilities."

In September of 2009 the Augustine commission delivered its report to the President's Office of Science and Technology Policy about the future of manned space flight. At his talk, Augustine stopped short of criticizing the administration's plan to cancel NASA's Constellation Program, the planned spacecraft that would replace the aging shuttle fleet. It was his first public appearance since the official announcement to cancel the program.

"It goes somewhat beyond any of our options," he said, "I would hope the nation could afford additional funds. I do realize we are in a tough financial period and [research] is one of the few places in the budget that got additional money."

According to the president's proposed budget, NASA received a $276 million budget increase, while funds from the Constellation program would be spread around to other research within the agency. About $1.2 billion would be added to research programs devoted to developing new technologies for human spaceflight.

He said that one of the major roles of human spaceflight is to inspire people and to get them excited about science: "There's nothing that inspires quite like space and dinosaurs, and we don't have any more dinosaurs."

RHIC continued from page 1

the highest temperature in the known universe,"

The Relativistic Heavy Ion Collider smashed gold ions together resulting in collisions close to 370 MeV per nucleon, energetic enough to melt protons into their constituent parts. At these temperatures, roughly 250,000 times hotter than the core of the Sun, the bonds that hold quarks together in protons and neutrons break apart, producing a free flowing liquid-like state of matter. For less than a billionth of a trillionth of a second, quarks and gluons flowed freely in a "perfect" frictionless fluid that hasn't existed for 13.7 billion years.

Members of the PHENIX collaboration used a technique that measured the energy distribution of the gamma rays emitted by the hot plasma to definitively record the temperature of the matter for the first time.

In 2005, physicists at RHIC announced that the first results from their experiments indicated that the quark-gluon plasma would behave more akin to a liquid rather than a gas as previously predicted. At the time, however, they were unable to pin down the precise temperature of the collisions, and it was unclear if the quark-gluon plasma had been produced.

Analyzing this exotic state of matter, sometimes referred to as "quark soup," offers insight into the nature of the universe at a very young age. By recreating conditions shortly after the Big Bang on a small scale, physicists can analyze how matter cooled from its initial energetic state to the universe of protons and neutrons that exists today.

"We can model some of the phenomena that occur at even higher temperatures in the even earlier universe, such as the generation of matter-antimatter asymmetry," said Dmitri Kharzeev, a theoretical physicist at the Lab.

Brookhaven physicists analyzing the behavior of the quark-gluon plasma created at the lab, reported hints of unusual "bubbles" of broken symmetry in the movements of charged quarks. Observations by the STAR collaboration found that magnetic fields induced by the high-speed ions caused positively charged quarks to move preferentially in one direction along magnetic field lines while negatively charged quarks tended to move in the opposite direction. These preferences were slight, only a few parts per 10,000, but significant enough to pique interest.

"These bubbles really are twists in the gluon fields," said Kharzeev, "We are not yet claiming observation of this, but it is very suggestive."

Physicists hope that this could lead to greater insights about the fundamental asymmetry of matter and antimatter in the early universe. The full results of the experiments were published in a recent edition of *Physical Review Letters*.

The temperature record is likely to stand until after the LHC starts its heavy ion collisions near the end of 2010. Once they begin, Vigdor estimates that it could take four to five years before they are able to make a definitive measurement of a higher temperature.

CANCER continued from page 3

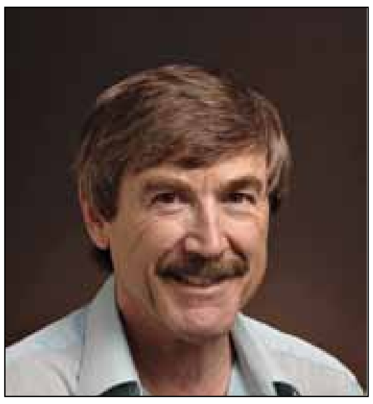


Photo courtesy of Tom Story/Arizona State University

Paul Davies

vital in cancer investigations, including condensed matter, biological networks, complex systems, and the physics of modeling, say the PIs. The chaotic morphology of a tumor is better understood by applying our knowledge of packing physics and spin glasses, say Davies and Austin. A tumor "is a very chaotic, complex, strongly interacting, evolving system," continues Austin. "There are many areas of the physics of complexity and emergent behavior that I think map over in our study of cancer."

At Princeton, Austin's group is researching how to control the evolution of cancer resistance to chemotherapy. In addition, his team is developing microfabrication techniques to design and build chips that represent "an artificial world…a very complex place where [cancer] cells can grow…and evolve." They will provide these chips to other centers to study using their own techniques, he says.

W. Daniel Hillis, physicist, entrepreneur, and director of the USC Physical Sciences-Oncology Center, is focusing on crafting a predictive model of a specific cancer that will allow scientists to better understand therapeutic responses. With a background in the physics of dynamical systems, he contemplates the use of models similar to the Metropolis Algorithm.

While it is a "familiar idea to physicists that you would build a predictive mathematical model of a system… that's a very unfamiliar concept in biology," Hillis points out. "Typically biologists tend to study a system at a single level of mechanism." But the technique of modeling complex systems has been an extremely productive area in physics, he says, and "physicists are very good at bringing together these multi-scale models and then calibrating them with very specific experiments from lots of different levels…If we could do something like that for cancer, then it would be a completely different paradigm for treating cancer."

Hillis sees cancer as a complex failure of a complex system, and imagines "it would be much more useful to have a model of a failure,…very similar to global climate models,…[with which] we can simulate different courses of action."

Davies' team, which like the others includes faculty from the host university and other institutions, is interested in the physical environment in which cancer grows. "Cells are remarkably responsive to the physical environment…and they probably respond to bioelectricity as well," he suggests. "So we are thinking that we may control cancer by controlling the physical environment."

Understanding information exchange between the cancer and its adjacent environs is key. "It's now becoming clear that this a two-way dialogue, that the cells and the surrounding tissue exchange information and change each others' properties." The point of cancer, Davies continues, is not the tumor itself, but rather the invasion, or metastasis, of cells from one organ to another. And no one knows why this happens, he says. "All we know is that they deploy all sorts of clever tricks to get there and when they're there, they change the properties of the site in which they take up residence. So we think the physical properties of those sites are important for site selection."

Davies furthermore intends to use Atomic Force Microscopy in combination with a confocal microscope to examine and try to correlate the elasticity and morphology of cancer cells.

Other centers' endeavors range from assembling a three-dimensional tumor model (Cornell), to exploring the mechanical forces in cancer (Johns Hopkins). Although every center has a physical science heart, USC, Cornell, Princeton, and ASU are the only universities whose center PIs are physicists, as opposed to engineers, biologists and oncologists.

W. Daniel Hillis

As is to be expected with physicists, controversial viewpoints have already blossomed. Austin, for example, posits that "cancer is not a disease. It is a programmed event which the body tolerates, which might give rise to a fitness advantage for the species," as opposed to the individual. "We have to rethink the way we deal with cancer," he says. "We're going to learn some fundamental rules about evolution and how evolution proceeds in non-random ways. And we might discover that cancer has been so recalcitrant because it is viewed perhaps as a good thing by the body and there may be systems there to control it and keep it running… We may have to stop trying to kill the cells… and try to maintain it in some homeostasis manner."

Although he admits that this perspective can make people upset, Austin says that "one thing physicists can be is heretical. We're supposed to be skeptics and look at things a different way…So that's another thing physicists can bring to the table –the willingness to be skeptical and think forbidden thoughts."

Hillis agrees with Austin's maverick hypothesis regarding cancer, and adds that "cancer" should be a verb, not a noun. "Cancer is…something your body is doing," he suggests. "We shouldn't say someone has cancer, we should say someone is 'cancering', like we say someone is crying or sweating."

It is too soon to speculate about therapeutic outcomes, says Nagahara, although already some of the centers are reporting data. But he conjectures that as a result of this work, new measurements based on physical science contributions could some day be part of standardized tests that are used in doctors' offices. For example, in the future, in addition to heart rate and blood pressure, the energy output of your cells may also be tested when you go for your yearly physical.

The researchers expect that the benefits of these projects will extend beyond a better comprehension of cancer. New physics discoveries are expected. "This initiative will yield new physics insights into complex adaptive systems," proposes Hillis. "Right now we don't understand complex systems very well. The edge of our understanding is a spin glass. I suspect that some of the [complex systems] phenomena we're going to discover in these biological systems are adaptive to physical systems in general."

Austin believes that another positive outcome of this work will be a change in physics curriculum at the graduate level. "Cancer is all about information and communication and evolution," Austin says. But physicists don't usually learn these subjects as part of the traditional physics curriculum. He wonders if "we'll have to start teaching the physics of information and game theory…" on a more regular basis.

Even with the potential for new information about and novel approaches to combating cancer, at least one physicist believes there may be resistance from traditional cancer researchers to this innovative initiative. "I'm absolutely sure they'll think we're a bunch of crazy people who don't know what were talking about," says Davies. "If I were to go to a cancer biologist and say 'I realize you don't know anything but we want you to do a research project on the application of quantum field theory to charged and rotating black holes, you can imagine how the physics community would react to that."

Yet "it's exciting stuff," says Davies, and with millions and millions of dollars being spent on cancer research every year, "the hope is by spending some small fraction on a radically new approach that might be brought by physical scientists, there's a chance that we could get a novel treatment."

For more information: http://physics.cancer.org

The Gang of Five

Photo by Jason Bardi

At this year's "April" meeting, the J. J. Sakurai Prize for Theoretical Particle Physics was presented to six recipients, for their work, done some 46 years ago, on spontaneous symmetry breaking in gauge theories. The mechanism they discovered is an essential ingredient in the unification of the weak and electromagnetic interactions that forms part of the standard model of particle physics. In the picture are five of the six recipients. They are (l to r): T. W. B. Kibble, Gerald S. Guralnik, Carl R. Hagen, François Englert, and Robert Brout. The sixth recipient, Peter Higgs, was unable to attend the meeting. The prize ceremony, the prize session and the associated press conference can be viewed on Youtube (search on "Sakurai Prize".)

President's Request Treats Science Well

In early February, President Obama sent Congress next year's federal budget request, which among other things, proposed an overall increase in federal science funding, including physics research.

This increase comes in spite of the President's announcement, a week earlier, that there would be a budget freeze in non-military discretionary spending. Though the net total FY 2011 Federal budget was frozen at the same level as 2010's, spending within agencies was adjusted to increase overall funding for scientific research.

Should Congress pass the president's budget as is, it would represent an overall increase of 5.9% in non-defense research and development funding in FY 2011. The budget for the National Science Foundation would increase 8%, NIST 6.9% and the Department of Energy's Office of Science 4.6%. The department of Defense, which was not part of the budget freeze, likewise received a 6.2% increase to its basic research budget.

The biggest increase to science funding is within NASA. Overall the budget for the agency only increased 1.5%, but funds directed for scientific missions have been increased by 11.4% overall. Much of this increase comes from the proposed cancellation of the Constellation program, which was developing a manned space capsule to replace the shuttle after its retirement later this year. Cancelling the Constellation program, already behind schedule and over budget, freed up a significant portion of the Space Agency's budget to put towards scientific missions.

Within the Department of Energy, almost all of the programs devoted to basic physics research have had their budgets increased. Basic energy science research got a $198.5 million, or 12.1% boost in funding. Nuclear physics received $27 million or 5% increase while high energy physics research saw an $18.5 million or 2.3% increase.

Fusion research was the only basic research sector in the Department of Energy to have its funding cut. The department reduced its spending on fusion research by $46 million, or 10.8%. According to the details released along with the budget, this reduction comes in part from frustrations over the speed of construction and management direction of the International Thermonuclear Experimental Reactor, or ITER.

"The President's budget cuts wasteful spending while making wise investments in innovation and clean energy that will put Americans back to work, save families money and keep our nation competitive in the global marketplace," said Secretary Chu in a released statement, "This budget supports new approaches to energy research and invests in the next generation of scientists and engineers, and it will spark new clean energy projects nationwide, including restarting the American nuclear power industry."

At the National Science foundation, Mathematical and Physical Sciences got a $58.1 million, or 4.3% boost. NIST's Scientific and Technical Research and Services program was designated a 13.5% increase.

Though overall science programs at NASA received a boost, some sectors saw cuts. Earth Science received a boost of $381 million, or about 27%, and Planetary Science received a boost of 145 million, or about 11%. However Astrophysics is set to receive a $28 million cut, or about 3 percent, and Heliophysics a $15 million cut, or about 2%.

A more detailed breakdown of the President's request can be found in the *Washington Dispatch* column on page 3.

INTERNATIONAL News

...from the APS Office of International Affairs

The African Physical Society-*Perspectives from its President*

By Francis K. Allotey

As you may have read in the February issue of *APS News*, the African Physical Society (AfPS) was launched on the 12th of January, 2010 under the distinguished patronage of His Excellence Maitre Abdulaye Wade, President of the Republic of Senegal. There were 110 African Physicists from 21 African counties; 10 national physical societies were represented. We are very grateful for the support and good will African Physical Society has enjoyed from researchers and teachers from all over Africa and from sister societies around the world. As the first President of the AfPS, I would like to share some of the history and background that led to its formation.

The African Physical Society is actually a re-launch of the Society of African Physicists and Mathematicians (SAPAM) which was formally inaugurated at the Abdus Salam International Centre for Theoretical Physics (ICTP) in October, 1984 at a Pan African Symposium on the "State of Physics and Mathematics in Africa," attended by over 120 African scientists from 26 countries in Africa.

Some of the reasons for the formation of SAPAM were the lack of cohesive and functional links among African Physicists and Mathematicians and the observation that there was a great scientific and technological gap between the industrialized and developing countries of the world, particularly countries in Africa, and that physics and mathematics are the basis of modern science, technology, and wealth creation industries.

The inauguration of SAPAM coincided with the opening ceremony of the 20th anniversary celebration of the existence of the International Centre for Theoretical Physics (ICTP), which the then Italian Foreign Affairs Minister, later the Prime Minister of Italy His Excellency Giulio Andreotti attended. During the same period, the meeting of Physics for Development and the 18th General Assembly of the International Union of Pure and Applied Physics (IUPAP) took place.

At the symposium, it was observed that among the problems contributing to the poor state of physics and mathematics in Africa were inadequate numbers of students, shortage of teachers, lack of critical mass for effective research, poor experimental facilities, shortage of textbooks and journals, inadequate interaction among African physicists and mathematicians, and lack of support by African governments.

Many of the problems listed above are with us today due to the lack of adequate support by African governments and development partners. Science is not considered a priority. It should be stated that African governments are not unaware of the role of science and technology for socio-economic development, for as far back as 1980 the then Organization of African Unity (OAU), now African Union (AU), launched the Lagos Plan of Action for sustainable socio-economic development of Africa and requested its member countries to allocate at least 1% of their GDP for science and technology in order to achieve the objectives of the plan. So far there are only two countries in Africa that have achieved this target.

Some leaders in Africa and even some in the developed countries, including donor agencies, question the need for spending the scarce financial resources in Africa on scientific research and teaching. They argue that African countries should buy finished technological products that have been developed elsewhere. Even until very recently the World Bank and International Monetary Fund were deemphasizing the importance of tertiary education in Africa.

However, transfer of technology can only take place between individuals with the same educational level. No technological package will ever be opened, if it can be opened at all, if the nation that bought the package does not have at least a small number of individuals with scientific and technological expertise at the same level as those in the nations that developed it. Georg Henrik Von

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to promote evidence-based thinking about teaching, and applauded the APS's New Faculty Workshops –a model that other scientific disciplines are considering imitating.

Slakey advertised grants offered by the NSF to help educators and scientists either study or implement STEM teaching strategies. She announced that the name of the grant program will change this year from Course, Curriculum and Laboratory Instruction (CCLI) to Research and Evaluation on Education in Science and Engineering (REESE). REESE has three types of grants with increasing cap amounts of $200,000, $600,000 and now $5 million over five years respectively. Slakey concluded, "There will always be work to be done to move [STEM education] forward."

Shirley Malcom, Director of the Education and Human Resources Directorate at AAAS, spoke next on "The Value of Diversity in STEM."

Malcom led off with a historical perspective in which she noted that the initial discussion of diversity in STEM fields centered on individuals' rights and opportunities, but that the focus had shifted toward recognizing the value of diversity within a research community.

"It's been easy for the biologist to get that," Malcom said. She believes this came about mainly because of the biological differences between men and women. "Among the mathematicians and physicists… there was this belief that everybody was the same. And it would be a very difficult thing to kind of change the community's mind about that… unless they had the sense that they were missing out on something by not being more diverse."

Malcom posited that diversity increases the richness of ideas brought to a field, provides additional role models for minority and female students, and increases the number of potential STEM professionals. Lack of diversity can impact public support and funding for science because the STEM community does not currently look like the general population.

The final speaker of the session was Robert Parris Moses, a civil rights leader and former organizer for the Student Nonviolent Coordinating Committee (SNCC). In the 1960's, Moses saw literacy as the key to economic and political freedom for the African American population. Today, Moses believes that for minority students to participate in the decisions that shape the world and to gain economic freedom, they must have *mathematical* literacy. It was this belief that led him to found the Algebra Project, an organization that (from the Algebra Project website) "uses mathematics as an organizing tool to ensure quality public school education for every child in America."

Moses gave a portion of his time to physics and mathematics educator Bill Crombie, who leads the Algebra Project at the Boys and Girls High School in Brooklyn, New York. Crombie stated that the project works with students who have previously found "no particular reason for engaging" in mathematics. Rather than what he called a "procedural approach" to math, the Algebra Project uses "pictorial representations [which] become geometric representations."

The following day, Crombie brought a group of 14-to 16-year old students from the Boys and Girls High School to the APS meeting, where they engaged in a question and answer period with some of the attending physicists. The core of the students' learning experience was focused on developing a deep understanding of the number line, and of positive and negative numbers. The students made number lines that featured pictures they took on a trip across the Brooklyn Bridge, a tactic that enables them to associate mathematics with an experience in their own lives. In addition, the students then taught what they had learned to younger students in the school. Nearly every student raised his or her hand when asked if they would consider becoming a math teacher.

MEETING continued from page 1

of each other could be an important step towards solving this problem. (X21.4)

Magnetic Tuberculosis Detector. Tuberculosis is a potentially deadly disease that infects up to two billion people around the world, often without them knowing it. Most of the time, TB remains dormant, but in about ten percent of cases, the infection can spread from a person's lungs to other parts of their body and develop into full-fledged tuberculosis disease. Today's septum smear infection test was first developed nearly a century ago, and only works when large numbers of the bacteria are present. A team of physicists at Massachusetts General Hospital and Harvard Medical School led by Ralph Weissleder and Hakho Lee has developed a new easy-to use hand-held device that can detect the presence of the bacteria at concentration levels 1,000 times less than previously. Fluid from a patient's lungs is combined with magnetic nanoparticles that adhere to the rod-shaped TB bacteria, which a miniaturized nuclear magnetic resonance system can detect. With further development, the device itself may cost as little as a few hundred dollars to produce while each test costs about ten dollars. The team hopes to field-test a prototype in South Africa later this year. (X30.8)

Solar Cells. Millions of trillions of joules of energy hit Earth every hour, and researchers have hope that capturing just a small fraction of that energy could help to power the world through the 21st century. Yang Yang of the University of California, Los Angeles has been working on ways to create cheap and easy-to-produce solar cells that could line the outside of city buildings. Using carbon-based photovoltaics combined with semiconducting polymers, Yang and his team were able to produce low-cost semitransparent solar cells that let as much light through as tinted windows, while at the same time generating electricity. Right now the solar cells have only achieved about a 7.7% efficiency rate, compared to most commercial cells that approach 20%, but research is continuing and Yang hopes that future designs that incorporate stacked "tandem" cells may reach up to 15% efficiency rates. Already a California-based company has licensed this research in hopes of developing a viable commercial product in the next few years. (L29.1)

New Technique for Measuring the Strength of Cells. Bacteria can be tough little critters. Many of these microorganisms spend much of their energy developing strong internal cytoskeletons and external cell walls. This lets them survive in even the toughest conditions. For doctors and researchers interested in creating effective antibiotics that can combat infections, finding ways to crack open the shells of these microbes is imperative. An important first step is determining exactly how tough they are. K.C. Huang of Stanford University has come up with an easy way to measure how strong a type of bacteria is. Growing cultures of them in gels of different stiffness allows researchers to see exactly how rigid a bacterium can be. Using this method, which they call the Cell Length Assay of Mechanical Properties, or "CLAMP," medical researchers will be able to easily see the effectiveness of a chemical or treatment designed to weaken a bacterium. (Q7.1)

AC/DC Power Converter as Wide as a Human Hair. Most electronic devices run on a direct current while wall sockets deliver an alternating current. To convert between the two usually requires bulky equipment akin to the blocky converters on laptop power cords. However, the United States military is interested in getting rid of any unnecessary bulk, and has been funding research towards finding ways to make smaller and lighter power converters. Mark Griep, Govind Mallick, and Shashi Karna of the U.S. Army Research Lab have developed a diode rectifier made of single walled carbon nanotubes the width of a human hair to convert AC to DC for low power devices. It runs at an efficiency level of about 20 percent, in the same range as larger MOSFET diodes. (X14.10)

Blood Clot Glue. When a tear opens up in a blood vessel, a gigantic protein molecule known as von Willebrand Factor unrolls itself and helps to clot the leak. The protein only exposes its sticky segments when the cut opens, and researchers Charles Sing and Alfredo Alexander-Katz at MIT have discovered why. The tear causes the blood vessel to constrict, pulling fluid in opposite directions along the vessel and stretching apart the ends of the protein. This research could shed new light on blood clotting disorders or possibly even identify new materials that could plug leaky pipes. (T11.10)

Nanotube Toxicity. Carbon nanotubes hold tremendous possibilities for medical treatments on a cellular level. Their small size means that they can penetrate through most cell membranes, delivering doses of medication directly. However recent concerns have been raised over potential dangers of the nanoparticles at high concentrations. Michelle Chen of Simmons College investigated some of the potential harmful effects of nanotubes. She treated ovarian cells of hamsters with different levels of nanotubes and watched for any ill effects. She found that in high concentrations nanotubes could be harmful, but at the lower levels being explored for medical treatments, the carbon molecules did not affect the cell's ability to survive. (X30.7)

Infrared Pictures with a Digital Camera. It may be possible to see behind the Mona Lisa's enigmatic smile using nothing more advanced than a digital camera. Physicist Charles Falco of Arizona State University will show how adding certain filters and adjusting focus and aperture settings on certain digital cameras can record infrared light waves. Many paints are at least partially transparent to infrared, and it would be possible to see through them using Falco's modifications. Many art researchers have used infrared and x-rays to probe deep into famous paintings to discover corrections, original sketches, and even lost works buried underneath layers of paint. (Q3.3)

ANNOUNCEMENTS

M. Hildred Blewett Scholarship

for Women Physicists

This scholarship has been established to enable women to return to physics research careers after having had to interrupt those careers for family reasons. The scholarship consists of an award of up to $45,000. The applicant must currently be a legal resident of the US or Canada. She must be currently in Canada or the US and must have an affiliation with a research-active educational institution or national lab. She must have completed work toward a PhD.

Applications are due June 4, 2010. Announcement of the award is expected to be made by August 2, 2010.

Details and on-line application can be found at http://www.aps.org/programs/women/scholarships/blewett/index.cfm

Contact: blewett@aps.org

PTEC Topical Workshop:

Pedagogical Content Knowledge

Rutgers University, New Brunswick, NJ

April 19-20, 2010

Rutgers University, in cooperation with the Physics Teacher Education Coalition (PTEC), invites you to attend a workshop that will change how you think about preparing physics teachers. This two-day topical workshop will highlight the unique Pedagogical Content Knowledge (PCK)-based curriculum developed at Rutgers.

For more information, please see www.ptec.org/conferences/PCK2010

Reviews of Modern Physics:

Recently Posted Reviews and Colloquia

Optical excitations in electron microscopy

F.J. García de Abajo

Electron microscopes utilize the focusing of electron beams on subnanometer spots to probe metal and/or dielectric response either by analyzing electron energy loss or by detecting emitted radiation. This review discusses the interaction of energetic electrons with matter using classical and quantum formulations and then describes the underlying phenomenology giving rise to unmatched spatial and energy resolution of both localized and extended optical excitations, including plasmons.

http://rmp.aps.org

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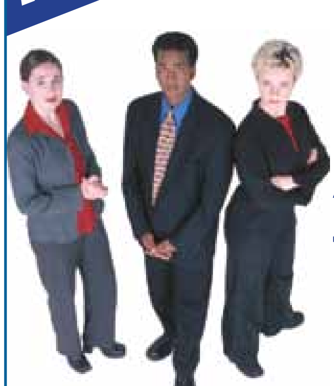

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PRIZE continued from page 2

plications of physics to emerging technologies. It is not necessary for the application to have already achieved commercial success, but it should have demonstrated potential for significant impact. Although nominees need not now be working in industry, the contribution for which they are cited must have been made while their principal employment was in industry. The recognized contribution may be a product, a process, or a tool enabling practical application of physics. Nominees need not be APS members, and there is no restriction with regard to geography or nationality."

More information, including details of how to submit nominations, is available on the Prize website at http://www.aps.org/programs/honors/prizes/industrial.cfm .

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Wright, a Finnish philosopher, defined modernity as consisting of two major components: science and technology on one hand and good governance on the other.

Over the past 25 years, SAPAM has had a long list of accomplishments, organizing conferences and workshops, building links amongst physicists working in Africa, and building links with physicists worldwide. In recognition of its activities and initiatives, the then OAU granted the society Observer status in 1990. With limited resources, SAPAM has made tremendous impact on the continent.

Long before climate change became a topical and global issue, SAPAM initiated in 1987 the APEPMA (Applicability of Environmental Physics and Meteorology in Africa) series of workshops to sensitize the physical science community and African policy makers with respect to issues related to climate and environment. The first workshop took place in Addis Ababa, Ethiopia, at the time that that part of the world experienced one of the most devastating droughts in the 20th century. The 8th in the series of these workshops will take place in Botswana from 19-23 April 2010.

Before energy became the concern of governments in Africa, SAPAM has been running the Kumasi (Ghana) College on Renewable Energy since 1986. Some of the participants at these workshops have held and some are still holding positions such as ministers in charge of energy or members of energy commissions in their countries.

Two years after its founding, SAPAM recognized the need for capacity-building for sustainability in Physics and Mathematics Education in Africa and has been equipping and encouraging the younger generation in these disciplines. For example, SAPAM organized in 1986 a pan-African workshop in Nairobi, Kenya, on harmonization of curricula in Physics, Mathematics and Computer Science at the tertiary level of education in Africa. At the same workshop the production of low-cost scientific equipment for education in the sciences was initiated. The founding and relative success of SAPAM led to the formation of the Edward Bouchet Abdus Salam Institute (EBASI) in 1988 in Trieste, Italy.

The 6th EBASI meeting of over 200 physicists from all over Africa took place on 24th January, 2007 at the iThemba Laboratory, South Africa. At this meeting, it was resolved that SAPAM should be transformed and become known as the African Physical Society (AfPS). It was recognized that we need a professional society that is an advocate for physics and physicists at the AU, in the governments of the 53 African countries, amongst universities, research institutes and corporations, in primary schools, and in the African general public; a society that organizes meetings, conducts professional development workshops, suggests standards of professional conduct, provides information, and does all the things that professional associations do.

The membership model for the African Physical Society is one where there are member societies, industry and research institute memberships, as well as individual memberships. The plan for the African Physical Society is not to replace any national physical society; actually it is quite the opposite. It will endeavor to build national physical societies where one does not exist and provide a forum for these new ones and existing ones, like the South African Institute of Physics, to exchange information, personnel and other resources across the continent.

Importantly, the African Physical Society will incorporate, as a subsidiary organization, the African Association of Physics Students. Because there is always a change in the student body from year to year, a student organization does much better if there is a permanent organization of professionals that help keep the organization alive.

Again, the plan is not to replace any national association of physics students on the continent, but rather to link those that already exist and provide a way for physics students to connect to the larger physics world where a student association does not exist.

One of the important acts at the meeting was a resolution supporting South Africa's bid to host the Square Kilometre Array radio telescope. Among the reasons given for the support were that the Square Kilometer Array will underscore Africa's capability in sciences and innovation. In addition, the enormous investment in infrastructure will contribute to economic growth in the region, and the requirement for ultra-high speed internet across Africa to operate the square Kilometre Array will lead to improved IT infrastructure and access for millions of people.

Francis K. A. Allotey is Consulting Director of the Institute of Mathematical Sciences in Ghana.

The Back Page

Physics for Future Physicians and Life Scientists: a moment of opportunity

by Catherine H. Crouch[1], Robert Hilborn[2], Suzanne Amador Kane[3], Timothy McKay[4], and Mark Reeves[5],

How should we teach physics to future life scientists and physicians? The physics community has an exciting and timely opportunity to reshape introductory physics courses for this audience. A June 2009 report from the American Association of Medical Colleges (AAMC) and the Howard Hughes Medical Institute (HHMI), as well as the National Research Council's Bio2010 report, clearly acknowledge the critical role physics plays in the contemporary life sciences. They also issue a persuasive call to enhance our courses to serve these students more effectively by demonstrating the foundational role of physics for understanding biological phenomena and by making it an explicit goal to develop in students the sophisticated scientific skills characteristic of our discipline. This call for change provides an opportunity for the physics community to play a major role in educating future physicians and future life science researchers.

A number of physics educators have already reshaped their courses to better address the needs of life science and premedical students, and more are actively doing so. Here we describe what these reports call for, their import for the physics community, and some key features of these reshaped courses. Our commentary is based on the discussions at an October 2009 conference (www.gwu.edu/~ipls), at which physics faculty engaged in teaching introductory physics for the life sciences (IPLS), met with life scientists and representatives of the NSF, APS, AAPT, and AAMC, to take stock of these calls for change and possible responses from the physics community. Similar discussion on IPLS also took place at the 2009 APS April Meeting, the 2009 AAPT Summer Meeting, and the February 2010 APS/AAPT Joint Meeting.

Reasons for Change

The great success of 20th century biology was to reveal the physical and chemical machinery of life. Biological molecules, cells, organisms, and ecosystems are all constrained and enabled by the same laws of nature that govern the inanimate world. In this new vision, life emerges as perhaps the richest and most complex example of a physical system. In the 21st century, the study of life requires an integrated, quantitative approach: physics, chemistry, and mathematics tightly interwoven with traditional biology.

This fundamental transformation has been widely recognized in recent education policy statements. The National Research Council report *Bio2010: Transforming Undergraduate Education for Future Research Biologists* argued that life science researchers need a strong grounding in mathematics and the physical sciences. In June 2009, a joint AAMC-HHMI committee issued an important report, *Scientific Foundations for Future Physicians* (SFFP). This report calls for removing specific course requirements for medical school admission and focusing instead on a set of scientific and mathematical "competencies." Physics plays a significant role in both reports: all life scientists ought to be able to apply the principles of physics to biological systems, to develop and adapt quantitative models for biological processes, and to understand the scientific basis of advanced technologies. The SFFP report provides recommendations that each medical school will now decide whether to adopt. Ongoing discussions among SFFP committee members, medical school deans and admissions officers, and undergraduate pre-health advisors indicate that the proposal to shift to a competency model is viewed very favorably. Although questions about implementation remain, it is certain to influence the revisions underway for the Medical College Admission Test (MCAT).

The call issued by these reports represents both a challenge to and an opportunity for the physics community. The challenge is to offer courses that cultivate general quantitative and scientific reasoning skills, together with a firm grounding in basic physics principles and the ability to apply those principles to living systems, all *without* increasing the number of courses needed to prepare for medical school. The opportunity is to craft new courses that not only serve life science students well, but reveal and celebrate the rich contributions that physics has made to our understanding of life.

The Scientific Foundations for Future Physicians: Recommendations for Change

The SFFP report identifies scientific and mathematical competencies that future physicians should acquire as undergraduates and in medical school. It encourages universities to develop innovative ways to help students meet the undergraduate competencies. How can an introductory physics course best accomplish this? Reading the proposed list is reassuring: traditional physics courses already cover most of the subject areas. (The complete report can be found at http://www.hhmi.org/grants/sffp.html; excerpts with the competencies relevant to physics can be found at http://www.gwu.edu/~ipls/HHMI-AAMC.html.) However, the SFFP report especially calls for developing the ability to apply physics knowledge *in the context* of understanding living organisms.

Photo by Margaret Throckmorton

Biology students studying diffusion are measuring Brownian motion of polystyrene beads

The content competencies most closely associated with physics include much material found in a traditional introductory physics course, but with significant omissions and some novel additions. These can be addressed through modifying the balance of topics and choice of examples in the introductory course. For example, while Newton's Laws remain central (indeed, biomechanics requires this), an extended discussion of kinematics and projectile motion could be replaced by more study of fluids and simple continuum mechanics. A more complete study of energy, with attention given to biologically appropriate topics such as diffusion and open systems, could replace the current focus on heat engines and equilibrium thermal situations.

In addition to content-based competencies, the SFFP report echoes the Bio2010 call for enhanced training in a broad range of scientific and quantitative skills–what many of us might be tempted to call "thinking like a physicist." Students should acquire both a rigorous grasp of physics concepts and the ability to understand and use quantitative models of physical systems based on those concepts. Specific skills mentioned in the SFFP report include: interpretation of a variety of representations of scientific information, including statistical and graphical analysis of data; dimensional analysis; the design and execution of experiments to test hypotheses, and the ability to critically read the scientific literature. Indeed, one of the overarching principles of the SFFP report is that "effective clinical problem-solving and the ability to evaluate competing claims" are essential skills for a physician.

Creating new IPLS courses

The primary purpose of an IPLS course is to teach fundamental physical principles, while examining how they shape and enable the organization and activity of living systems. As mentioned previously, the core topics covered by an IPLS course will look familiar to any physicist: mechanics, statistical and thermal physics, fluids, electricity and magnetism, waves and imaging, and some aspects of modern physics. Such a course need not venture far into the full interdisciplinary of modern biophysics. However, most current introductory physics courses use examples inspired largely by engineering. Why not instead choose biologically relevant topics and examples for the IPLS audience? The IPLS courses discussed at the October workshop and recent APS and AAPT meetings make only a modest number of changes to the core topics, with more extensive changes to the examples used to illustrate the core topics. Sample syllabi and lists of biologically relevant examples are available at the website for the October workshop.

We argue that it is not difficult for physics faculty members who have taught introductory physics to teach an IPLS course that addresses the SFFP competencies. They will have to invest time retooling their usual course examples to this life science-oriented approach, but they should find themselves on familiar ground with the subject matter being taught. Ideally, an experienced faculty member taking on an IPLS course will find her own appreciation of physics refreshed by a new approach. This has certainly been our experience. Those of us who have taught courses including biologically-inspired content find our students enthusiastic about that material and eager for more.

Well-designed introductory physics courses can also help students master broad scientific and quantitative skills, and the physics community is recognized as being at the forefront of undergraduate science education in teaching these skills effectively. Challenging, multi-step problems can develop general problem-solving skills as well as the ability to critically use mathematical models. Laboratories can offer practice analyzing and interpreting quantitative data, as well as learning the connections between physical principles and biological problems by direct experimentation. As described in *How People Learn* (National Academy Press, 1999), the transfer of skills and knowledge to different contexts is among the greatest challenges for students. Teaching strategies that help students develop and test physical models of biological phenomena will be particularly important in this regard, and an introductory physics for the life sciences course offers a rich context in which to explore these strategies.

Next Steps

Efforts to revise IPLS courses across the country will require resources and infrastructural support, including new curricular materials (textbooks, in-class activities, model homework and exam problems, laboratory experiments, etc.) and equipment for new life science-related demonstrations and laboratories. Many in the physics community are already working on new IPLS courses. How can we best share the wealth of good ideas already in existence or under development to speed the suggested changes in IPLS courses?

To start this process, we have set up a wiki on the October 2009 conference website, where we will gather available IPLS material. In particular, we are calling on the physics community to (1) post material on the wiki linked to the conference website, (2) use the material posted there and return feedback, and (3) post notices and summaries of meetings on IPLS courses. Experience shows that the process from creative exploration to the ultimate production of polished products for any significant curricular change, including the proposed changes for IPLS courses, will be long and complex and that flexible and effective ways to share ideas are essential.

Careful assessment of new materials and teaching strategies will be essential to this process. Assessment will help determine whether IPLS courses enable students to acquire the proposed competencies, including general scientific and quantitative skills. The physics education research community can provide expertise and experience that can help guide the development of the needed assessment tools.

The AAMC has convened an "MR5" committee charged with reviewing and revising the MCAT. MR5 currently is surveying undergraduate and medical school faculty to create a revised set of MCAT topics. It appears that the choice of those topics will be shaped by the competencies recommended in the SFFP report.

Where do we go from here?

The physics community faces a challenging opportunity as it addresses the issues surrounding IPLS courses. A sizable community we serve has articulated a clear set of skills and competencies that students should master as a result of their physics education. We have for a number of decades incorporated engineering examples into our physics classes. The SFFP report asks us to respond to another important constituency. Are we ready to develop courses that will teach our students how to apply basic physical principles to the life sciences? The challenges of making significant changes in IPLS courses are daunting if we each individually try to take on the task. But with a community-wide effort, we should be able to meet this challenge. The physics community is already moving to develop and implement changes in IPLS courses, and the motivations for change are strong. The life science and medical school communities stress that a working knowledge of physical principles is essential to success in all areas of life science including the practice of medicine. Thus we see significant teaching and learning opportunities as we work to answer the question that opened our discussion: how should we teach physics to future physicians and life scientists?

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