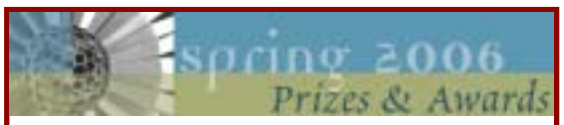
APS NEWS

A Publication of the American Physical Society

March 2006
Volume 15, No. 3
www.aps.org/apsnews



See Pullout Insert Inside

Baltimore Hosts Largest Physics Meeting of 2006

The latest developments in an incredible variety of research areas will be presented at the 2006 APS March meeting. The meeting, the largest physics conference of the year, with over 6500 papers being presented, will be held March 13-17 at the Baltimore Convention Center by the harbor in Baltimore, Maryland.

Sessions cover the latest research in condensed matter physics, biological physics, chemical physics, new materials, fluid dynamics, polymers, and large-scale computing. The diverse array of subjects includes planetary interiors, ultrafast chemistry, liquid splashing, biological swarming, optical clocks, snake infrared vision, nanoplumbing, microscale synthetic swimmers, a plastic-explosive-degrading enzyme, double electromagnetically induced transparency, antimicrobial coatings for medical devices, and fast electrons in graphene. A number of talks highlight the interdisciplinary nature of physics, showing how physics methods apply to problems from biology to economics, and even sports and traffic.

Baltimore's Inner Harbor

Physics also has implications for many social issues, and the program includes sessions that address topics such as Intelligent Design, nuclear proliferation and terrorism, physics in developing countries, and the changing dynamics of industrial research, as well as issues relating to university physics departments including the status of women, curricula trends, foreign students, and ethics.

A sampling of highlights of the meeting follows. The full program can be found online at http://www.aps.org/meet/MAR06/

Nobel Prize symposium

This Tuesday morning session will feature all three winners of the most recent physics prize, Ted Haensch, John Hall, and Roy Glauber. (session G1a)

Foundations of Evolution

From gene chips to microfluidics and nanotechnology, new tools now exist to test and explore biological evolution at a much deeper level than was possible 20 years ago. According to speaker Daniel Fisher of Harvard, evolution can

March Meeting continued on page 7

Special Events

Sunday, March 12
8:00 am – 5:00 pm
APS Workshop on Opportunities in Biological Physics

1:30 pm–5:30 pm
Special Workshop: Quantum Mechanics using Interactive Computer-Based Tutorials

7:30 pm – 9:00 pm
NRC/NAS Town Meeting
Condensed Matter and Materials Physics in the Next Decade

Monday, March 13
5:30 pm – 6:30 pm
Awards Program

6:30 pm – 7:45 pm
Welcome Reception

8:00 pm – 10:00 pm
Special Symposium: Emerging Emergent Phenomena

Tuesday, March 14
8:00 am – 2:30 pm
High School Physics Teachers Day

7:30 am – 9:30 am
CSWP/FIAP Networking Breakfast for Women in Physics

2:30 pm – 3:30 pm
APS Journal Editors Panel Discussion

3:30 pm – 5:30 pm
Meet the Editors of AIP and APS

6:00 pm – 8:00 pm
Alumni Reunions

Wednesday, March 15
1:00 pm – 2:30 pm
Students Lunch with the Experts

5:30 pm – 6:30 pm
Student Reception

7:30 pm – 9:00 pm
Special Symposium: Perspectives on Our Energy Future

APS Membership Hits Record High in 2005

APS membership has climbed to a new record high of 45,519 as of January 2006, up from 43,462 in 2005.

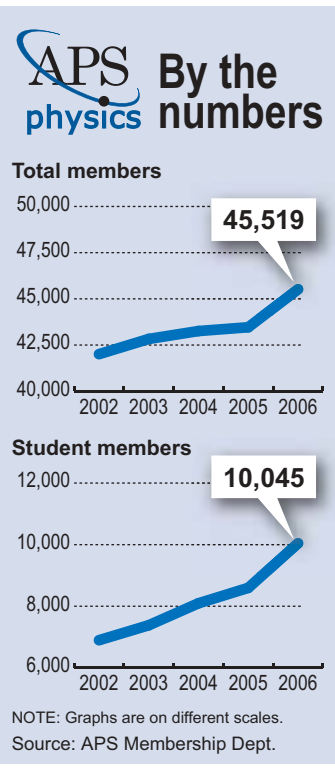
Some of that increase can be attributed to a large number of new student members. In 2005, 2773 students joined, taking advantage of the free trial membership available to new student members from the United States, Canada, and Mexico. After the free trial year, the student membership rate is $27. In addition to new graduate student members, many undergraduates join APS through the Society of Physics Students.

Another source of new members in 2005 came from the Division of Fluid Dynamics, which has made it easy for meeting attendees to join APS and the Division when registering for the DFD meeting, with a nonmember meeting registration fee that included a one-year APS/DFD membership. (This is not the case for the March and April meetings, where membership dues and meeting registration are separate fees). At the November 2004 DFD meeting, 381 physicists joined APS and DFD, and another 467 joined at the November 2005 meeting.

Membership has increased fairly steadily over the years since the Society formed in 1899 with just 59 members.

The APS Membership

Record High continued on page 6



APS News staff

Physicists Rally Around Efforts to Promote S&T Initiatives

President George W. Bush gave his 2006 State of the Union address to the nation on January 31st, and took the opportunity to announce two major new science and technology initiatives. The efforts are aimed at combating growing economic competition from countries such as India and China; maintaining US status as a world leader in technological innovation; and breaking US dependency on Middle Eastern oil.

Bush's proposed "American Competitiveness Initiative" is a ten year, $136 billion undertaking that would double the federal commitment to basic scientific research in the physical sciences and train tens of thousands of new math and science teachers. This would increase spending on federal R&D next year by nearly $6 billion, a level more than 50% higher than in 2001. The budgets of the NSF, the Department of Energy's Office of Science, and NIST's core programs would double over ten years with $50 billion in new funding.

Bush also announced the Advanced Energy Initiative–a 22% increase in clean-energy research–at the Department of Energy (DOE), to push for breakthroughs in automobile fuel and electrical generation, in order to free the US from what Bush termed an unhealthy "addiction" to oil.

The issue of competitiveness has gained prominence among scientists and Congressional leaders since last fall, thanks to an R&D benchmarks report released a year ago by the Task Force on the Future of American Innovation, which first caught the attention of policy makers with its warning of a pending national crisis.

It was followed in October 2005 by a National Academies report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, which listed several "worrisome indicators" that the US was losing its global competitive edge, and proposed numerous specific actions the federal government can take to ensure the country's global leadership through the 21st century. In a January 11 speech to the US Chamber of Commerce, White House Chief of Staff Andrew Card called the National Academies report "compelling," although he cautioned that the report's recommendations would need to be considered in context of federal

Physicists Rally continued on page 3

JLab, Brookhaven Hope For Turnaround After Severe Budget Cuts Last Year

Last fall Congress approved a $34 million cut in the Department of Energy's nuclear physics budget, a reduction of 8.4% from FY05. These cuts mainly affect the nation's two major experimental nuclear physics facilities, RHIC at Brookhaven National Lab and Jefferson Lab's CEBAF.

RHIC has recently been saved by a private donation, while JLab still faces cuts in run time and possible layoffs.

Under the final FY06 budget, the DOE would have funded 12 weeks of operation at RHIC during 2006. As many as 100 Brookhaven staff could have lost their jobs. Increases in electricity costs late last year would have forced even more reductions in operating time. In December Brookhaven officials decided it was not worth running the collider for such a short time, and instead decided to minimize layoffs and shut the machine down for the year.

However, in January the lab was saved by a private donation of $13 million. The donation was organized by James Simons, a member of the Board of Directors of Brookhaven Science Associates, which runs the lab. Simons is a mathematician and president of Renaissance Technologies, an extremely successful investment management company.

The donation will allow RHIC to run for 20 weeks this year. No experiments will be cancelled, and no layoffs will occur, said Brookhaven Director Praveen Chaudhari. "There is not another facility like RHIC in the world. It's been doing a set of unique experiments," he said.

Chaudhari said he expects this donation to be a one-time

JLab continued on page 3

Members in the Media

``It is vital to the nation that we retain those women who seek graduate degrees. Otherwise, we will lose our lead in innovation and ultimately our standard of living, as well as national security."

–Arthur Bienenstock, Stanford University, on Stanford's new maternity leave policy for graduate students, San Jose Mercury News, January 27, 2006

"It was quite striking. It used to be that a position at MIT was the best in the world, and now people are turning us down."

–Marc Kastner, MIT, on losing researchers to other countries where research funding is easier to obtain, The Boston Globe, January 23, 2006

"At the time I didn't think it was a good name, but it caught on fairly quickly."

–Saul Perlmutter, Lawrence Berkeley Lab, on the name "dark energy," Baltimore Sun, January 20, 2006

"In principle, the ball should go further in Denver" when it is thrown with the same amount of force.

–Adam Leibovich, University of Pittsburgh, on a Pittsburgh Steelers game in Denver, Pittsburgh Tribune Review, January 18, 2006

"There are a lot of interesting applications. Snails may be slow and may require a slime trail, but the good thing is they can crawl over anything– sand, mud, twigs. If they encounter a wall or ceiling, they keep moving."

–Anette Hosoi, MIT, on a robotic snail she developed, ABC news.com, January 26, 2006

"We would like to get them there yesterday. I have no doubt that it will make a difference. We feel modestly hopeful that it will relieve some of the hardship in the lives of these two million people."

–Ashok Gadgil, Lawrence Berkeley Lab, on bringing more efficient stoves to women in Darfur, where longs trips from refugee camps to gather firewood leave them vulnerable to attacks, Contra Costa Times, February 6, 2006

"It could snow day and night until the sun dies before two snow crystals would be exactly, precisely alike."

–Kenneth Libbrecht, Caltech, Christian Science Monitor, January 24, 2006

"There's the famous expression that when you build a wall, always make sure you know what you're walling in and what you're walling out. [The US has] set up a set of mechanisms that have the power to do more harm than good."

–Steven Block, Stanford University, on regulations that discourage foreign scientists from coming to the US, New Scientist, January 31, 2006

"Obviously, something got screwed up in the mail."

–Frank Stadermann, Washington University, on discovering that a box mailed by NASA did not contain the comet dust he was expecting, St. Louis Post-Dispatch, January 30, 2006

"This is a once-in-a-lifetime opportunity to get (cosmic) material like this."

–Hope Ishii, Lawrence Livermore National Lab, on NASA's Stardust mission, San Francisco Chronicle, February 1, 2006

"Oh, and the game-ending field goal kicked from the 300-yard line now spends almost 20 seconds in the air. The suspense is killing me."

–Todd Holden, Brooklyn College, on an imaginary football game on the moon, the Cleveland Plain Dealer, February 5, 2006

"There's been a dismal history of inadequate investment in physics, computer science, and the non-biology side of R&D in this country for the last 20 years."

–John Hopfield, Princeton University, on the budget for science, Technology Review, February 8, 2006

"That's either due to one person who is extremely varied, or it's due to a number of different artists."

–Richard Taylor, University of Oregon, on his analysis that six paintings attributed to Jackson Pollock may have been painted by someone else, The New York Times, February 9, 2006

This Month in Physics History

March 20, 1800: Volta describes the Electric Battery

In the late 18th century, scientists were fascinated with electricity. Ben Franklin had conducted his famous kite experiment, drawing electricity from lightning in 1752. Leyden jars, invented in 1746, could store charge and produce a spark of electricity. Doctors were treating patients with electric shocks for all sorts of ills. But further research on electromagnetism and any practical use of electricity would require a source of continuous current, which was not available until 1800, when Alessandro Volta invented the first electric pile, the forerunner of the modern battery.

Alessandro Volta was born in Como, Italy in 1745, to a wealthy noble family. He attended the Como Jesuit school and a local seminary. His teachers tried to persuade him to enter the priesthood, while his family wanted him to study law. But Volta, even at age 14, knew his real interest was physics. Like many scientists of the time, he was especially fascinated by electricity.

Volta dropped his formal studies, and did not attend university. Nonetheless, by age 18 he was corresponding directly with accomplished scientists, and conducting experiments in the laboratory of a family friend. In 1769 he wrote a treatise "On the forces of attraction of electric fire," in which he put forward a theory of electric phenomena.

In 1774 Volta accepted a post as an instructor at the Como grammar school, and continued his experiments on electricity. In 1775 he devised a "perpetual electrophorus" that could transfer charge to other objects, and in the next few years he noticed the bubbling of methane in swamps and was able to isolate the gas. Volta was made a professor of physics at the University of Pavia in 1778.

Alessandro Volta

Volta's early work had already made him a well-known scientist, but his greatest contribution to science was the voltaic pile, which he invented as part of a scientific dispute with Luigi Galvani.

In 1780, Galvani, an Italian physician and anatomist, was experimenting with dissected frogs' legs and their attached spinal cords, mounted on iron or brass hooks. In most of his experiments, the frog leg could be made to twitch when touched with a probe made of another metal. The frog legs would also jump when hanging on a metal fence in a lightning storm. These observations convinced Galvani that he had found a new form of electricity, which was being generated by the frogs' muscles. He called the phenomenon "animal electricity."

Volta, though initially galvanized by this work, argued that the frogs' muscles were simply reacting to the electricity, not producing it. He set out to prove Galvani wrong, and sparked a controversy that divided the Italian scientific community.

Volta realized that the crucial feature of Galvani's experiments was the two dissimilar metals–the iron or brass hook and the probe of some other metal. The metals were generating the current, not the frog parts. Instruments available at the time could not detect weak currents, so Volta, always a dedicated experimentalist, often tested various combinations of metals by placing them on his tongue. The saliva in his mouth, like the frogs' tissue, conducted electricity, resulting in an unpleasant bitter sensation.

A Voltaic Pile

To show conclusively that the generation of an electric current did not require any animal parts, Volta put together a rather messy stack of alternating zinc and silver discs, separated by brine-soaked cloth. He built the pile, which consisted of as many as thirty disks, in imitation of the electric organ of the torpedo fish.

When a wire was connected to both ends of the pile, a steady current flowed. Volta found that different types of metal could change the amount of current produced, and that he could increase the current by adding disks to the stack.

In a letter dated March 20, 1800, addressed to Joseph Banks, president of the Royal Society of London, Volta first reported the electric pile.

Volta soon traveled to Paris and demonstrated his invention, which he initially described as an "artificial electric organ," emphasizing that animal tissue was not needed to produce the current.

The battery was a huge success. Not only did it swing the scientific community to his side in the debate with Galvani, it was immediately recognized as a useful device. In 1800 William Nicholson and Anthony Carlisle used the current generated by a battery to decompose water into hydrogen and oxygen. Sir Humphry Davy also studied the same chemical effect. In the 1830s Michael Faraday used a battery in his groundbreaking studies of electromagnetism. Other inventors made improvements on Volta's original design, and soon it was powering telegraphs and doorbells.

Napoleon was impressed by the voltaic pile as well, and recommended many honors for Volta, including making him a count in 1810.

The invention of the battery brought him great renown, but Volta seems to have preferred a quiet life, and soon gave up most of his research and teaching. He spent his last years living in a country house, where he died on March 5, 1827, at age 82. Since his death, Volta's portrait has appeared on currency and stamps, and his name is immortalized in the unit of electric potential, the volt.

APS NEWS ©2006 The American Physical Society

Series II, Vol. 15, No.3
March 2006

Coden: ANWSEN ISSN: 1058-8132

Editor ..... Alan Chodos
Associate Editor ..... Jennifer Ouellette
Staff Writer ..... Ernie Tretkoff
Special Publications Manager ..... Kerry G. Johnson
Design and Production ..... Amera Jones
Forefronts Editor ..... Craig Davis
Proofreader ..... Edward Lee

APS News (ISSN: 1058-8132) is published 11X yearly, monthly, except the August/September issue, by the American Physical Society, One Physics Ellipse, College Park, MD 20740-3844, (301) 209-3200. It contains news of the Society and of its Divisions, Topical Groups, Sections and Forums; advance information on meetings of the Society; and reports to the Society by its committees and task forces, as well as opinions.

Letters to the editor are welcomed from the membership. Letters must be signed and should include an address and daytime telephone number. The APS reserves the right to select and to edit for length or clarity. All correspondence regarding APS News should be directed to: Editor, APS News, One Physics Ellipse, College Park, MD 20740-3844, E-mail: letters@aps.org.

Subscriptions: APS News is an on-membership publication delivered by Periodical Mail. Members residing abroad may receive airfreight delivery for a fee of $15. Nonmembers: Subscription rates are available at http://librarians.aps.org/institutional.html.

Subscription orders, renewals and address changes should be addressed as follows: For APS Members–Membership Department, American Physical Society, One Physics Ellipse, College Park, MD 20740-3844, membership@aps.org.

For Nonmembers–Circulation and Fulfillment Division, American Institute of Physics, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502. Allow at least 6 weeks advance notice. For address changes, please send both the old and new addresses, and, if possible, include a mailing label from a recent issue. Requests from subscribers for missing issues will be honored without charge only if received within 6 months of the issue's actual date of publication. Periodical Postage Paid at College Park, MD and at additional mailing offices. Postmaster: Send address changes to APS News, Membership Department, American Physical Society, One Physics Ellipse, College Park, MD 20740-3844.

Washington Dispatch

A bimonthly update from the APS Office of Public Affairs

ISSUE: SCIENCE RESEARCH BUDGETS

On December 30, President Bush signed into law the DOD appropriations bill, completing the FY 06 budget. Funding for DOD 6.1 (basic research) fell by 2.9 percent to $1.47 billion while funding for DOD 6.2 (applied research) rose by 6.5 percent to $5.17 billion. Over all agencies, basic research rose by a scant 1.8 percent, well below inflation.

In his State of the Union Speech, President Bush launched the American Competitiveness Initiative that includes a ten-year budget doubling for NSF, DOE's Office of Science, and NIST's core programs. The Fiscal Year 2007 (FY07) budget requests for these three agencies represent the first step in the Initiative. A budget summary follows.

Account	FY04 ($B)	FY05 ($B)	FY06 ($B)	FY07 Request	
				($B)	% Change
DOE Office of Science	3.48	3.64	3.60	4.10	+14
NSF	5.61	5.48	5.58	6.02	+7.8
NIST STRS	0.34	0.38	0.40	0.47	+18
DOD 6.1	1.36	1.49	1.47	1.42	-3
DOD 6.2	4.35	4.79	5.17	4.48	-13
NASA Science	NA	5.50	5.25	5.33	+1

For details of the FY06 and FY07 budgets, go to http://www.aaas.org/spp/rd/.

To address the US competitiveness challenges, the Senate is considering two bipartisan bills. Both of them would authorize increases for science research and education budgets and make the R&D tax credit permanent.

•In December, Senators Ensign and Lieberman introduced "The National Innovation Act of 2005" (S. 2109) that is based heavily on the National Innovation Initiative, a report released by the Council on Competitiveness in December 2004. Among its provisions, the bill, which has 25 co-sponsors, authorizes a 75 percent increase in NSF's budget by FY 2011, calls on DOD to support more basic research, encourages all federal agencies to support more high-risk frontier research and provides mechanisms to increase the number of qualified scientists and engineers.

•In January, Senators Alexander, Bingaman, Domenici and Mikulski introduced a set of three bills under the umbrella, "Protecting America's Competitive Edge (PACE)," largely based on the National Academies report, Rising above the Gathering Storm (Washington Dispatch, January 2006). The bill, which has 60 co-sponsors, would strengthen America's K-12, undergraduate and graduate education in science and math, authorize increases for the DOE Office of Science and the NSF, establish a DARPA-like program at DOE, increase early-career research grants, create a new class of visas for science and engineering graduate students and both increase and make permanent the R&D tax credit.

•Following President Bush's call for the nation to address the competitiveness change, House Republicans are expected to consider similar legislation later in the session. Last December, the House Democratic Leadership embraced the Gathering Storm report, issuing its "Innovation Agenda: A Commitment to Competitiveness to Keep America #1." Representative Bart Gordon has introduced legislation that contains its provisions.

***

ISSUE: GRASSROOTS

To broaden APS grassroots efforts, March Meeting participants are encouraged to come to Washington during the meeting to advocate for science research funding. The APS Washington Office will provide a briefing on the current Washington environment and tips on how to have a successful Hill meeting. Buses will be provided. For further information, see http://www.aps.org/public_affairs/marchmeeting.cfm. The DC office is also organizing a network of District Advocates, volunteers willing to act as Congressional district liaisons for APS Advocacy efforts. The DC Office will provide materials and talking points. Contact Kimberly Regan (regan@aps.org) for more information.

***

ISSUE: NEW POPA STUDY GROUP ESTABLISHED

The APS Panel on Public Affairs has established a new study group to examine the governance models for national laboratories. The group will produce a short paper that reviews the development and application of the GOCO governance model and will recommend steps to improve implementation of the model.

***

ISSUE: EVOLUTION-INTELLIGENT DESIGN ACTIVITY UPDATE

A multi-society working group has been established to address the Intelligent Design issue. Members include AAAS, ACS, AIBS, AIP, APS, ASA, ASPEC, COSSA, NAS, NSTA, and SDB. Initial activity of the group will be to analytically explore public attitudes as a means of shaping participating societies' respective education and outreach programs.

Log on to the APS Public Affairs website (http://www.aps.org/public_affairs) for more information.

Thousands of APS Members Respond to Funding Alerts

Responding to two email alerts, APS members have contacted Congress and the White House to urge them to support the physical sciences.

A message in December to all APS members in the US from then President Marvin Cohen encouraged them to write to their congressmen, asking for an increase in the DOE science budget. The alert was sent after the Congress passed the Energy and Water Appropriations bill, which reduced funding for the DOE's Office of Science for FY06 by $17 million from FY05, a 0.5% reduction.

Nearly two thousand APS members responded to the alert, sending letters to their Senators and Representatives asking them to correct those losses by contacting the Office of Management and Budget to request higher funding levels for the DOE Office of Science for FY07.

"The consequences of these cuts are grave and will cripple some of the top rate facilities that researchers from around the country and around the world have come to rely on," the letter reads. "Increased federal investment in basic research today will ensure America's prosperity and security propagates well into the future."

President Bush's budget request for FY07 includes $4.1 billion for the DOE Office of Science, a 14.1% increase over current funding (see the Washington Dispatch on this page).

Another alert, sent in January to the 5862 US members of the APS Forum on Industrial and Applied Physics, urged FIAP members to write to the White House to ask President Bush to use the State of the Union address and FY07 budget to bring focus to issues of competitiveness and innovation.

In response, 335 FIAP members contacted the White House. President Bush did discuss these issues in his State of the Union speech, in which he announced an American Competitiveness Initiative, which would encourage innovation, double federal funding for basic research in the physical sciences over the next ten years, and train more teachers in math and science.

It is difficult to to know exactly how much effect these alerts had, but it's important that APS members contact Congress, said Kimberly Regan, APS Policy Fellow. "We're excited to see that our members are active. We encourage an even larger response. The members of Congress are listening."

JLAB CONTINUED FROM PAGE 1

occurrence, and does not believe the private funding will affect government support for basic research. "Private money has always gone into science, and that has not stopped the government from supporting it," he said. "You can't get away without government support. Nuclear physics has to be supported by the US government in this county."

Chaudhari is optimistic about the future of funding for science, especially after hearing President Bush's State of the Union address, in which he called for doubling funding for basic physical science research. "I was greatly heartened. Clearly we will see an increase in the budget in the Office of Science."

At Jefferson Lab, the budget was cut by $7.8 million, from nearly $87 million for FY05 to $79 million in FY06. Some experiments are being delayed by decreased run time. As many as 40 layoffs are still possible at JLab, but lab officials have not yet decided what specific cuts will be made.

David Armstrong, a physicist at the College of William and Mary who does research at Jefferson Lab, said, "Even a relatively short period of poor funding delays important science. But more important is what it does to the pipeline." Recent PhDs and postdocs often react to a poor funding situation by leaving the field, he said.

Armstrong described his outlook about the future budget for nuclear physics as "hopeful, but very concerned."

Gordon Cates, a physicist at the University of Virginia and chair of the Jlab Scientific Users Group, said he expects the budget situation for physics to improve soon. "We're getting close to a turnaround. There's growing recognition of the importance of physical science. I do think we're seeing the pendulum swing the other way," said Cates. However, he cautions, that positive outlook is not a certainty. "I don't think it's a done deal. The outlook is quite positive, though I think everyone is waiting for the follow through."

PHYSICS RALLY CONTINUED FROM PAGE 1

budget constraints.

Last December, a National Summit on Competitiveness was held that further made the case that the federal government should be investing more in R&D in the physical sciences, math and engineering, and education in these fields at all levels. In response, the APS Forum on Industrial and Applied Physics (FIAP) sent out a member alert just prior to Bush's address, urging FIAP members to write to the White House asking the President to include the issue of competitiveness and innovation in his speech.

Congress responded with a flurry of legislation that incorporates many similar features to Bush's proposed initiatives. APS President John Hopfield released a statement expressing strong support for bipartisan legislation submitted to the US Senate that would substantially increase federal investments in physical science research and education.

The three bills–lumped together under the umbrella title "Protecting America's Competitive Edge" (PACE)–would also provide larger tax incentives for industry to invest in R&D, and would establish a new class of student visas for doctoral candidates studying in the fields of math, engineering, technology and science. S.2197 focuses on energy, S.2198 addresses education, and S.2199 is a finance bill that would double the federal R&D tax credit, provide an employee education tax credit and support the development of science parks.

Hopfield noted that apart from biomedicine supported by the National Institutes of Health, basic research activities in the rest of American science has declined over the last 20 years. "On this issue, we must set political partisanship aside and work together to get the job done," said Hopfield. "Our future depends on it." But he emphasized that the PACE bill merely authorizes the federal government to take action. "What we must do now is to put teeth into the legislation, by appropriating funds and enacting laws that actually carry out the mandates called for."

S.2109–known as the "National Innovation Act"–was introduced in December. The bill would establish a President's Council on Innovation to promote innovation in the public and private sectors, as well as the Innovation Acceleration Grants Program, encouraging federal S&T funding agencies to allocate 3% of their R&D budgets to grants for high-risk frontier research.

S.2109 also calls for a near-doubling of research funding for NSF by 2011 and encourages the development of regional cluster ("hot spots") of technology innovation throughout the US, modeled on the success of areas like Silicon Valley. Senate staff members have emphasized that S.2109 is complementary to, not competitive with, the PACE bills, and that the final legislation would incorporate the best features of all the bills.

In the US House of Representatives, three separate bills seek to implement the recommendations of the National Academies report. H.R. 4596 seeks to strengthen long-term basic research by authorizing 10% increases per year in funding. H.R. 4434 would establish an NSF scholarship program for science, math and engineering students who commit to becoming teachers at elementary and secondary schools, along with summer teacher training institutes funded by NSF and DOE to improve the knowledge and pedagogical skills of science and math teachers. H.R.4435 would establish a new agency within the DOE to reduce US foreign energy dependence by 20% over a ten-year period.

Links

Full text of President Bush's State of the Union address, with annotated links: http://www.nytimes.com/2006/01/31/politics/text-bush.html?_r=1&oref=slogin

About the American Competitiveness Initiative: www.whitehouse.gov/news/releases/2006/01/20060131-5.html

About the Advanced Energy Initiative: www.whitehouse.gov/news.releases/2006/01/20060131-6.html

Reports

Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. Executive Summary: http://fermat.nap.edu/books/0309100399/html/1.html

National Summit on Competitiveness Statement. http://usinnovation.org

Legislation

In the House:
H.R. 4596 "Sowing the Seeds Through Science and Engineering Research Act"

H.R. 4434 "10,000 Teachers, 10 Million Minds"

H.R. 4435 "Advanced Research Projects Agency-Energy Act"

In the Senate:
S.2109 "National Innovation Act"
"Protecting America's Competitive Edge (PACE)":
S.2197 "PACE Energy"
S.2198 "PACE Education"
S.2199 "PACE Finance"

Letters

Zero Gravity = Seven Letters

I would like to propose corrections to the Zero Gravity column of the December, 2005 issue of *APS News*. A megaphone should be a trillion microphones, not a million. A million microphones is just 1 phone. Also, 1 megacycle should be 500,000 bicycles, not a million. One megacyles is a million monocycles.

Lior Burko
Huntsville, AL

*****

I was very disappointed to spot a serious order of magnitude error in your December issue. It is clear that a million microphones do not suffice to make a megaphone. They make only a phone, today presumably a cell phone.

I trust that the inappropriate reference to Megaphone does not constitute an inadvertent disclosure of a (classified?) surveillance program authorized under the Patriot Act.

G. K. Wertheim
Morristown, NJ

*****

At the risk of sounding too serious, I noticed an error in the Zero Gravity in the December 2005 *APS News*.

1 Million Microphones should equal "1 phone." 10^{12} Microphones will equal 1 Megaphone.

Phil Shemella
Troy, NY

At the risk of being labelled "Physically Correct", I feel compelled to point out a couple errors in the conversion factors presented in the last Zero Gravity column.

First off, wouldn't 1 million bicycles actually equal *two* megacycles?

And then 1 kilogram of falling figs would be 9.81 fig Newtons, at least here on Earth.

Right?

Andrew Russ
Athens, OH

*****

Beware the conversion factors! In the Zero Gravity column for December, one million microphones is of course is only a föhn. One trillion microphones would be a proper megaphone.

Jos van Schagen
Seattle, WA

*****

You omited one important conversion factor:

10 logs= 1 decalogue

Do you need a reference?

Leo M. Silber
Brooklyn, NY

*****

Correction: one American TRILLION (10^{12}) microphones = 1 megaphone

Jim Pivarski
Ithaca, NY

ID Does Not Stimulate Further Research

This letter is in response to "Religious Bathwater May Contain Scientific Baby" by Edward J. Garboczi (*APS News*, December 2005), who compares Intelligent Design (ID) to the belief in a Creator as espoused by Faraday, Maxwell, Newton, Einstein, Galileo, and Kepler, the argument being that if one "throws out the religious bathwater" one would have thrown out the accomplishments of the above-mentioned scientists who were motivated by their religious beliefs. This comparison ignores one great difference between the beliefs of these scientists and the tenet of ID. These scientists developed theories that have been tested and found to contribute to the understanding of the workings of Nature. In contrast, the basic tenet of ID is that there are some things in Nature that are too complex to be explained by natural laws. This ID tenet does not stimulate further research that might lead to a better understanding of how Nature works, but rather it is a statement that some things are too complex to be understood so why even try.

Scientists with religious views have contributed to science in the past and there is no reason to believe that this trend will cease. Nothing is lost if one throws out the ID bathwater, for there is no baby to be found.

Kenneth S. Schmitz
Kansas City, MO

Scientific Proof Beats Leap of Faith

Regarding your letters on creationism and intelligent design: a point overlooked in these discussions is the difference between a scientific solution and a leap of faith. For example, if an explanation that the strange goings on in a house is the work of ghosts, then that is fine for those who believe in ghosts but from a scientific point of view it is not complete until one has shown independently that ghosts exist and are capable of doing whatever it was. (As in the question of whether power lines caused cancer, despite any statistics, an actual mechanism had to be found). Likewise, it is clear anti-evolutionists take the leap of faith when they don't complete the science and show that a Designer exists and has the capability. There are probably many scientists who have the same faith but realize that it is not an appropriate answer to a scientific investigation, unless there is more evidence for their faith than their personal beliefs. Of course, to the creationists the existence of God and His unlimited powers is self-evident and their real problem is that there are those of us who say that it is not correct to mix the criteria in the two realms. It may turn out that the ID people are right, but only after the existence and capabilities of a Designer are proven scientifically.

Meanwhile, there seem to be plenty of scientific solutions to the quite proper questions that they raise.

Henderson Cole
Danbury, CT

INTERNATIONAL News

...from the APS Office of International Affairs

Raising the level of science in developing countries

K.R. Sreenivasan

The Abdus Salam International Centre for Theoretical Physics (ICTP), in Trieste, Italy, is a research center that has been mandated "to foster advanced studies and scientific research in developing countries." Despite its name, the mandate covers basic work in all areas of physical sciences including sustainable development. Scientific development is part of the overall development and the increased interconnectedness of the world today implies that it is dangerous for all of us to leave any part of it too far behind. Thus, the Center's mandate is more relevant today than when it was created a little over 40 years ago.

Perhaps a few words are useful on what a "developing country" means. Except for Western Europe, its recent extensions through the European Union, United States, Canada, Russian Federation, Australia, New Zealand, Japan and Israel, the rest of the world is classified by the United Nations as developing. About 70% of world's population belongs to this class. The quantitative basis for this classification is a human development index that measures not only per capita income but also social development through literacy, education, healthcare and life expectancy. By this compound measure, countries such as Saudi Arabia are regarded as developing despite their oil wealth. Taiwan, Hong Kong, Singapore and South Korea are shedding the label and a few countries such as Chile and Turkey are seeking an active transition.

There are big differences within the class of developing countries. The needs in Qatar are different those from those in Namibia, and China cannot be compared with Ethiopia. To make further distinctions, the phrase "least developed countries," or LDCs, is used for the poorest nations which cannot be regarded as developing by any measurable index. They include 10 countries in Asia, 34 in Africa, 5 small countries in Oceania, as well as Haiti. This is a large number of countries and includes too many people to ignore.

Given this diversity of development, what is ICTP's strategy? What determines how well, and how much, ICTP works with scientists in a given developing country?

We can state ICTP's aspirations in simple terms:

1. In those countries which already have some good institutions but the development is rather spotty (e.g., Cameroon, Ghana, Indonesia, Pakistan, Iran and Nigeria), we support carefully selected good scientists, in the most effective ways possible and with little bureaucracy. They form the nucleus of scientific excellence.

2. For smaller countries whose development is low, a long term goal is to establish a "few" decent institutions within their territories, with at least a small number of groups there having some international visibility.

This is not overly ambitious or utopian, but is already a tall order for ICTP to accomplish on its own. But ICTP can, and does, stimulate the process and its evolution: one of its strengths is that it knows most of the good scientists in those countries, in one context or another. More importantly, it can build the needed scientific capacity through its many programs.

For example, ICTP promotes the progress of science in LDCs not only by offering its own facilities but also by backing up institutions in those countries to network with others in their region. Among the Asian LDCs, ICTP has strong ties with Bangladesh and Nepal, although, despite some efforts, no connection exists with countries such as Myanmar and Afghanistan. Among the LDCs in Africa, we work reasonably well with countries such as Benin, Mozambique, Sudan and Uganda but less with others. The links with countries of the Oceanic region is poor. Perhaps understandably, ICTP has had strong ties with countries such as Argentina, Brazil, Cameroon, China, Egypt, Ghana, India, Indonesia, Iran, Malaysia, Mexico, Nigeria, Pakistan, Russia, South Africa, Sri Lanka, Turkey and Venezuela. In very rough terms, we are connected to all countries that show interest in science and are still in serious need of some aspect of development. Where some combination of interest, opportunity, potential and need is large, our Center's involvement has also been extensive. Where the needs are large but no infrastructure exists to take advantage of science, active involvement has been rather difficult.

> "What is new is not the organization of such activities...but the commitment and the financial contributions from the major countries in the region."

Now that Taiwan, Hong Kong, Singapore and South Korea have broken out of the mold of developing countries, and countries such as Brazil, China, India, Mexico, South Africa and Turkey have made strong strides in science and technology in the last decade or so, ICTP can employ a new strategy for building S&T in their less developed neighbors. The latter group of countries combines areas of considerable development with aspects of neglect and decay; they are therefore well positioned not only to understand the main problems of development but also to do something concrete about them. They must take greater responsibility for increasing the level of science in countries in that region, and generate adequate capacity for making intelligent decisions on science and science policy. This emphasis is part of the new strategy of ICTP. I shall illustrate, through two of several examples, how ICTP has been enabling these large countries to discharge some of this responsibility.

(a) *Mathematics in Brazil and Latin America, Condensed Matter Physics in China and East Asia, and Information Technology in India and the South Asian region.* The plan is to utilize the powerful scientific resources of these big countries to organize high-level meetings, schools and workshops in the respective topics collaboratively and open them up for the rest of the region. Roughly speaking, the expenses for local participants and local expenses will be covered by the host country and travel for participants from other countries in the region will be covered by ICTP. What is new is not the organization of such activities–for instance, the Latin American String Theory School organized by ICTP has been going on for more than 8 years–but the commitment and the financial contributions from the major countries in the region.

(b) *Material science and accelerator physics in South Africa and the rest of Africa.* This arrangement allows African scientists to work in South African laboratories and maintain long-term connection with them. The travel costs will be provided by ICTP and the subsistence allowances will come from South Africa.

ICTP has begun work on other fronts as well. It has begun to work with the optics network in Africa to raise the capacity of ICTP-affiliated institutions to offer advanced education and training to students and researchers alike; undertaken new initiatives in mathematics in East Africa; coordinated the role of expatriate Sri Lankan scientists in working with their country's scientists and scientific institutions; supported new institutes in South Korea and Pakistan. It has started to work on common programs on seismology in the earthquake-prone region that includes Iran and the Indian subcontinent, and on climate changes in Northern Africa and Mediterranean countries.

The goal again is to make available the expertise present in the larger countries of a region to all the others in that region. We hope that a large-scale interest in assisting science of neighboring countries will improve their political relationships as well. Sometimes, ICTP has been a good mediator in this regard.

The author is the director of ICTP.

PHYSICS AND TECHNOLOGY FOREFRONTS

Silicon Lasers

Bahram Jalali

Silicon, the wonder material of the 20th century, appears to have one more trick up its sleeve. After dominating the digital electronic industry, the bedrock of the digital world, it is now being considered as a platform of choice for building optoelectronic devices. Silicon's mature and large-scale manufacturing base is believed to be precisely what is needed to effect a much needed reduction in the cost of photonic devices that are currently being manufactured in compound semiconductors such as Gallium Arsenide and Indium Phosphide. Such a cost reduction can bring the power of optical networks to the desktop computer and to home entertainment systems. Imagine downloading digital movies in seconds! The technology, termed *silicon photonics*, would be compatible not only with complementary metal-oxide-semiconductor (CMOS)-based electronic integrated circuits, but also with micro-electro-mechanical systems (MEMS). It could enable a new generation of electro-opto-mechanical chips that perform the job of today's complex systems at a fraction of the cost, size, and power dissipation.

For some time now, it has been known that when surrounded by its native oxide (SiO_2), otherwise known as ordinary glass, silicon becomes a low-loss optical waveguide at wavelengths of 1300 nm and 1550 nm, the regions of the spectrum where optical networks operate. Using such waveguides as basic building blocks, optical filters and switches have been developed, and by adding Germanium to the chip, photo-detectors have also been produced. In other words, most of the building blocks that make up an optical communication system are already available. If we also had optical amplifiers and lasers, the tool box would be complete.

Silicon light sources and amplifiers have remained elusive because of the material's bandstructure. Silicon has an indirect bandstructure, which means that the upper and the lower electronic states (conduction and valence bands) do not occur at the same value of crystal momentum (Fig.1). Because visible or infrared photons have negligible momentum (compared to that of the electron), the de-excitation of an electron (recombination) needs to be mediated by emitting or absorbing a phonon in order to conserve momentum. Such 2nd order radiative recombination events do not occur frequently, as characterized by a very long lifetime that is in the order of one second. The electron in the upper state has to sit and wait until a phonon with the right momentum shows up. While waiting, it becomes prone to non-radiative recombination with the energy being dissipated as heat. The experimentally measured lifetime in silicon is in the millisecond to microsecond range, depending on the impurity or defect concentration. This suggests that the desired radiative processes are insignificant compared to undesired nonradiative recombination. Even when using the highest purity silicon, devices have an electrical to optical conversion efficiency of only 10^{-4} to 10^{-3}. The situation would be different if one could break free of the low radiative recombination rate of bulk silicon.

According to the Heisenberg Uncertainty Principle, when the electron is localized, its momentum becomes uncertain. This phenomenon may offer a solution to the indirect bandgap of silicon. An interesting case study is the semiconductor, GaP, which is used for light emitting devices despite its indirect bandgap. Here the momentum conservation requirement is relaxed when an electron is localized at a Nitrogen impurity site. A possible technique to create quantum confinement is the use of silicon nanocrystals that occur naturally in a Silicon Rich Oxide (SRO) thin film. When a SiO_x ($x < 2$) film is subjected to high temperature anneal, the excess silicon leaves the oxide matrix and forms nanometer size grains of crystalline silicon dispersed throughout the oxide. The nanocrystals are excited by pumping the material with a high intensity light beam. Several research groups, notably at the University of Trento in Italy and at the University of Rochester, NY, have reported optical amplification in these films. However, the observed characteristics cannot be explained on the basis of electron localization in the nanocrystals, and the observations are highly dependent on how the sample was prepared. Consequently, questions remain regarding the nature of the observed optical gain. Additionally, the emission wavelength is in the 800-900 nm range, i.e., outside of the important telecommunication bands.

Other attempts at exploiting quantum confinement in defect sites or in intentionally formed quantum structures are showing promise. Researchers at Brown University have reported evidence of lasing at cryogenic temperatures (≤70 K). A two dimensional array of nanometer size holes were etched into a thin film of silicon that resides on oxide layer. The sample was cleaved (forming mirrors) and pumped optically. The mechanism for light emission (1270 nm wavelength) is believed to be from defects on etched silicon surfaces. In anther report, a team consisting of researchers at the University of California, Irvine, and in Taiwan used a junction diode in which the dopants were confined to nanometer size regions. They reported compelling evidence of stimulated emission at room temperature. Optical amplification was not demonstrated, but the room temperature operation and the electrical pumping feature are indeed intriguing.

The successful realization of light emission and amplification in optical fibers that are doped with Erbium has motivated efforts aimed at Erbium in silicon. However, silicon is not a good host for Erbium resulting in poor emission at room temperature. The reason is believed to be the back-transfer of energy from the excited Er ions to silicon and also the low concentration of Erbium that can be accommodated by silicon.

But optical fiber is made from SiO_2, so why not add Erbium to SRO? Similar to its fiber counter part, Erbium doped SRO exhibits light emission at the technologically important wavelength of 1550 nm. The material can be excited electrically, by sandwiching the film between a silicon and a metal film. A voltage applied to the so-called Metal-Oxide-Semiconductor (MOS) structure causes electrons to tunnel through the oxide, and in the process, to excite the Erbium atoms. Silicon nanocrystals also become excited and transfer their energy to nearby Erbium ions. Light emitting diodes with efficiencies of about 10%, as high as commercial Gallium Arsenide devices, have been reported by STMicroelectronics in Italy. Unfortunately, energetic electrons injected into the oxide (by tunnelling) cause premature device failure (a link between "hot" electrons and device failure is well established in the electronics industry). In addition, the maximum output power of silicon LEDs is currently far less than their Gallium Arsenide counterparts. Nonetheless, the observation of efficient electrical to optical conversion is a major development, and research on means to overcome the current limitations is underway.

Under funding from the Defense Advance Research Projects Agency (DARPA) in 2001, my group at UCLA proposed the use of Stimulated Raman Scattering (SRS) as a mean to realize amplification and lasing in silicon. So far, this has been the most successful approach and has yielded high gain amplifiers and efficient pulsed lasers. Raman back-scattering in silicon was used in the late 60's and early 70's as an analytical tool to study the vibrational properties of the material. More recently, SRS has been exploited in optical fibers to create amplifiers and lasers. However, several kilometers of fiber are typically required to create a useful device, suggesting that the approach is not applicable to silicon. Often overlooked was the fact that the gain coefficient for SRS in silicon is approximately 10^3 to 10^4 times higher than that in silica fiber. Additionally, owing to the large refractive index of silicon, silicon waveguides can confine the optical field to an area that is approximately 100 to 1000 times smaller than the modal area in a standard single-mode optical fiber, resulting in proportionally higher Raman gain. When combined, these facts make it possible to observe SRS over the interaction lengths encountered on a chip. This was validated through experimental demonstration of spontaneous and stimulated Raman scattering in silicon waveguides in 2002-2003 at UCLA. The first Si laser was demonstrated by us in 2004 and made use of the Raman effect under pulsed pumping. The laser showed a surprisingly high slope efficiency of 34% (as good as conventional lasers) and peak pulse power of over 2.5 Watts. The work was followed by Intel Corporation's demonstration of a continuous-wave (CW) Raman laser in 2005. At present, CW operation is frustrated by low output power and efficiency that are caused by accumulation of electrons that are generated by two photon absorption. Unfortunately, a diode used to sweep out the electrons is only partially effective.

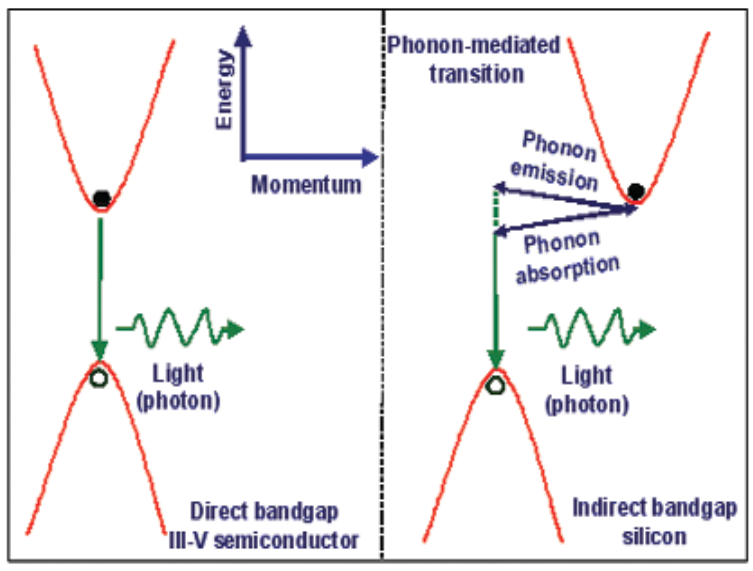


Figure 1. Difference of light emission mechanisms between direct and indirect bandgap materials.

Fortuitously, the two photon absorption vanishes in the mid infrared. This along with silicon's excellent thermal conductivity and high optical damage threshold makes the silicon Raman laser an ideal technology for power combining (taking several low power lasers and combining their beams to create a high power lasers) and wavelength shifting. A joint UCLA/Northrop Grumman team is investigating high power mid infrared sources by combining a silicon Raman laser with low power and shorter wavelength lasers. This technology is aimed at biochemical detection, with the potential to also be applicable to free space optical communication and eventually to defense against heat seeking missiles.

Bahram Jalali is Professor of Electrical Engineering at UCLA. He also serves as Chair of the UCLA Optoelectronic Circuits and Systems Laboratory, and is Director of the DARPA Consortium for Optical A/D System Technology.

New Report Examines Management and Public Perceptions of Nanotechnology

A new report concludes that while the potential benefits of nanotechnology are "almost limitless," little is known about its possible harmful effects, and the benefits will be realized only if adverse consequences "are examined and managed."

The January 2006 report, entitled "Managing the Effects of Nanotechnology," was released by the Project on Emerging Nanotechnologies, a partnership between the Woodrow Wilson International Center for Scholars and the Pew Charitable Trusts. The author of the report, Terry Davies, is a senior advisor to the Project on Emerging Nanotechnologies, and a senior Fellow at Resources for the Future.

The report finds that while strong government management and oversight is needed, existing laws and regulations suffer from major shortcomings and would be difficult to adapt to the production and use of nanotechnologies (NT). It also offers suggestions for management mechanisms, institutional capabilities, and regulatory authority, but acknowledges the political obstacles in the way of new or enhanced regulation.

This report follows a September 2005 survey of public attitudes toward NT, also from the Project on Emerging Nanotechnologies, which found that respondents knew little about NT, questioned the commitment of government and industry to public safety, and wanted more knowledge available to consumers.

Many voices in Congress and industry have been touting the potentially dramatic consumer and health benefits that could result from the emerging field of NT. But it is widely recognized that not enough is yet known about the possible environmental, health, and safety (EHS) concerns arising from such novel materials, and that public fears about real or imagined risks could stall broad acceptance and limit the beneficial uses of the technology. Past examples of public perceptions limiting the widespread utilization of technologies such as genetically-modified organisms and nuclear power are often cited as precautionary tales.

To address public concerns, the National Nanotechnology Initiative (NNI), the multi-agency federal program to foster NT development, includes funding for research into possible EHS impacts. (Of the Bush Administration's $1.1 billion FY 2006 request for NNI, about $38.5 million, or 4%, would go toward EHS research.) However, at a November hearing of the House Science Committee, several private-sector witnesses called that amount inadequate.

But with substantial new funding unlikely, witnesses were less unified when pressed on how much funding was the right amount and how funds should be reprogrammed. Richard Denison of Environmental Defense suggested "at least $100 million annually for at least the next several years," while Clayton Teague of the NNI Coordination Office countered that the current amount was adequate, given the funding available.

The report cautions that with the

Nanotechnology continued on page 7

Featured PhysTEC University: Colorado "Learning Assistants" Make a Big Difference

At the University of Colorado, becoming a K-12 science teacher is a popular career option for some of the best science students.

This is in part due to some of the reforms that have been implemented in connection with the university's participation in an APS-led program to improve teacher preparation, said Valerie Otero, a professor of science education. In particular, the university's "learning assistant" program has inspired more students to be interested in teaching.

The University of Colorado is one of the participating institutions in PhysTEC, the Physics Teacher Education Coalition, a program led by APS in partnership with the American Association of Physics Teachers (AAPT) and the American Institute of Physics (AIP). Schools that participate in PhysTEC implement several reforms, including increasing collaboration between the physics and education departments, revising introductory courses to be more inquiry-based, and having a "teacher-in-residence" who mentors students and provides advice to the faculty. The University of Colorado PhysTEC leader is Noah Finkelstein. Co-leaders are Otero, Michael Dubson, and Steven Pollock.

One unique aspect of the University of Colorado's program is its innovative use of "learning assistants," undergraduates who help students in the introductory science courses in problem-solving tutorial sessions. The learning assistants help make it possible for the introductory classes to do more student-centered activities, said Otero. Their role is similar to that of graduate student "teaching assistants," said Otero. "We call them 'learning assistants' because they assist people learning."

In some of the introductory science classes, the students participate in tutorial sessions, in addition to large lectures. Students break into small groups, and the learning assistants help them with problems, guide their learning, and assess what they've mastered and what concepts are troublesome. They do not provide the students answers to the problems, but help them progress through Socratic dialogue.

Studies by the physics education research group at the university have shown that the students in courses with learning assistants show greater learning gains than students in other types of courses.

In addition to helping other students, the learning assistants take a special course designed for them on teaching and learning science. The course has proved quite useful, said Otero, and in fact some graduate student teaching assistants say they want to take the course too.

At the University of Colorado, there are 48 learning assistants, 18 of them in physics, the rest in other science departments. Undergraduates can apply to become learning assistants as early as the second semester of their freshman year. It is a desirable position that many students want.

Many of the learning assistants have not previously thought of teaching as a career, said Otero, but their experience as learning assistants inspires them to consider it. About 15 percent of the learning assistants end up enrolling in the university's school of education teacher preparation program.

These are some of the best science students with high grade point averages, not students who are doing poorly. Otero emphasized that it used to be that science students who expressed interest in becoming K-12 teachers were considered weird, but now teaching has become a cool and popular option, she said.

More faculty members are getting involved in using learning assistants as well. "The faculty are embracing it," said Otero. They learn from feedback that the learning assistants provide them. Even faculty members who were initially skeptical of the idea are now trying it.

In addition to their learning assistant program, the Colorado PhysTEC team has implemented several other programs. A teacher advisory group, composed of teachers from local schools, meets several times a year with the University of Colorado PhysTEC team. The teachers in the group share their experiences and provide advice and insights on what works best in their classrooms and what training new teachers need. Two teachers-in-residence also provide real-world advice for the PhysTEC program.

The University of Colorado has a strong physics education research program in the physics department, and they incorporate what they learn from that research into the PhysTEC program and revised courses.

The university also has a special curriculum in physics for elementary school teachers, which integrates physics and education.

As with the other PhysTEC participating institutions, there is significant coordination between the physics and education departments, and between the university and the local schools.

That coordination is extremely important. "It would be ridiculous for the education department to try to prepare students to be physics teachers without the help of the physics department, and it would be ridiculous for the physics department to try to teach science without input from the education department. It's also ridiculous to try to prepare future teachers without input from teachers," said Otero.

Since the Colorado PhysTEC program is new, having just started in 2004, they don't have any graduates yet, but after the program has produced some new teachers, the physics education research group plans to conduct a study comparing the preparation of those new teachers to ones who have not participated in PhysTEC.

RECORD HIGH CONTINUED FROM PAGE 1

Department is always working to recruit new members and retain current members. In the past there have occasionally been special membership drives and special promotions. Most recently, the membership department has concentrated on improving correspondence with members.

"Since the Centennial we've focused a lot on communicating," said Trish Lettieri, APS Director of Membership. For instance, new members now receive a message reminding them of the benefits of membership. The department is also dedicated to retaining members, including contacting those whose membership is about to lapse. Membership retention is quite high, typically around 90% for regular members, said Lettieri.

Communication with members may also help foster a sense of community. When surveyed, APS members say that other than receiving *Physics Today*, their top reason for being APS members is to "be part of the physics community," according to Lettieri.

Membership dues are currently $109 for regular members, and are increasing slowly with inflation, in order to avoid the large increases that have happened at times in the past, said Lettieri.

Slightly more than 20% of members are international, and that percentage has been holding steady over recent years.

The membership department made some improvements in 2005. For instance, it is now possible to join APS online. New member benefits that were added include a book discount through Elsevier, and a member article pack that enables members to download 20 articles from *Physical Review* journals for $50. This mainly benefits industrial members, who make up about 25% of APS members, and who, unlike academics, often don't have access to a library subscription to the journal. A summary of member benefits can be found at the membership website, www.aps.org/memb.

zero gravity

The Lighter Side of Science

Create Your Own Physics Crossword Puzzle!

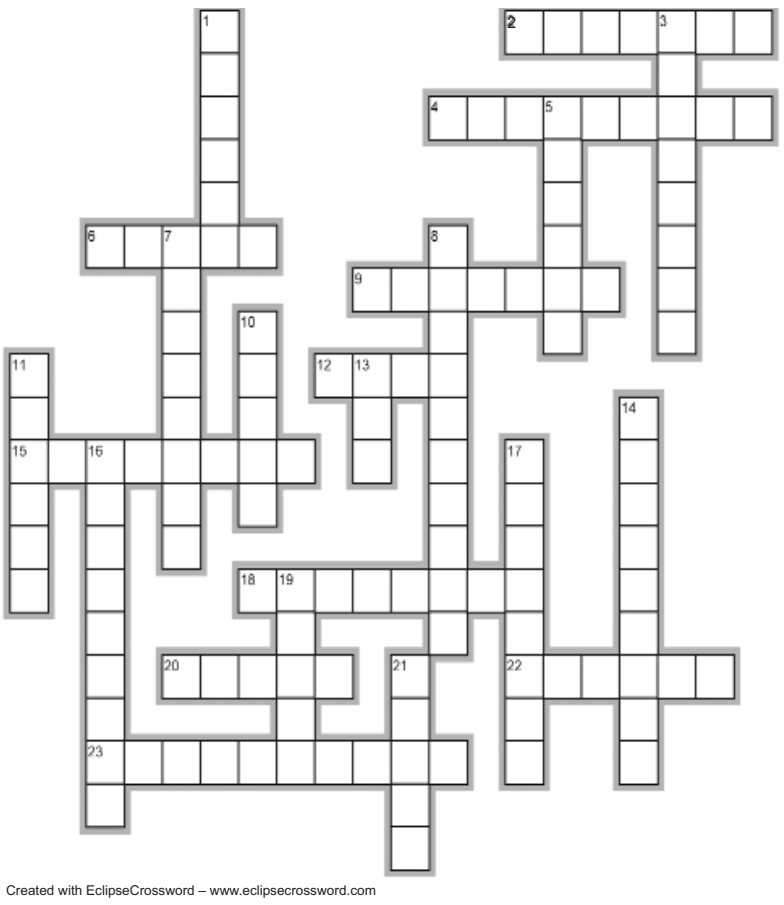
Certain editors of *APS News* are hopelessly addicted to crossword puzzles, a compulsion we suspect is shared by many of our readers. So imagine our delight at discovering a free software program that lets us create our very own puzzles. It's inspired us to announce yet another contest for APS members around the globe. We hereby invite you to submit physics-themed crossword puzzles of your own creation.

The puzzles can be as easy or as difficult as you like, on any topic, subfield, person, era of history, theme, etc., with one restriction: no equations. (Save those for the Sudoku puzzle contest.) Submissions will be evaluated based on creativity and degree of difficulty–admittedly subjective criteria.

We're kicking things off in this issue with a special "Modern Physics Review" crossword puzzle, created in 2005 by James Alexander, a student at St. Mary's High School in Manhasset, New York. You can download the free software to create your own physics-related puzzle here: http://www.greeneclipsesoftware.com/eclipsecrossword/download.html

And feel free to check out the rest of St. Mary's physics teacher Tony Mangiacapre's award-winning educational Web site: http://www.smgaels.org/physics/home

The deadline for puzzle submissions is September 1, 2006. The winner will receive a fabulous prize and the proverbial 15 minutes of fame by having his or her name and puzzle featured in an upcoming issue of *APS News*. Send submissions to editor@aps.org, or, by snail mail, to Editor, *APS News*,The American Physical Society, One Physics Ellipse, College Park, MD 20740.



Created with EclipseCrossword – www.eclipsecrossword.com

Across

2. The protons are found in the____.
4. A photon's energy varies directly with its___.
6. The atom is mostly_____space.
9. 6.63 x10^{-34} Js is_____constant.
12. An antiparticle has the same____ but different charge of a particle.
15. When going up an energy level, energy is___.
18. Light is both a wave and a_____.
20. If the atom were a football stadium, the nucleus would be a____.
22. The nuclear force is short-range and very _____.
23. The energy needed to remove an electron from an atom is called the____ energy.

Down

1. The color_____ has the highest frequency.
3. $E=mc^2$ was discovered by_____.
5. Up, Down, and Charm are all different types of_____.
7. The electron's antiparticle is called a_____.
8. The "lost mass" of an atom that is converted to binding energy is _____ _____. (2 words)
10. Inside orbits have____energies than the outside ones.
11. Light energy is carried in discrete units called_____.
13. One____ converts to 931 MeV.
14. _____are small enough to show a wave behavior.
16. The particles smaller than an atom are called_____particles.
17. When going down an energy level, energy is____.
19. Rutherford used___particles in his Gold Foil experiment.
21. The current atom model is the_____model.

MARCH MEETING CONTINUED FROM PAGE 1

now become a quantitative experimental science, with the ability to do such things as manipulate microorganisms at the genetic level, move biomolecules with microfluidics, and make detailed measurements with state-of-the-art optics tools. The University of Chicago's Jim Shapiro will show how an information-science approach will offer many new details about evolution. Michael Deem of Rice University will explain how "Life Has Evolved to Evolve." (Session R7)

Science and Art: Not-So-Strange Bedfellows.

Five years ago, renowned artist David Hockney stirred up a controversy with his contention that artists as prominent as Dutch master Jan van Eyck must have used optical devices to aid to in the production of realistic, almost photographic, details in their works. The debate has continued to rage among art historians. At the Baltimore meeting, Hockney's scientific collaborator, Charles Falco (University of Arizona), will present a wealth of optical evidence to support Hockney's claim, and will share his experiences of this unusual and remarkably productive collaboration between an artist and a scientist. He will also give a public lecture on this subject at the Walters Art Museum in Baltimore on Wednesday, March 15, at 6:30 p.m.

At the same session, Brian Schwartz (The Graduate Center of the City University of New York) will discuss CUNY's ongoing "Science as Performance" program, designed to communicate to the public the excitement of science, technology, engineering and mathematics. Schwartz will also discuss his personal involvement in bringing to the stage two musical versions of *Einstein's Dreams*, a novel by physicist Alan Lightman, one of which opens in Philadelphia this month. (Session H4a)

Searching for Supersolids

In 2004 evidence for superfluid behavior in a solid, solid helium, was reported for the first time. At last year's APS March Meeting Tony Clark and Moses Chan of Penn State reported that they had obtained evidence also for superfluidity in solid hydrogen. Because the existence of a superfluid solid would require much new thinking about macroscopic quantum behavior, the number of theoretical papers on this topic has been increasing rapidly, and several groups have commenced experimental studies. At this year's meeting, Chan's group will report more definitive results on these two supersolid systems. Other groups will also report their latest theoretical and experimental results. (Sessions B2 and G41)

Intelligent Design

A Tuesday night session looks at the impact of this topic much in the news and the efforts of many to keep science education on a scientific footing. Jeremy Gunn (American Civil Liberties Union) will review some of the legal milestones concerning the teaching of evolution, such as the Scopes trial of 1925, and will suggest how scientists can contribute to the ongoing debate. Marshall Berman (Sandia National Lab and past vice president of the New Mexico State Board of Education) looks at the social and political standing of science and of religious fundamentalism. Francis Slakey (APS) will review past policy action by the APS and current efforts in this area. Finally, Cornelia Dean of *The New York Times* will describe how the evolution and intelligent design issue has been covered in her newspaper. (Session M50)

Nanotube Yarns and Textiles

New carbon nanotube yarns and sheets, stronger than steel and extremely light, could be used for a wide variety of futuristic applications, including artificial muscles, solar cells, energy storage, solar sails, electrically conducting appliqués, and several types of lamps, displays and sensors. These sheets are transparent, flexible, light, and extremely strong, and can be produced quickly. Ray Baughman of the University of Texas at Dallas will describe his new method for producing these yarns and textiles in the solid state, and will evaluate their use for some of these amazing applications. (Paper N32.1)

Nanopore DNA Sequencing

Some proteins naturally form nanometer-scale pores through which ions travel to enable communication within and between nerve cells. Researchers are developing biotechnology applications for natural and artificial versions of such nanopores. For example, nanopores are coming closer to enabling faster and better DNA sequencing than present biochemistry-based methods. A Brown University group led by Sean Ling will present one solution to reading the individual letters of DNA molecules through nanopores even though they are only 4 angstroms apart (paper N26.10). An entire session on nanopore biophysics will present a number of advances, including the latest work with artificial nanopores and the use of the nanopore protein secreted by anthrax for technologies for quickly detecting anthrax in blood samples and studying the effectiveness of therapeutic agents that fight anthrax. (Session H7)

Anti-Brownian Trap

Nanometer-scale objects, such as proteins and DNA, constantly jiggle around in a liquid solution as they are bombarded by the solvent molecules that surround them. This Brownian motion makes studying nano-objects very difficult. Adam Cohen of Stanford will present the Anti-Brownian Electrokinetic (ABEL) trap, which eliminates the Brownian motion of one molecule in a solution. The researchers have trapped single fluorescently labeled protein molecules in solution. This achievement opens the possibility of studying individual proteins free-floating in solution. (Paper G26.1)

The Hydrogen Economy

Hydrogen power has the potential to produce less pollution and reduce dependence on fossil fuels, but significant challenges remain in order to make a hydrogen economy efficient and economically feasible. Speakers in Session A5 will present an overview of the challenges for the hydrogen economy, and some promising ways in which physics and materials science can enable progress. Mildred Dresselhaus of MIT will discuss the needs of a practical hydrogen economy, including production, storage, and utilization, and will also highlight recent progress and opportunities. Other speakers will present advances in new materials for the hydrogen economy. (Session A5)

Topsy-Turvy Superconductivity

When a superconducting zinc nanowire is attached to bulk superconducting leads of another material, one would expect that the wire remains superconductive. In a recent experiment at Penn State, Minglian Tian and his colleagues observed that when the wire was connected to superconducting leads consisting of indium or tin, its superconductivity was suppressed. Bizarrely, when the indium or tin attachments were driven into a non-superconducting state, the superconductivity in the zinc nanowire recovered. (Session A1)

Is the US Losing its Technological Edge?

The US has held the undisputed lead in science and technology for more than half a century. Recent competitiveness benchmarks, however, suggest that the US may be giving up its advantage as competing nations focus on coming up to speed and the US loses its technological head of steam. Michael Lubell, APS Director of Public Affairs, will examine the sliding US benchmarks and explore various governmental policies that may keep the nation at the top of the research heap. (Session N5)

Thermodynamics of Money

Econo-thermodynamics is an emerging interdisciplinary field that is generating considerable excitement. Physicists often model economic interactions as if they were collisions of atoms in gases: one agent, or atom, gains from the interaction, while the other loses. This means they can use equations drawn from thermodynamics to predict distribution patterns of wealth in various countries, for example. Victor Yakovenko (University of Maryland) will describe his work analyzing empirical data on income in the US, which he believes follows the equilibrium probability distribution of energy in a closed physical system. (Session A33)

NANOTECHNOLOGY CONTINUED FROM PAGE 5

field's rapid progress, delays caused by government regulation could be costly to industry, especially to small firms. It also warns that information about possible harmful effects is likely to "lag behind commercial applications." However, according to the report, even the early, fragmentary data available on adverse consequences "is enough to show that there are potential or actual effects that warrant concern."

Both reports are available on the Project on Emerging Nanotechnologies site at http://www.nanotechproject.org/. The January 2006 report, "Managing the Effects of Nanotechnology," can be found under the heading "Getting Nanotech Right: A New Report on Government Oversight of Nanotechnology." To find the September 2005 report, "Informed Public Perceptions of Nanotechnology and Trust in Government," click on "Reports, Papers and Presentations."

Courtesy of FYI, the American Institute of Physics Bulletin of Science Policy News (http://aip.org/fyi).

APS Bylaws Amendment
Related to a Change in the Responsibilities of the Publications Oversight Committee

First Vote: Approved by Council – November 20, 2005

27 September 2005
To: The Committee on Constitution & Bylaws
From: The Publications Oversight Committee, via A. Halsted
Re: Revision of POC Bylaw

Background: At the January 2005 meeting, several POC members noted that the existing entry for the Publications Oversight Committee in the APS Bylaws no longer accurately describes the duties and functions of the committee, and implies that the POC makes direct recommendations, rather than advising to and through the Treasurer and Editor in Chief. In particular there was no mention of the major responsibility of the POC, that of recommending and approving pricing for the Physical Review journals as proposed by the Treasurer. The present bylaw with proposed changes as approved at the 3 June meeting is presented below.

ARTICLE III - STANDING COMMITTEES

A. OPERATING COMMITTEES

2. Publications Oversight Committee. -The membership of the Publications Oversight Committee shall consist of the Editor-in-Chief, the Executive Officer, the Treasurer, four members elected by Council to staggered four-year terms and four members appointed by the President-Elect to staggered four year terms. The President-Elect shall appoint a Chairperson from among these eight members. The Committee shall **advise the Editor-in-Chief on editorial policy, advise the Treasurer on journal subscription pricing,** ~~propose guidelines for the operating philosphy of publications~~ and shall oversee general ~~editorial policy~~ **operating philosophy for publications.** It shall meet at least twice each year and shall make recommendations to **the Executive Board and/or** Council regarding the research publications of the Society.

DRAFT AMENDMENT TO APS BYLAWS Related to the Composition of the Committee on Membership

First Vote – Approved by Council: November 20, 2005

The following proposed amendment is intended to formally allow one representative from the Forum on Graduate Student Affairs to serve on the Committee on Membership. This has been the informal practice for the past several years and it has been found to be quite beneficial to the Committee on Membership. Approval of the amendment would bring the bylaws into compliance with current practice.

ARTICLE III - STANDING COMMITTEES

A. OPERATING COMMITTEES

7. *Committee on Membership*. -The membership of the Committee on Membership shall consist of the Executive Officer, nine members appointed by the President-Elect to staggered three-year terms **and one representative from the Forum on Graduate Student Affairs serving a one-year term.** The President-Elect shall appoint the Chairperson from among ~~these nine~~ **those** members **serving three-year terms.** The Committee shall suggest to Council means for improving the relationship between the Society and its members, for services the Society provides to its members including APS publications members receive on payment of their membership dues, and for other activities in the area of membership as delegated to it by the Council.

JOB FAIRS AT APS MARCH AND APRIL MEETINGS

MARCH 2006
APS March Meeting Job Fair
March 13 – 15, 2006
Baltimore, MD

APRIL 2006
APS April Meeting Job Fair
April 23 – 24, 2006
Dallas, TX

Don't miss the opportunity to connect with employers and job seekers from all areas of physics and physical sciences. This is the perfect opportunity to reach high-level candidates who will bring skill, dedication, and energy to your organization.

Recruiters
- Showcase your company with a Recruitment Booth
- Advertise open positions
- Interview qualified job candidates
- Search resumes specific to the meeting

Job Candidates
- Network with technical staff and human resource recruiters
- Post resumes and search jobs
- Interview for positions

For more information, please contact Alix Brice at (301) 209-3187 or abrice@aip.org.

The Back Page

Competing in a 21st Century World

By Frank Wolf

In my role as chairman of the House Science-State-Justice-Commerce Appropriations subcommittee, which controls the budget of NASA, the National Science Foundation, the White House Office of Science and Technology policy and NOAA, I have met over the past year with groups that advocate for business, education, and research and development. What I heard from them is that America is facing unprecedented competition from countries such as China and India and our role as the global innovation leader is being challenged. I was alarmed to learn that three key measuring sticks show America on a downward slope: patents awarded to American scientists; papers published by American scientists, and Nobel prizes won by American scientists.

To help find solutions to reverse those alarming statistics, I included a directive in last year's supplemental spending package in Congress for the Department of Commerce to work with groups such as the Council on Competitiveness, the Business Roundtable, the National Association of Manufacturers and the American Physical Society to hold a National Summit on Competitiveness in Washington to evaluate America's future in science and innovation. The conference took place in December and helped to elevate this issue in the national consciousness.

In speaking with the nation's science and engineering community, I also was troubled to learn about the shortage of math, science and engineering students in the United States. According to the National Academy of Engineers, China awards 300,000 engineering degrees per year, more than four times the 70,000 engineering degrees awarded in the U.S. I was surprised to learn that while the number of undergraduate degrees awarded has increased 14 percent over the last 10 years, the number has declined in fields such as engineering and mathematics. The number of mathematics degrees declined by 16 percent over the last 10 years.

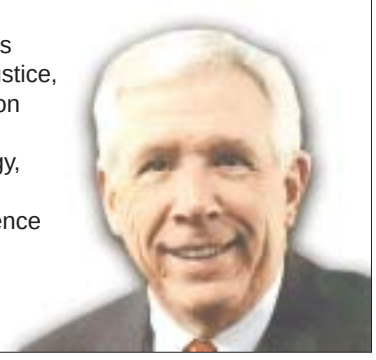
The National Academies' report Rising Above the Gathering Storm released last October also makes it clear that we must vastly improve K-12 math and science education. Average student test scores show a declining percentage of proficiency over the course of the student's academic career. That means that there are a higher number of 4th graders who are proficient in math and science than there are 12th graders. That's a disturbing trend.

Another troubling fact is that three out of four 4th-grade math and science teachers in the U.S. do not have a specialization in those subjects. And students from low income communities are far less likely to have teachers certified in the subject they teach. Compounding this situation is the fact that more than half of the current math and science teachers are expected to retire in the next five years. If teachers aren't confident in the subject matter they are teaching, it's nearly impossible for them to inspire another generation to study that subject.

Congressman Frank Wolf

Republican member of Congress, representing Virginia's 10th District. He's serving in his 13th House term.

Wolf chairs the House Appropriations Subcommittee on Science, State, Justice, and Commerce, which has jurisdiction over the budgets of NASA, National Institute of Standards and Technology, National Oceanic & Atmospheric Administration and the National Science Foundation.



Congress has taken notice of these developments. To respond to the challenge of reversing this math/science education deficit, I introduced legislation with Rep. Vern Ehlers (MI) and Rep. Sherry Boehlert (NY) last April aimed at attracting more students to math, science, engineering and related fields. The Math and Science Incentive Act would forgive interest on undergraduate student loans for math, science and engineering majors who agree to work five years in their field upon graduation.

A few months later, the House Education and the Workforce Committee approved legislation to reauthorize the nation's higher education programs–the College Access and Opportunity Act. The bill includes a number of provisions to improve mathematics and science education, including: establishing Mathematics and Science Honors Scholarships for students pursuing a degrees in physical, life, or computer sciences, mathematics, and engineering, repaying up to $5,000 of the interest accrued on student loans for math, science and engineering majors who agree to work for five years in their field of study–similar to the proposal in my legislation, and awarding grants to Mathematics and Science Education Coordinating Councils, which are composed of education, business, and community leaders, to implement reforms to achieve better teacher recruitment and training, increased student academic achievement, and reduced need for remediation at all levels.

Congress also recently approved the National Science and Mathematics Access to Retain Talent Grants (National SMART Grants). The bill provides grants of up to $4,000 to Pell Grant eligible students in their third and fourth academic year of undergraduate education at a four year, degree granting institution of higher education. The student must be pursuing a major in the physical, life, or computer sciences, math, technology, or engineering (or a foreign language). The student must also have a grade point average of at least 3.0.

But it will take more than Congress passing a few pieces of legislation. The national crisis in innovation demands a dedicated national response. Remembering how the nation was mobilized to compete for the space frontier after the Soviet Union launched Sputnik in the late 1950's, I wrote President Bush last year urging him to embrace this issue. I asked that he dramatically increase our nation's innovation budget–federal basic research and development–over the next decade to ensure U.S. economic leadership in the 21st century. Many in the scientific community have told me now that at that time, they didn't think there was a realistic chance of that happening.

But sitting in the House chamber on January 31 and listing to the President's State of the Union address, I was thrilled to hear him lay out the American Competitiveness Initiative–a bold proposal which marks an exciting new chapter in America's history as the global innovation leader. This ambitious strategy will increase federal investment in critical research, ensure that the United States continues to lead the world in opportunity and innovation, and provide American children with a strong foundation in math and science.

The American Competitiveness Initiative commits $5.9 billion in FY 2007, and more than $136 billion over 10 years, to increase investments in research and development (R&D), strengthen education, and encourage entrepreneurship and innovation. The centerpiece of the plan is the President's strong commitment to double over 10 years investment in key federal agencies that support basic research programs in the physical sciences and engineering–the National Science Foundation, the Department of Energy's Office of Science, and the Department of Commerce's National Institute of Standards and Technology. I share the President's commitment and will be working this year in the appropriations process to fund this effort.

The President's proposal can help catch and keep the interest of our nation's children in math and science, while preparing them for the global competition we face in the 21st century. I applaud the President for his commitment to train 70,000 high school teachers to lead advanced placement courses in math and science. His goal of bringing 30,000 math and science professionals to teach in classrooms will help more students understand the connection between the classroom and today's global marketplace. America is a land of opportunity and providing true opportunity involves helping students who struggle with math–just like the President proposed–because top skill jobs translate into high wage jobs.

About the time in early 2005 that many of the nation's science-related programs were added to my appropriations subcommittee jurisdiction, I also saw the film Longitude, which involves the successful 40 year effort of 18th century clockmaker John Harrison to solve the elusive problem of measuring longitude at sea. In 1714, the British Parliament had offered the Longitude Prize, a generous reward to anyone who solved the problem, and Harrison devoted his life to that solution. Thousands of sailors perished at sea before Harrison's triumph changed history.

Similar to the British effort in solving the longitude problem and the U.S. effort in space after Sputnik, America is poised to mobilize again to ensure that our country remains the world leader in innovation. The challenge is before us all–public policymakers, the scientific community and the American people alike. Knowing the can-do attitude Americans possess, I believe our future as the solid world leader in innovation is again looking bright.

And the Winner is....

As part of the World Year of Physics, with funding from NSF and DOE, APS repeated the successful PhysicsQuest program in the Fall of 2005. Over 700 middle school classrooms took on the challenge. After performing a set of experiments, students used their answers to navigate through a map of the Institute for Advanced Study and find Einstein's "hidden treasure." Of the 450 classes that submitted correct answers, Albert Einstein randomly picked 10 to receive prizes. The grand prize winners, Ms. Down's class from Havana, IL, received iPods, classroom materials, and a $300 gift card for purchasing additional science materials.

Photo credit: Jessica Clark (with a hand from Alan Chodos)

APS News welcomes and encourages letters and submissions from its members responding to these and other issues. Responses may be sent to: letters@aps.org.