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APS physics

Spring Prizes & Awards
See Insert

March Meeting Covers Broad Spectrum of Research

The APS March Meeting, the largest physics meeting of the year, will take place March 16-20, 2009 in Pittsburgh at the David L. Lawrence Convention Center. Scientists from around the world will present more than 7,000 papers on the latest research in condensed matter physics, new materials, chemical and biological physics, fluids, polymers, and computational physics. A number of sessions will also address the role of physics in society, such as its relevance to education in developing nations, the quantitative study of paintings, the greening of the city of Pittsburgh, and climate change mitigation.

Some special sessions to be held at the meeting include a session on Energy and the Environment on Monday evening and special evening symposium Wednesday on Windows on our Universe: Breakthroughs in Observational Cosmology.

Graphene Stays Hot

More than two dozen sessions are devoted to the study of graphene, a two-dimensional form of carbon. Session A1 looks at how graphene properties can be tweaked to produce novel effects and possible applications in micro-circuitry. Changing the substrate on which the graphene sits or the triggering of small terraces in a graphene sheet are methods for tuning graphene behavior. Other sessions feature new experimental results (B1), electronic behavior (H1), and electron trajectories in graphene (J1).

Iron-Arsenic Superconductors

These new materials–the first superconductors above a temperature of 50 Kelvin not made from copper-oxide planes–have made a big splash over the past year. Last year's meeting featured no session on this topic; this year; a dozen sessions. Topics include the possible ways in which electrons pair up on the Fe-based materials, summaries of how the materials are made, electronic properties, theoretical explanations, and the manifestation of the Josephson effect and other superconducting phenomena.

Cheap, Bendy Photodetectors

Xiong Gong and his colleagues at the University of California, Santa Barbara and CBrite Inc. have developed prototypes of low-cost flexible photodetectors that are sensitive to infrared, visible, and ultraviolet light in the wavelength range of 300 to 1450 nanometers. The photodetectors are made with semiconducting polymers that work much like common commercial silicon-based photodetectors by converting light into electrical signals. They are at least as sensitive as silicon photodetectors, says Gong, and they have the advantage of covering a very broad spectral range as well as being flexible and much cheaper to produce. The potential commercial applications include image sensing, communications, chemical, biological, and environmental monitoring, remote control, night-time surveillance, and military applications. Gong predicts that the technology will be commercially available in less than five years. (H20.10)

Nano-Tool Box

If you want to build tiny things, it's handy to have some tiny tools. Abha Misra and colleagues at

MEETING continued on page 6

APS President's Message Stimulates Strong Member Response

Thousands of APS members responded to a letter from APS president Cherry Murray requesting that they contact their senators regarding the need to include science funding in the Senate's economic stimulus package.

In January, the House passed an economic stimulus bill with over $800 billion in spending intended to jump-start the economy, including a significant boost for the physical sciences. The House bill included $2 billion for the DOE Office of Science, $2.5 billion for NSF, and $500 million for NIST.

On January 28, Murray sent a letter to APS members asking them to thank House Speaker Nancy Pelosi for her hard work in support of science funding.

The stimulus bill under consideration in the Senate in early February included less funding for physical science than the House version. Murray urged APS members to write to their senators asking them to include the same level of funding for science in their version of the stimulus bill.

APS has been actively involved in promoting funding for science, Murray told APS members in her letter. APS recommended investments in scientific infrastructure that would create more than 100,000 direct and indirect jobs. "The investments we proposed are principally in infrastructure in our national laboratories and universities, high performance computing, in procurements of scientific instruments and material for projects such as ITER, and in creation of jobs for young investigators at our universities to ensure that they have a place to go during these trying economic times. As a result of our efforts, many of our recommendations were used by the House and Senate in formulating their proposed stimulus packages," Murray's letter said.

Responding to Murray's message, 2785 APS members had written to their senators, and 1342 had written to thank Pelosi as of February 10.

In early February, the Senate passed a stimulus bill that included much less funding for science than the House bill: $1.2 billion for NSF, $330 million for

MESSAGE continued on page 7

Panel Pushes More Investment in Energy Research

By Michael Lucibella

An advisory committee to the Department of Energy has called upon both the private and public sectors to increase investment in advanced energy research. Constituted as a subcommittee of the Basic Energy Sciences Advisory Committee (BESAC), the group put forward a series of recommendations to help curtail global warming and manage the nation's energy needs at a February press conference at the Center for Strategic and International Studies in Washington.

At the press conference, a panel consisting of the BESAC chair and the two co-chairs of the subcommittee (all 3 of them APS Fellows) called for greater use of green energy technologies that would curb carbon dioxide emissions and use more renewable energy sources. Widespread use of these technologies has been hampered because their current capabilities lag far behind the country's needs. Technologies such as solar power, carbon sequestration and superconducting electrical wires have shown promise in labs, but have not yet been fully developed for large scale commercial use.

"Virtually all of the potentially revolutionary technologies in the energy and environment area have what we call scientific roadblocks," said BESAC chair John Hemminger of the University of California-Irvine, "Areas where we just don't understand how nature works."

The report, "New Science for a Secure and Sustainable Energy Future" (www.sc.doe.gov/bes/reports/list.html) recommended that the Department of Energy's Basic Energy Science Advisory Committee create research "dream teams" of the nation's top scientific minds to hasten the pace of discovery. These teams would spearhead research in the cutting edge of energy technology to help protect US national and economic security.

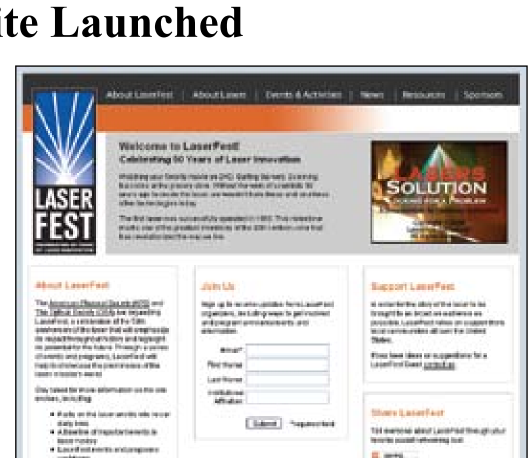
"Someone over the next ten to fifteen, twenty years is going to invent new energy technology. If that is us, we're going to be selling that to the world. If that is China or Japan or Europe, we're going to be buying that from them," Hemminger said.

The panel also called for greater financial investment in research and development, pointing to declining levels over the last two decades. In 1989 the US federal government invested on average 10% of its research budget in energy issues compared to only 2% today. In the private sector, the energy industry reinvests on average 0.23% of its revenue to research, compared to 3.3% in the auto industry

PANEL continued on page 5

LaserFest Website Launched

A new website for LaserFest, the 2010 celebration of the 50th anniversary of the laser, has recently been launched. The site, www.laserfest.org, contains information concerning LaserFest events and activities, the history of the laser and its impact on society, and its potential for the future.



Visitors to the site can sign up to receive updates and program announcements. Those with plans or ideas for events are encouraged to submit them through the online event submission form. LaserFest is being organized by APS and the Optical Society of America.

"Now that the website is up and running, we hope LaserFest will become more accessible–hopefully visitors will find the site engaging and informative," said Nadia Ramlagan, APS LaserFest project coordinator.

The site's laser history section provides information about the early history of the laser, from Einstein's theory of stimulated emission to the demonstration of the first working laser

LASERFEST continued on page 5

APS Honors Rabi and Columbia

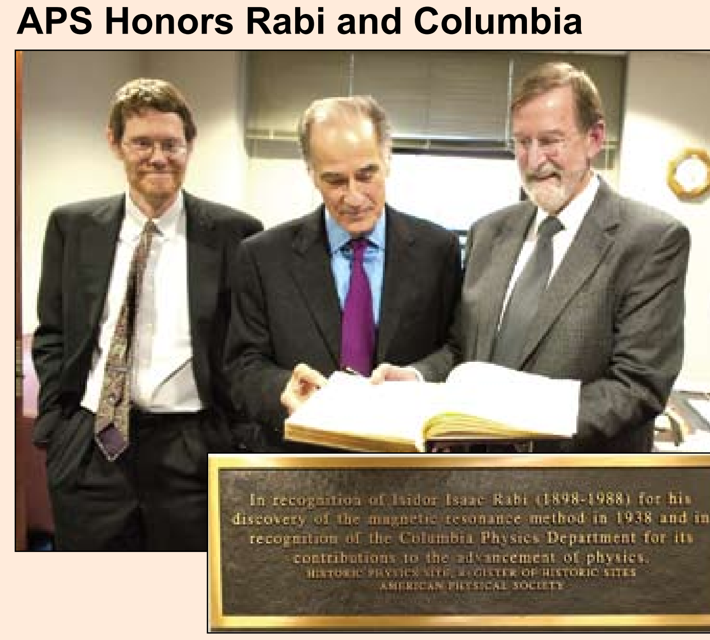


Photo by David Wentworth

On January 29, as part of its historic sites initiative, APS presented a plaque (see inset) to the physics department at Columbia, honoring the achievements of I. I. Rabi and also more generally the contributions of the department. Rabi was cited specifically for his discovery of the magnetic resonance method. In the photo, APS Editor-in-Chief Gene Sprouse (right) and Columbia vice-President for Research David Hirsh (center) examine the APS register of historic sites, while Chair of the Columbia Physics Department Andrew Millis (left) looks on.

Members in the Media

"We look at the economic sensibility of an idea and why the market doesn't understand it and we do."
***Ronald Kahn**, Barclays Global Investors, on his approach to quantitative finance,* The Financial Times*, January 26, 2009*

"What we've done is to create a situation with a lot of people who smell big money and they're working very hard. I'm optimistic that in a few years, they're going to lick the problem."
***John Goodenough**, the University of Texas at Austin, on battery research,* Christian Science Monitor*, January 22, 2009*

"People are crazy, and I think it's the dog. I blame it on the dog because people in Europe don't behave this way."
***Neil deGrasse Tyson**, American Museum of Natural History, on why Americans were so upset at the demotion of Pluto from planet status,* The Daily Show*, January 28, 2009*

"We've made tremendous progress in the last 30 years, and we realize there's still a significant distance to go. I think there's no question fusion will be a viable energy source. The time scale –that's a tricky question."
***Earl Marmar**, MIT, on ITER, the* Cleveland Plain Dealer*, January 21, 2009*

"Jack Tatum was vicious–that helps–but he had a way of popping with the perfect angle and timing."
***Timothy Gay**, University of Nebraska, on the physics of the hit in football,* The New York Times*, January 30, 2009*

"Roughly speaking, we predict there could be a 1,000-time reduction in power consumption with electronic computers built in this new way, and they could be something like 1,000 times smaller in size."
***Robert Wolkow**, University of Alberta, on making the world's smallest quantum dots, which could be used in making smaller computers,* Calgary Herald*, February 3, 2009*

"What we did is show that the atom is not the limit–that you can go below that."
***Hari Manoharan**, Stanford University, on creating subatomic letters,* San Jose Mercury News*, January 31, 2009*

"I view it as a recognition of many hundreds of scientists who have gotten seriously involved in policy one way or another, either advising the government, writing for the public, getting involved in schools or working with federal, state and local government on any number of policy issues. It's a concept I call the civic scientist."
***Neal Lane**, Rice University, on receiving the National Academy of Sciences' Public Welfare Medal,* The Houston Chronicle*, January 31, 2009*

"Evolution has achieved an efficient solution to this complex problem."
***Harry Swinney,** University of Texas at Austin, on the problem of walking on sand,* MSNBC.com*, February 10, 2009*

APS Debuts on Facebook and LinkedIn

The stereotypical physicist is not particularly socially adept. Whether or not its members fit that stereotype, APS felt it was time to take advantage of networking opportunities on the web, and recently created its own fan page on Facebook and a group on LinkedIn. Members can use these social and professional networking sites to start discussions, review articles, post comments and notices, share photos, or check APS updates, all by simply logging in and searching for "APS Physics".

APS researched multiple social media sites before deciding where to create APS groups. "There are many intriguing sites available, but after polling some of our members, we decided to begin with Facebook and LinkedIn," said Margaret Black, Web Content Coordinator.

As online networking begins to play a more prominent role in how scientists communicate, APS hopes these social media groups will facilitate the exchange of information from casual to technical among members. Through Facebook and LinkedIn it is easy to leap geographical and institutional boundaries, meet new colleagues, reconnect with former associates, and maintain dialogues long after APS meetings end.

This Month in Physics History

March 13, 1930: Clyde Tombaugh's discovery of Pluto announced

In early 1930, Pluto was discovered by a farm boy from Kansas with no formal training in astronomy. The announcement in March of Pluto's discovery was a moment of excitement for both scientists and the public.

Clyde Tombaugh was born on February 4, 1906 in Illinois, and grew up on a farm in Kansas. He became interested in astronomy as a teenager after observing craters on the moon and rings around Saturn through his uncle's three inch telescope. The family soon ordered a better telescope to encourage their son's interests. When he was 20, Clyde Tombaugh began building his own telescopes.

By 1928 Tombaugh had built his third backyard telescope and used it to make drawings of Mars and Jupiter. He sent these to Vesto M. Slipher, the director of the Lowell Observatory in Flagstaff, Arizona, asking for comments. After a short correspondence, Slipher offered him a job at the observatory. His task would be to search for "Planet X."

Photo courtesy of Lowell Observatory Archives

Clyde W. Tombaugh at the door of the Pluto discovery telescope, Lowell Observatory, Arizona.

Planet X had been predicted by Percival Lowell. Lowell, a businessman and astronomer known for his belief that a network of canals existed on Mars and was evidence of an intelligent alien civilization, built the Lowell Observatory to prove his theory. But as it became more and more clear that there was no evidence for that theory, he began to focus on searching for a new planet. Lowell had observed some peculiarity in the orbits of Neptune and Uranus and figured there must be another planet with a mass comparable to Neptune's orbiting the sun beyond Neptune. Lowell searched for the planet, which he called Planet X, from 1905 to his death in 1916.

For years after Lowell's death, the Lowell observatory was hampered by an expensive legal battle with Lowell's widow. In 1927 the observatory was ready to resume the search for Planet X, and it acquired a new 13 inch refracting telescope for the search.

Slipher assigned the task to Tombaugh, who arrived in Flagstaff in January 1929. First, he had to use the telescope to make many photographic plates, systematically taking pictures of regions of the night sky where the new planet might appear. For each region, Tombaugh made two photos, taken several days apart. He spent many cold nights in the unheated observatory dome carefully making the observations.

After creating many such pairs of plates, he would compare the two members of each pair. Distant stars would appear in the same position on both plates, but a planet would have moved in the several days between the two exposures. Tombaugh used a device called a blinking comparator to make the comparison. The device would present him with sections of the two photo plates to be compared, shifting between the two several times a second. Most of the time the photos were the same and Tombaugh would see nothing, but if an object had moved between the two exposures, Tombaugh would see a blink.

It was incredibly tedious work requiring intense concentration, but Tombaugh greatly preferred it to going back to work on the farm, so he persisted.

After months of searching, he had found several asteroids, but nothing that fit the criteria for Planet X. Finally, in February 1930, while scanning the plates he had taken a few weeks earlier, he saw something that moved. He determined that the object had moved about 3 mm on the plates between the two exposures, indicating an orbital distance of about 40-43 AU, putting it outside the orbit of Neptune at about the right place to be the predicted planet.

Tombaugh told Slipher he had found Planet X, and on March 13, 1930, the Observatory announced the finding of the new object. The announcement date was chosen to coincide with both the anniversary of Herschel's discovery of Uranus in 1781 and Percival Lowell's birthday in 1855.

The public and astronomers were enthusiastic about the new planet. Later that month the object was officially named Pluto, after the Roman god of the underworld, who could make himself invisible. The name was suggested by an 11 year old girl in England. A secondary reason for the name was that the first two letters are Percival Lowell's initials.

Though exciting, the planet was tiny, just a dot on the photograph, and some astronomers doubted whether it was massive enough to affect the orbit of Uranus and Neptune.

Pluto's mass was not known until 1978, when its moon Charon was discovered. Pluto's mass is about 0.002 that of Earth, making it much too small to influence the orbit of Neptune.

Ultimately, Pluto lost its planet status. Other objects in the neighborhood of Pluto have been discovered in recent years, including several comparable in size to Pluto. In 2006, much to the disappointment of children around the world, the International Astronomical Union redefined the term "planet." The new definition of a planet requires an object to orbit a star, be large enough to be made round by gravity, and have cleared its orbit of other debris. The third criterion disqualifies Pluto, which is now known as a dwarf planet.

After the discovery of Pluto, Tombaugh received a scholarship to study astronomy at the University of Kansas. He began as a freshman in 1932 and continued to work in astronomy for many years. Tombaugh was later known as one of only a few scientists to take UFOs seriously. He died in 1997, mercifully before the demotion of his planet to the status of a dwarf.

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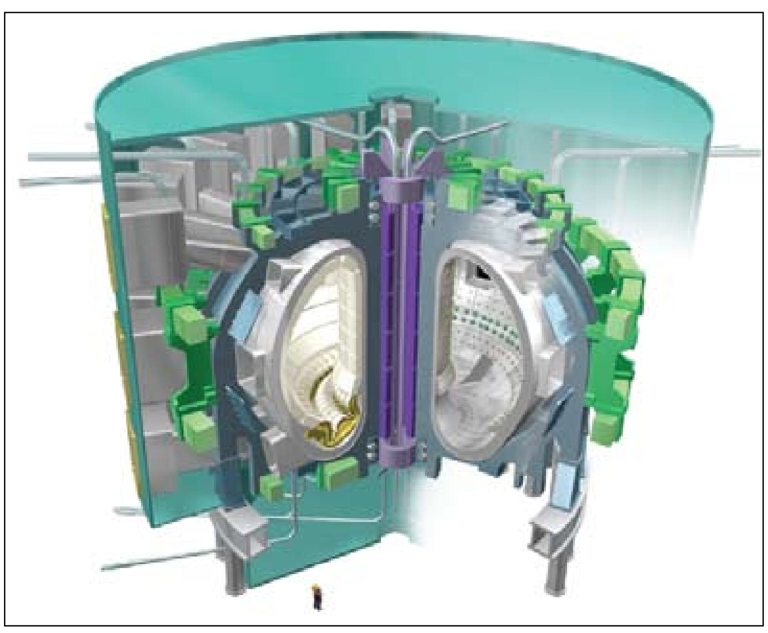
Viewpoint...

ITER and Fusion Energy

By Robert J. Goldston and Ned R. Sauthoff

"Burning plasmas" are very hot fully ionized gases whose temperature is maintained dominantly by self-heating from fusion reactions within the plasma. The governments of China, Europe, India, Japan, Russia, South Korea and the United States (representing more than half the world's population) have assessed that we are scientifically and technologically ready to explore the "burning plasma" state [see the report *Burning Plasma, Bringing a Star to Earth,* National Academies Press, Washington DC, 2004], and have embarked on an international partnership to construct the ITER Project, near Aix-en-Provence, France. The mission of ITER ("the Way" in Latin) is to "demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes."


The ITER device

The basic nuclear reactions that are contemplated for use in ITER, and in future fusion power plants, are:

$D + T \rightarrow \alpha + n + 17.6$ MeV

$n + {}^6Li \rightarrow T + \alpha + 4.8$ MeV

ITER will enable research on key scientific questions that bear on the feasibility of fusion power as well as intellectually fascinating questions such as the dynamics of a complex self-organized system, non-linear interactions between supra-thermal charged alpha particles and thermal plasma, and evolution of the interacting physical phenomena of turbulent transport and global stability at the physical scale of a fusion power plant.

Fusion is attractive as an energy source because the basic raw materials, deuterium and lithium-6, are abundant, and because it is physically impossible for a fusion power plant to explode like Chernobyl or melt down like Three Mile Island. The radioactive waste from fusion will not require geological storage like Yucca Mountain. No large energy storage, long-distance energy transmission nor large land use would be required. The catch, however, is that we are only part way to developing fusion. Extensive worldwide development of experimental and theoretical understanding of fusion plasmas has provided the physics basis for ITER construction. Research now going on in the domestic fusion programs of each of the ITER parties is key both to assuring the success of ITER operations and to moving beyond ITER to demonstrate that fusion is economically practical.

To put ITER in context, it is valuable to compare fusion power production, energy gain, and pulse duration between 1975 and today, ITER's goals, and the goals of a practical power plant. (The figures below are for simultaneous accomplishments, and are rounded.)

	Fusion Power	Gain	Duration
1975	100 mW	3×10^{-7}	0.01 sec
Today	~ 10 MW	≤1	~ 1 sec
ITER	**500 MW**	**10**	**300–500 Sec**
Power Plant	2500 MW	25	1 month

As can be seen, ITER is a very dramatic step beyond present capabilities, and today's results represent an equally dramatic step beyond the first results with strongly heated plasmas in 1975. Extensive experimental scaling and large-scale computer models point to success for ITER and possibilities for further improvements in both stability and confinement, opening the way to options to improve the operations of ITER and thus to go further towards a power plant, based on research in ITER. Fusion power levels depend quadratically on the plasma pressure. β, the ratio of the particle pressure $n_iT_i + n_eT_e$ to the magnetic field pressure $(B^2/2\mu_o)$, is a key parameter determining the global stability limits of plasmas, which determine the power producing capabilities. ITER can explore β-limits and opportunities for improving pressure limits. Fusion gain (fusion power production divided by the plasma heating power supplied externally) depends on the parameter $n_iT_i\tau_E$, where $1/\tau_E$ is the decay rate of the energy stored in the hot plasma when all heating is turned off.

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Come Back with my Abstract!


Photo by Ken Cole

Sorting abstracts for the April Meeting can get pretty tense, what with sorters competing over whose abstract goes in which session. Here Steve Detweiler of the University of Florida (standing), representing the Topical Group on Gravitation, gestures vigorously for more abstracts, while Stan Whitcomb of Caltech looks on. In all, about 20 physicists assembled at APS headquarters on January 17 to sort almost 1000 abstracts for the meeting, which will take place in Denver, May 2 through May 5.

INSIDE THE BELTWAY
WASHINGTON ANALYSIS AND OPINION

It Takes Two to Tango

By Michael S. Lubell, APS Director of Public Affairs

When Barack Obama announced in December that Rahm Emanuel would be his White House Chief of Staff, I winced. Here was a President-Elect who had campaigned on defusing the partisan-charged Washington atmosphere selecting one of the most notorious Democratic flame-throwers as his second. What was he thinking?

I've known Rahm for the better part of two decades, and I've admired him as a brilliant tactician, despite his often over-the-top partisanship. Now, as I've watched our new President stretch his quest for bipartisanship to the breaking point, I only wish he would let a little of Emanuel's bad temper escape from the West Wing, at least once in a while.

Washington, even in good times, suffers insufferably from a climate of backstabbing disguised as political rectitude. But when one party routs the other, as happened in 2008, the losing side looks for every opportunity to pummel the winning team right from the outset, without ever considering white-glove etiquette.

So it was no wonder that Republicans took immediate advantage of the opening President Obama gave them in the debate over the $789 billion economic stimulus bill. They didn't have the votes to block its passage, but with the new occupant of the White House singularly focused on his let-us-reason-together mantra, they seized control of the economic message, and by the time the legislation reached the President's desk, the American public had begun to question's the bill's efficacy. Score one for the GOP.

What had begun as a rational debate over the validity of Keynesian economic theory in early November ended as a well-crafted Republican taunt that the stimulus bill was far from economically stimulating. By the time the House and Senate finished tallying the votes in mid-February, only three Republicans broke party ranks and joined the Democratic majority in supporting the legislation.

In the end, the President won the battle over a stimulus bill he wanted, but he didn't achieve his goal of a bipartisan endorsement. The goal was probably unrealistic from the start, but the Administration practically put it out of reach when it shifted the bill's original rationale of job creation and economic stimulus to its final justification of economic recovery and reinvestment.

As Frank Luntz points out in his book, *Words that Work*, it's not what you say that matters, it's what people hear you say. "Jobs" and "stimulus" are easy for people to connect with at an emotional and visceral level. "American Recovery and Reinvestment Act"–the stimulus bill's official name–is not only a mouthful, it is an abstract concept that contains little emotional appeal for the average citizen. And Drew Westen, the author of *The Political Brain*, will tell you that unless you arouse the emotions of your listeners, you have no chance of engaging them, no matter how cogent the intellectual content of your message.

Disregarding the importance of words and their emotive content was only one of three errors President Obama committed. By broadening the focus of the bill, he also opened the door for House Democrats to add funding for social programs that Republicans had blocked for more than a dozen years. And that gave the GOP ample ammunition to attack the "stimulus package" hyperbolically as a trillion dollar pork project. And judging by the polling results, the public accepted the charge as fact.

Through its persistent use of the word "stimulus" to describe the recovery legislation, the media reinforced the public's perception that Republicans, not Democrats, were balanced guardians of the purse. Given such a landscape Republicans had no political upside for supporting the legislation. Yet the new President continued to woo them, and his quixotic preoccupation with changing the culture of Washington, led to a lost opportunity–portraying the GOP as a band of obstructionists.

President Obama's errors permitted Senate Republicans to utilize the threat of a filibuster to change the thrust of the legislation. And eventually, three moderate northeastern senators, Susan Collins (R-ME), Olympia Snowe (R-ME) and Arlen Specter (R-PA), found themselves in the roles of ultimate arbiters of the bill's content.

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Letters

The Real Reason Water is Blue

Dear Editor,

"This Month in Physics History" is my favorite part of *APS News*, and the February column about Raman was particularly good. It is easy to believe that the question "why is water blue" led Raman eventually to his great discovery. What is not mentioned in the article is subsequent discussion of this question, which has shown that water is selectively absorbing in the red. This is familiar to divers, who experience the ghostly blue illumination that sunlight provides at depths of 10 meters or more. Raman scattering is not a significant part of the answer to this wonderful puzzle. Impurities in water are not either. There are no electronic transitions in pure water until the ultraviolet, and vibrational transitions are surely deep in the infrared, so what is the explanation? The answer is a great surprise to students of optical properties of matter. It is so interesting that I think readers of *APS News* should be fascinated to hear it. Fourth harmonics of the symmetric and antisymmetric "O-H stretching vibrations" lie just at the lower end of the visible energy spectrum, and are responsible for the weak absorption. It is the only familiar situation where vibrations are the primary cause of visible coloration, although other cases (liquid ammonia, for example) could be found if desired.

I am not sure to whom this explanation should be attributed. Confirmation and popularization of the vibrational mechanism was done by Charles Braun and Sergei Smirnov. They have a delightful paper in the *Journal of Chemical Education* (v.70(8), p.612, 1993), which is available on Prof. Braun's web page at Dartmouth, http://www.dartmouth.edu/~etrnsfer/water.htm. There you can see the spectrum of liquid H_2O compared with D_2O, which gives convincing evidence of the vibrational mechanism. Braun and Smirnov cite various earlier authors, the earliest being W. A. P. Luck (1965), and several good pedagogical treatments, especially by C. F. Bohren. Paraphrasing Bohren, they mention that "Light scattering by suspended matter is required in order that the blue light produced by water's absorption can return to the surface and be observed."

Yours truly,
Philip B. Allen

Back Page Labeled Propaganda

I am appalled that Wasif Syed's Back Page (*APS News*, January 2009), which ostensibly purported to deal with science and nuclear policy in Pakistan, was craftily turned into shameless propaganda.

The article suggests that Abdul Qadir Khan, the illegitimate father of the Pakistani nuclear program, is a "scientist whose abilities are not in doubt." Regardless of ethnocentric and personal biases, we can all agree that scientific ethics and professional integrity are two of the greatest litmus tests for every scientist. For a scientist of his supposed caliber, why was Khan compelled to steal centrifuge technology from URENCO, with whom he worked in the Netherlands, to develop Pakistan's nuclear program? Pakistan, after all, has produced eminent physicists such as Nobel Laureate Abdus Salam, after whom the International Centre for Theoretical Physics in Trieste, Italy is named!

The clandestine nuclear program in Pakistan, and its fly-by-night operators, are the greatest source of nuclear proliferation in the history of nuclear weaponry, having sold nuclear technology to Iran, Libya and North Korea, all under the watch of General Pervez Musharraf. Pakistan is the epicenter of global terrorism and nuclear proliferation, a most dubious perfecta. Pakistan, a failed state, is every terrorist's dream for obtaining nuclear weapons as clandestinely as they were developed by the state itself.

Jai A. Pathak
Arlington VA

Blunder May Not Have Been Einstein's

This Month in Physics History (*APS News*, January 2009) asserts that in 1929, "The cosmological constant looked unnecessary, and Einstein then abandoned it, calling it his greatest blunder." Actually, we do not know that Einstein called the cosmological constant a "blunder" much less his greatest one; we know only that George Gamow, in his 1970 biography, "My World Line," asserted "Much later, when I was discussing cosmological problems with Einstein, he remarked that the introduction of the cosmological term was the biggest blunder of his life."

Gamow, of course, was a brilliant physicist, but besides his physics brilliance he was known for his waggishness, for example adding Hans Bethe's name to a paper by Ralph Alpher and himself, in the middle position, to make the authors' names sound like the alpha, beta, gamma that open the Greek alphabet. Gamow should not be considered the most reliable source, particularly not for a specific quotation, and it appears to me that the "blunder"comment may not have really been made by Einstein.

Jay M. Pasachoff
Pasadena, CA

Simultaneous Cross-country Conferences Host Women in Physics

Hundreds of women gathered at three simultaneous conferences for undergraduate women in physics held January 16-18 at Yale University, the University of Illinois at Urbana Champaign, and the University of Southern California.

The conferences gave undergraduate women a chance to hear research talks, present their own research, learn about graduate school and career options, and network with other women in physics.

These conferences have been going on for several years. The University of Southern California held its first conference for women undergraduates in 2006, and has been holding them annually since. In 2008, Yale and UIUC held their first annual conferences. The three conferences were organized separately but focus on the same goals. The conferences were supported by NSF, DOE, and the universities that hosted them.

About 130 women undergraduates from around the Midwest attended the conference at UIUC.

In addition, a growing number of universities are forming organizations for women in physics. For instance, the Society for Women in Physics at UIUC has meetings and invites speakers to talk about career options and other topics.

At the UIUC conference Monica Plisch, APS assistant director of education, gave a keynote talk in which she described the role of APS in improving education and promoting diversity, highlighting the many programs APS offers, such as awards and scholarships for women, childcare grants, minority scholarships, lists of female-friendly departments, professional development workshops for women, and the PhysTEC programs to prepare future teachers. About half of the students at the conference said they were members of APS, according to Plisch.

Plisch was especially excited by the enthusiastic participation of so many women at the conference, as well as seeing seven female faculty members at the university, a contrast to only one female professor when she attended as an undergraduate. "I really feel like the face of physics is changing," she said.

Beller, Marshak Lectureships to Enhance March and April Meetings

Two named APS lectureships will bring distinguished foreign scientists to speak at the 2009 March and April meetings. The speakers were selected by the APS Committee on International Scientific Affairs (CISA), from nominations submitted by various APS units.

The Beller Lectureship was endowed by Esther Hoffman Beller for the purpose of bringing distinguished physicists from abroad as invited speakers at APS meetings. The lectureship provides support for speakers at the March and April meetings.

The Marshak Lectureship, endowed by Ruth Marshak in honor of her late husband and former APS president, Robert Marshak, provides travel support for physicists from developing countries or Eastern Europe invited to speak at APS meetings.

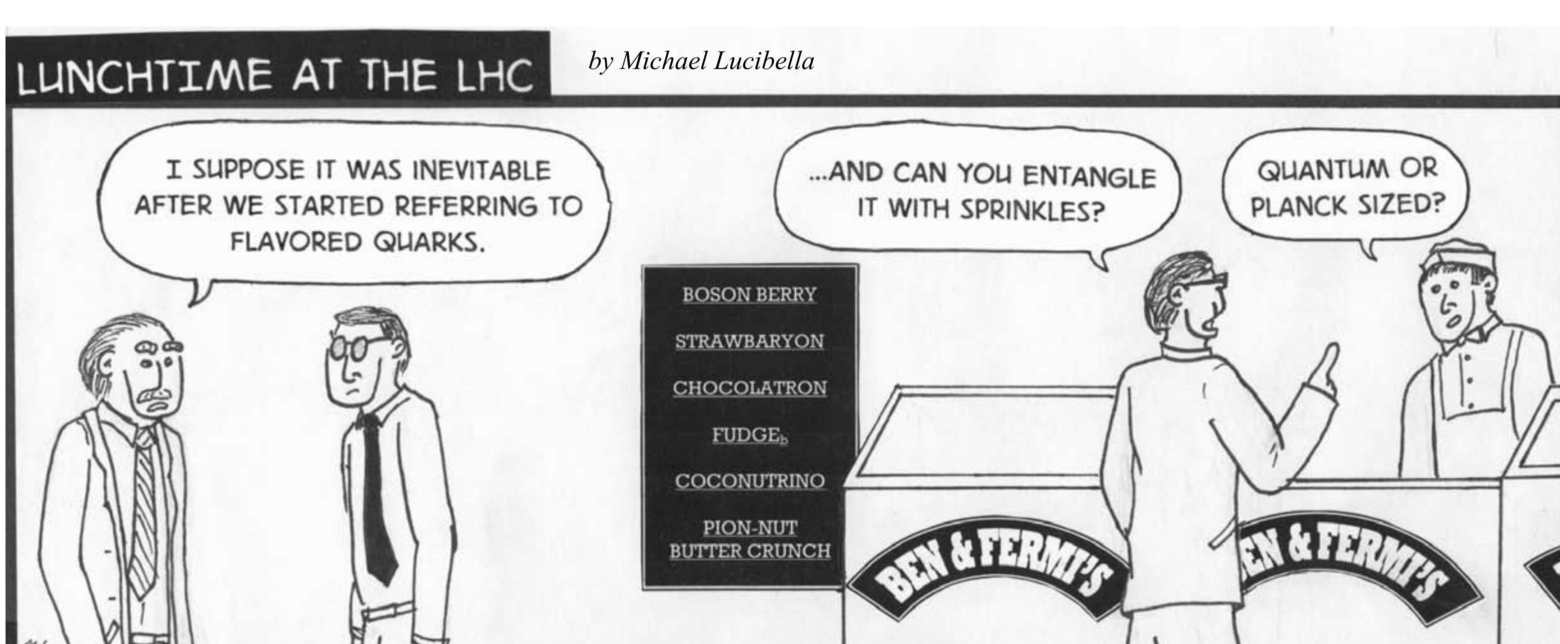
Two Beller lectures will be given at the March Meeting. Mikhail I. Dyakonov of the Université Montpellier II, France will present a talk on the spin Hall effect. Dyakonov was nominated for the Beller Lectureship by the Topical Group on Magnetism and its Applications. The other March Meeting Beller lecturer is Samuel A. Safran, of the Weizmann Institute of Science, Israel. He will give a talk on "Active response of biological cells to mechanical stress." Safran was nominated for the Beller Lectureship by the Topical Group on Statistical and Nonlinear Physics.

At the April Meeting, a Beller Lecture will be given by Christopher Llewellyn-Smith, of Oxford University, United Kingdom. Llewellyn-Smith, a former Director-General of CERN, was nominated by the Forum on Physics and Society.

The 2009 Marshak lecturer will be Karimat El Sayed, of Ain Shams University, Egypt. At the March Meeting, she will deliver a lecture on Women in Physics in Egypt and the Arab Worlds. El Sayed was nominated by the Forum on International Physics.

zero gravity

by Michael Lucibella



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Education Corner

A column on educational programs and publications

Physics Teacher Video

APS and the Knowles Science Teaching Foundation recently produced a short video profile of Mary Lee McJimsey, a physics teacher who graduated in 2006 from Cal Poly, San Luis Obispo, which received substantial funding under the APS-led PhysTEC project to improve its teacher preparation program. The video seeks to showcase a young, dynamic physics teacher who will inspire future undergraduates and high school students to pursue a career in teaching. In the video, McJimsey explains why she loves teaching physics, and describes the impact that PhysTEC and her Knowles Fellowship had on her preparation to be a teacher. PhysTEC is a partnership between APS, the American Association of Physics Teachers (AAPT), and the American Institute of Physics (AIP).

The video can be viewed on the PhysTEC website (www.PhysTEC.org) and also on YouTube.

Education special events at the April Meeting

Future Physicists Day

All undergraduates attending the April Meeting are invited to participate in Future Physicists Days. Events will include undergraduate poster and oral sessions, a "Careers for Physicists" lunch session, and an awards session recognizing the outstanding oral and poster presentations of undergraduates. Registration for the meeting is *free* for undergraduates. For more information, please see the April Meeting page on the APS website or contact Cathy Mader at mader@aps.org.

Nuclear Forensics Workshop at Teachers' Day

The 2009 April Meeting Teachers' Day will feature a new workshop on nuclear forensics, inspired by the 2008 APS/AAAS *Nuclear Forensics: Role, State of the Art, Program Needs* report. The workshop is part of an effort APS is leading to develop the first-ever nuclear forensics curriculum for high school students. The development team, which includes APS and AAAS staff members, high school science teachers, nuclear scientists, and experts in nuclear forensics, plans to produce about 10 hours of classroom activities. At the workshop, participants will utilize gamma ray spectra to identify hypothetical unknown radioactive materials that have been interdicted at a border crossing.

For information and schedules for both the March and April Teachers' Days, please see www.aps.org/programs/education/teachers/teachers-days. APS members are welcome to visit.

Course, Curriculum, and Laboratory Improvement Program

The next round of proposals to the NSF's Course, Curriculum, and Laboratory Improvement (CCLI) are due May 21st. The CCLI program has, for several decades and under a number of program names, been one of the most significant funding sources for the improvement of undergraduate science and math education. Innovations in physics education, the development of many of the most significant pedagogies in use today, and renovation of a large number of classrooms and laboratories have received funding from this program. According to the NSF, the program "funds projects that develop faculty expertise, implement educational innovations, assess learning and evaluate innovations, prepare K-12 teachers, or conduct research on STEM teaching and learning."APS Members are welcome to visit.

For more information, go to www.nsf.gov and search on "ccli."

New Faculty Workshops

Department chairs are invited to nominate recently hired faculty to attend the next APS, AAPT, and American Astronomical Society (AAS) New Faculty Workshop, which will be held from June 25—28, 2009 at the American Center for Physics (ACP) in College Park, Maryland. "Recently hired" means faculty in the first few years of their initial tenure-track appointment. The ideal nominee would be one who has been teaching for a year or two and who is beginning to realize that good teaching may be a more difficult enterprise than he or she originally thought.

The nomination deadline is April 1. For more information, see http://www.aapt.org/Events/newfaculty.cfm.

Education Research Report in Science

In the January 2, 2009 issue of *Science*, editor-in-chief Bruce Alberts wrote that the journal "now plan[s] to build on this strong beginning [*Science's* three-year-old Education Forum] by recruiting high-quality articles on education from the world's best experts for every section of the magazine." Accordingly, the magazine included one of its first education research reports, entitled "Why Peer Discussion Improves Student Performance on In-Class Concept Questions." The article, authored by a team of researchers from the University of Colorado at Boulder that includes Physics Nobel Prize laureate Carl Wieman, describes a study the team performed to determine whether peer discussion had a lasting impact on the conceptual understanding of students in an introductory science class.

Pound for Pound

Photo by Ken Cole

The APS Executive Board met for the first time this year on February 7 at the APS editorial offices in Ridge, New York, and, following tradition, past-President Arthur Bienenstock of Stanford (left) handed the gavel, symbolic of the APS Presidency, to his successor, Cherry Murray of Livermore National Laboratory.

PANEL continued from page 1

and 16% in the semiconductor industry.

The panel highlighted four areas that need technical breakthroughs in basic science in order to be commercially viable. These projected breakthroughs would allow for more efficient energy generation and transmission while reducing pollution at the same time.

The process of transferring electricity loses between 8% and 10% percent of its energy to heat alone. In addition, the national power grid is already near full capacity and suffers from some of the worst power outages in the developed world, costing the national economy nearly $80 billion a year. Proposed smart grid systems and high temperature superconducting power lines could go a long way to alleviate these problems. However the superconductor's cooling costs have been prohibitive, since they can only operate at temperatures up to 138 Kelvin so far.

"There are revolutionary solutions; breakthrough solutions that would bring the performance of the grid to a new level," said George Crabtree of the University of Chicago.

Carbon capture and sequestration is another field of intense research aimed at reducing greenhouse gas emissions. Carbon dioxide from coal plants would be trapped and condensed into a liquid form, then buried underground. Already coal plants are being built to be sequestration compatible; however it's unclear exactly what happens to the carbon dioxide after being buried.

"Unfortunately if you look at these methods, they all raise questions. First of all can you really inject CO_2?" said Marc Kastner of MIT, "And once you put it there, will it stay there?"

Solar cells and improved electric car batteries are the other areas the panel highlighted for increased research. Both would likely benefit from advances in new materials sciences and nanotechnology.

The report calls for fast and expansive action. Prompted by concerns about depleting fossil fuel reserves and increased greenhouse gas emissions, the presenters emphasized that a multidisciplinary approach would be needed to confront the nation's energy issues.

"If you want to stabilize CO_2 emissions, you're not going to be able to do it with one technology, there's no magic bullet," Kastner said, "You're going to have to introduce a whole bunch of technologies each of which will reduce the CO_2 emissions by some amount."

In addition to the dream teams working on these problems, the panel called for greater recruitment of students and young researchers to help address each issue. Programs such as incentives and career awards could be used to bring in the next generation of energy scientists.

Job Fair Attendance Lags in Gloomy Economy

With the difficult economic climate, both employers and job seekers seem to be reluctant to attend job fairs this year. As of mid February, both the number of job seekers registered for the job fair at the APS March Meeting and the number of employers registered were lower than in previous years.

In 2008, there were 30 employers attending the March Meeting job fair; as of mid-February, there were 12 employers registered for this year's event. However, more were expected to sign up closer to the deadline, according to job fair coordinator Alix Brice. The deadline for employers to register is March 2.

About 300 job seekers had registered for the job fair by mid-February. Job seekers may register on-site, and many are expected to do so. Last year, 488 job seekers attended the March Meeting job fair.

A job fair was also held at the American Association of Physics Teachers winter meeting in Chicago in February. At that event, the numbers of both job seekers and employers were down from recent years.

"Job seekers are finding it hard to make the trip," said Brice. Some employers also cannot afford to attend.

Employers at the AAPT meeting are primarily colleges, universities and secondary schools. Employers attending the APS March Meeting job fair represent a wider variety of employers, including some from industry, academia, and government. The list of employers attending the 2009 job fair is expected to be similar to those who attended in recent years.

The 2009 APS March Job Fair will be held in the David L. Lawrence Convention Center in Pittsburgh. Recruitment booths will be open Monday, March 16 and Tuesday, March 17. More information about the March meeting job fair is online at http://www.aps.org/meetings/march/events/jobfair/.

LASERFEST continued from page 1

by Theodore Maiman in 1960. Visitors can also browse a timeline of the milestones that paved the way for the experimental realization of the laser. Specific contributions from key scientists whose work led to the invention of the laser is available, including Robert H. Dicke, Gordon Gould, Charles Townes, and Arthur Schawlow, as well as a list of Nobel laureates whose prize-winning research involved lasers.

The website also includes instructions for individuals or corporations interested in being involved in LaserFest. All sponsors will be offered appropriate recognition on the website and in other LaserFest promotion materials, and donations to LaserFest are tax deductible.

New material is continually being added. Visitors will soon be able to explore how the laser works and how laser light differs from regular light. Other upcoming sections include "Women in Laser Science" and "50 Laser Innovations," podcasts, and interactive games. Eventually, the site will show a calendar of national and local events, listing LaserFest activities happening in the Washington DC area and communities around the US and the world. As events get underway next year, a LaserFest blog will document ongoing events with weekly entries and photos.

Focus on APS Topical Groups

Group on Instrument and Measurement Science

By Michael Lucibella

This year's March Meeting marks the twenty-fifth anniversary of the Group on Instrument and Measurement Science (GIMS), where they will celebrate their quarter century with a tribute to the group's founder Lawrence Rubin.

As its name implies, the primary focus of GIMS is promoting the development and dissemination of the best tools and techniques for making all classes of precise measurements. Because the need for accurate data is integral to all fields of science, members of GIMS represent a broad cross-section of disciplines.

Innovations from the instrumentation and measurement technologies have had a huge impact in every scientific field. Laboratory applications are constantly pushing the cutting edge of research and spurring innovation. Devices such as the boxcar integrator and the lock-in amplifier which were just making their debuts when the group was starting are now commonly found in labs around the world.

Outside of pure scientific research, developments from the field can be seen in a wide assortment of practical applications as well. Medical technologies, such as MRIs, PET and CAT scans all depend on the sort of precise instrumentation that emerges from the cutting edge of GIMS research. This ability to precisely scan and interpret data is used in countless commercial electronics ranging from cell phones to television sets.

The group's membership often reflects where the major fields of study are in physics today. Anyone with an interest in measurement science can join GIMS, so the most popular disciplines tend to have the largest numbers of members in the group. Some of the most prominent areas of specialization include research into all manner of scanning probes, synchrotron radiation instruments and high-field magnets. In addition, technicians devising new technologies for low temperature physics and acoustic and photothermal research play a major role, reflecting the constant need for new techniques in these fast-moving fields.

Founder Lawrence Rubin said that he originally conceived of the group as a forum where the latest research about instrumentation and measurement techniques could be shared. At the time he saw information about the different techniques of measurement scattered across numerous different fields of physics.

"The whole idea is to get publicity to newer techniques and newer equipment," Rubin said, "Lord Kelvin once made the statement that if you can't measure something you don't know anything about it."

One of the original inspirations for the group came when Rubin was working at the High Field Magnet Lab at MIT. During his time there, he saw what he described as many thousands of people who had come to test their experiments within the powerful magnetic fields generated at the lab. He took notice of the need for precision measurement that all of the experimenters shared. In addition he served as an associate editor at the *Review of Scientific Instruments*, a publication devoted to scientific instruments and techniques. He was struck by the need for a dedicated organization for physicists and technicians to come together to share their research.

When GIMS was founded it was the first APS topical group. Rubin continued to work closely with RSI to help publicize the latest research, and remained active in GIMS until his retirement in 2004. Rubin said that though the technology may have changed over the years, the group's direction has always stayed true to its original focus on bringing the newest and best information to its members.

Today the group comprises over 600 members, many of whom are expected to attend the annual March Meeting. One of the major highlights at each of the meetings is the presentation of the Joseph F. Keithley Award for Advances in Measurement Science, given each year to an individual who has made a major contribution to the field. This year APS will be honoring Robert Schoelkopf of Yale for developing the single electron transistor to better take high frequency mesoscopic measurements.

In addition, GIMS continues to promote the latest research and developments through the journals it keeps a close association with. Al Macrander, former Chair and the current Secretary Treasurer, is also the current head editor of RSI, continuing the group's close affiliation with the *Review*. In addition, member Carolyn MacDonald serves as the editor-in-chief of X-ray Optics and Instrumentation.

"GIMS has reached out indirectly to instrumentalists and young scientists by facilitating personal contact with journal editors," Macrander said, adding that it maintains a close connection with the Keithley Company as well.

Macrander said they are expecting over 200 members to attend the March Meeting. Members will be presenting about 100 papers on topics ranging from real-time monitoring of electron spins, to the use of pulsed magnetic fields to study the structural properties of materials.

MEETING continued from page 1

Caltech are shaping carbon nanotubes into minuscule soldering irons. The researchers used electron beams to carve the world's smallest soldering tips from iron-filled nanotubes, and demonstrated their tiny tool by soldering other carbon nanotubes together. Ultimately, the nano-soldering iron should be ideal for linking together molecular-scale mechanical and electronic devices (J24.2). Keith Brown of Harvard will present an innovative proposal to move components with the sharp tip of an Atomic Force Microscope (AFM). In order to prevent nano-objects from sticking to the AFM tips, Brown and his fellow researchers are looking to a method that permits them to hold objects without actually touching them. Applying a radio frequency signal to specially-designed AFM tips allows them to capture small objects while keeping them a small distance away from the AFM tip (V27.2). Andreas Huber of the Max Planck Institute for Biochemistry will describe an imaging system that provides nanometer resolution and is particularly well suited to analyzing superconductors, semiconductor devices and even individual molecules. The new nanoscope relies on terahertz (THz) light. Imaging devices usually can't resolve structures smaller than the wavelength of the light they are using, but Huber and colleagues have managed to image objects with resolutions 3000 times smaller than the wavelength of terahertz light, setting a new record for sub-wavelength resolution (P27.13).

A Touching Technique For Identifying Cancer Cells

Distinguishing between healthy cells and cancerous ones is often an inexact science, traditionally relying on visual identification, analysis of cell growth, or genetic tests, among other techniques. Researchers at Clarkson University and the University of Australia have now found that they can tell the difference between normal and cancerous cells through touch. The group used an atomic force microscope (AFM) to study the adhesion of silica beads to malignant and normal cells cultured from the human cervix. They found that analyzing the relative stickiness of cells is a good way to tell cells apart, potentially taking the guesswork out of cell identification and leading to a quicker and more reliable method of cancer diagnosis. Igor Sokolov of Clarkson University will present the study of their novel detection technique (V27.4).

Hybrid Protein-Nanoparticle Memory Unit

Researchers in Israel have developed a novel memory unit that combines a ring-shaped protein molecule 11 nanometers in diameter with a 5 nanometer particle of silicon. The structure can be electrically charged to store a single bit of information. The achievement is an example of a promising bottom-up approach to building nanoscopic electronics, rather than the top-down technique of carving devices out of silicon, which is getting increasingly challenging as technology moves to ever smaller scales. (A28.11)

To Crack, Or Not To Crack

A brittle material fails because cracks form and ruin its structural integrity. This is one of the most basic tenets of material physics, but the propagation of cracks has never been well understood. A new theoretical and experimental analysis offers valuable insights into how a material will fare over time. Materials break around the weakest points, which are usually impurities or defects in the object's molecular structure. Up to now, it has been very difficult to predict how different stresses would cause these defects to crack and fail. Caltech physicist Laurent Ponson's new model describes how a material's natural impurities affect its long term durability. It has been well known for years that some material impurities can actually increase an object's life by deflecting cracks, but this new model quantifies the process. This will give engineers a powerful tool for predicting how brittle substances like clay or glass hold up over their lifetimes. (W9.1)

Supersolids

In 2004 Penn State physicist Moses Chan presented preliminary evidence of superfluid behavior in a sample of solid helium. This evidence consisted of the sample, or least part of the sample, remaining stationary even when its container was given a quick twist. Since then the experimental observations of Chan have been confirmed in at least six other laboratories. However, the exact physical mechanisms responsible for the observation are still unclear. What is clear is that superfluidity in solid helium is quite different from that in liquid helium. (W1 and V16)

A Polymer That Beats Like A Heart

The overall function of certain biological tissues like the heart emerges from the fact that its cells can join together in coordinated movements like a heartbeat in response to a triggering signal. Now this ability has inspired researchers to design polymer materials that can do the same sort of thing. Anna Balazs of the University of Pittsburgh will describe her research on one such material: a polymer gel that's sensitive to pressure and beats like a heart when touched. The gel contains a metal catalyst, and touching it in one spot induces a cyclic chemical reaction that spreads over the entire material and causes the whole gel to vibrate. Balazs has developed the first computational model describing the microscopic shape changes that occur in these touch-sensitive gels. Balazs and her group have also designed polymeric materials that vibrate in response to light and will actually wiggle away from a light source when exposed to it. The overall goal of the research, she says, is to impart lifelike functions, such as the sensitivity to touch, to inanimate objects. Touch-sensitive robots and damage sensors on airplanes and other vehicles are some of the more obvious applications. (X4.1)

Titanium Dioxide Kills Skin Cells

Titanium dioxide is a common pigment used in everything from paint to sunscreen–even breath mints–but despite its ubiquity in commercial products, its safety may be a cause for concern, according to Miriam Rafailovich and her colleagues at Stony Brook University. The problem, she says, is that titanium dioxide produces peroxide and other chemicals that can damage cells when it is exposed to UV light. Using cultures of a common type of skin cell known as "dermal fibroblasts," Rafailovich and her colleagues showed how titanium dioxide can damage the cells' DNA and lead to cell death. They also showed that coating the particles with electrically active polymers can protect the cells from damage. (J40.7)

Physics And Culture

Speakers in sessions Q3 and W5 examine the ways physics relates to a variety of artistic ventures, from the paintings of Van Gogh, Monet, and Pollock, to the architecture of medieval Islam and contemporary China (such as the Olympic Water Cube in Beijing), to the overlap of science, scientists, and the making of movies in Hollywood.

10,000 Physics Majors

Right now, only about 1.4% of STEM graduates are in physics. Both the American Physical Society and the American Association of Physics Teachers (AAPT) have issued statements calling for doubling the number of undergraduate physics majors in this country. (Roughly 5,700 physics baccalaureate degrees are presented annually.) Theodore Hodapp, APS director of education and diversity, will present the rationale for having 10,000 physics majors. A main reason is that an education in physics prepares a student for tackling many of the large technical issues facing society. (B3.1)

Periodic Table For Quantum-Dots

A quantum dot is a tiny speck of semiconducting material in which electrons are confined to an essentially zero-dimensional point. A lone electron, freed from an atom in the dot by laser light, along with the migrating vacancy left behind, form a composite object called an exciton. That exciton within the confines of the dot constitutes an artificial hydrogen atom, with a unique energy spectrum of its own. Maneuver to have two such excitons in the dot and you have an artificial helium atom. McGill University physicist Patanjali Kambhampati will report on the first detailed studies of a "helium" quantum dot. Artificial "lithium" and indeed many other atoms seem to be in the offing. (H10.2)

Quartz-Like CO_2

Pressures of 100 GPa, equivalent to a million times atmospheric pressure, are comparable to the chemical strengths of solids made of molecules, such as H_2, CO_2, and N_2. Much higher pressures than that can be brought to bear on materials, either through static methods, such as with diamond anvil cells, where pressures can reach 360 GPa, or dynamic methods, such as with laser pulses or explosions that can reach pressures over a trillion Pascal (TPa). Choong-Shik Yoo, a scientist at Washington State University, will discuss TPa chemistry and will report on specific molecular-to-nonmolecular transitions observed in his lab under high pressure. Examples include quartz-like and silica-like forms of carbon dioxide. (P13.4)

ANNOUNCEMENTS

IN A RECESSION...

...employers must hire highly skilled employees and jobseekers must set themselves apart.

Register for the upcoming **APS March Meeting Job Fair** and give yourself an edge.

Employers will have access to hundreds of highly skilled candidates and jobseekers will have access to their ideal jobs.

APS March Meeting Job Fair

Date: March 16-17, 2009

Place: David L. Lawrence Convention Center, Pittsburgh, PA

Register today at: http://www.aps.org/careers/employment/jobfairs.cfm

ITER continued from page 3

Again in this area ITER is well positioned to explore opportunities for improvements in understanding and performance.

ITER is also well positioned to explore opportunities for very long-duration plasma pulses, which are desirable from the power-plant perspective. The pulse duration for ITER shown in the table above is defined by the ability to sustain the current in the ITER plasma through induction. A solenoid generates changing magnetic flux to drive an electric field around the plasma torus. This process is well understood, and the projected pulse length of ITER is all but guaranteed. The 300–500 second pulse will be long enough that all of the plasma-facing components will come into thermal steady state, so key steady-state physics and engineering issues can be explored. ITER is also designed to study non-inductive means to drive current efficiently and so can advance this science towards fusion power plants. ITER will utilize non-inductive techniques explored in the superconducting devices now on line in China and South Korea, and in construction in India and Japan.

Achieving the goals for a fusion power plant will require advances beyond plasma physics, and will require joint physics and engineering innovation. The very high heat and particle fluxes that will emerge from fusion plasmas will need to be handled in a way that allows the plasma-facing components to operate for two to five years without replacement. The high-energy neutron flux that will emerge from fusion plasma needs to be captured in a lithium bearing "blanket" to produce the needed tritium, as well as high quality heat. This blanket also needs to maintain its required properties for two to five years without replacement. ITER will make dramatic advances in both of these areas. Furthermore, Europe and Japan are working on the engineering design and engineering validation of a beam-driven high-energy neutron source to test the materials being developed for fusion.

We certainly do not claim that fusion energy research is easy, nor that economically competitive energy production is assured. The international fusion research community has made tremendous strides, but the distance yet to cover is considerable. The world will continue to be in need of safe new energy sources as our population grows, as the standard of living hopefully rises everywhere, and as limits must be respected for emission of CO_2 from energy systems worldwide. Thus, the international collaboration to develop fusion as a new energy source, with ITER its centerpiece, is not only an exciting scientific and technological challenge, but also a key part of the nation's and the world's long-term approach to energy.

Robert J. Goldston was Director of the DOE Princeton Plasma Physics Laboratory from 1997 until recently. Ned R. Sauthoff is Head of the U.S. ITER Project Office at the Oak Ridge National Laboratory.

Call for Proposals: India-U.S. Travel Program

The Indo-U.S. Science and Technology Forum (IUSSTF) and the American Physical Society (APS) are pleased to announce the launch of two new programs: 1) the **India-U.S. Physics Student Visitation Program**, and 2) the **India-U.S. Professorship Awards in Physics.**

Through the **Physics Student Visitation Program**, U.S. and Indian graduate students may apply for travel funds of U.S. $3,000 to pursue opportunities in physics. The travel funds could be used to attend a short course or summer institute, to work temporarily in a laboratory, or for another opportunity that the student and the host professor believe is worthy of support. The Physics Student Visitation Program aims to mostly support graduate student travel to India by U.S. citizens, while enabling some students of Indian citizenship to travel to the United States.

The **Professorship Awards in Physics** funds physicists in India or the United States wishing to visit overseas to teach short courses or provide a physics lecture series delivered at a U.S. or Indian university. Awards will be up to U.S. $4,000.

Further details about both programs, including proposal guidelines, are provided at www.aps.org/programs/international/us-india-travel.cfm.

The **upcoming deadline is 31 March 2009**. Recipients will be selected by a joint APS-IUSSTF Review Committee.

Now Appearing in RMP: Recently Posted Reviews and Colloquia

You will find the following in the online edition of *Reviews of Modern Physics* **at http://rmp.aps.org**

The electronic properties of graphene

A. H. Castro Neto, F. Guinea, N. M. R. Peres, K. S. Novoselov and A. K. Geim

Theoretical treatments of graphene, the one-atom-thick allotrope of carbon, are reviewed and placed into context with respect to the most recent developments in this very active and rapidly evolving field.

The topics discussed, which include the role of two-dimensional Dirac-like electronic excitations, the presence of unusual surface (edge) states, the consequences of disorder, elastic properties, bilayers and stacks, response to magnetic fields, and a treatment of complex many body effects, enable a comprehensive understanding of the promise of this unique two-dimensional material.

M. Hildred Blewett Scholarship for Women Physicists

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

Applications are due June 1, 2009. Announcement of the award is expected to be made by August 1, 2009.

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

Contact: Sue Otwell in the APS office at blewett@aps.org

APS Provides Childcare Assistance to Meeting Attendees

The APS Committee on the Status of Women in Physics (CSWP) has received a grant from the Elsevier Foundation's New Scholars program that will allow CSWP to make awards of up to $400 to APS meeting attendees who are bringing small children or who incur extra expenses in leaving them at home.

This is the second year that CSWP has made these grants available. The grant from Elsevier, which was announced in late January, will allow the committee to increase both the number and the amount of the awards. These funds will augment funds already provided by the APS.

The childcare grant program aims to ease the financial disadvantage parents responsible for childcare may face in attending meetings, which are essential to collaboration, visibility, networking, and a successful career.

Within the New Scholars program this year, the Elsevier Foundation awarded five grants to enable scholars to balance childcare and family responsibilities during the early stages of their careers in science and technology. The grant recipients represent a range of international institutions pioneering new approaches to childcare, mentoring and networking.

A parent-child quiet room is also available at the March Meeting for attendees with children.

Details on APS CSWP childcare grants are at http://www.aps.org/meetings/april/services/index.cfm.

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the DOE Office of Science, and $475 million for NIST. The final House and Senate compromise version of the bill, which President Obama has signed into law, provides $3 billion for the National Science Foundation, $1.6 billion for the Department of Energy's Office of Science, $400 million for the Advanced Research Project Agency-Energy (ARPA-E) to support high-risk, high-payoff research into energy sources and energy efficiency, and $580 million for NIST.

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The swing-gang whacked away at the House priorities, and by the time they were done, Collins, Snowe and Specter, joined by a cadre of conservative Democrats, had removed more than $6.5 billion for science, much of it related to infrastructure projects that would create several hundred thousand blue collar jobs. But the last chapter of the stimulus saga was still to be written. House Speaker Nancy Pelosi (D-CA) rejected as unacceptable the Senate's insistence that its verdict be final, and in a powwow of ten, the science funding was restored.

Science escaped narrowly, but bipartisanship didn't. President Obama may want to change the partisan culture of Washington, but it takes two to tango.

The Back Page

New Eyes on the Universe: 400 Years of Physicist Astronomers

By Michael S. Turner

Four-hundred years ago Galileo turned a 2-cm telescope to the sky and increased the sensitivity of human eyes on the Universe by a factor of 100–an increase only matched since by that of the Hubble Space Telescope. His discoveries, including the phases of Venus and the resolution of the Milky Way into stars, established the Copernican paradigm and profoundly changed our view of the Universe. Since then, the sensitivity of optical telescopes has improved by another factor of 100 million, and we have added radio, infrared, UV, x-ray, gamma-ray, cosmic-ray, and neutrino eyes on the Universe. These new and more powerful eyes have continued to deliver stunning discoveries.

Because physicists have contributed so significantly to the improvement of the performance of "our eyes on the Universe" and in shaping the science of astrophysics, it is appropriate that our Society take part in the celebration of this anniversary (the International Year of Astronomy) through the theme–New Eyes on the Universe: 400 years of telescopes–and content of the April Meeting. Galileo was not only the first physicist to turn a telescope to the sky, but the telescope and microscope were the first instruments of science that extended our ability to explore the physical world.

The telescope Galileo used was a simple refractor. The sheer weight of a large glass lens makes a refracting telescope larger than about a 1 meter in diameter impractical. The introduction of the reflecting telescope by Newton in 1669 paved the way to virtually all modern telescopes. Newton made a few other contributions relevant to astronomy including his invention of the fields of gravitational physics and spectroscopy.

George Ellery Hale, the MIT-educated solar-physicist, was the pre-eminent telescope builder of the 20th century. After starting the first Department of Astronomy and *Astrophysics* at the University of Chicago, Hale took astronomy to the mountains of California where the seeing (image quality) is much better. (When observing point-like objects, sensitivity improves as the point-spread function squared. On the best mountaintops seeing can be 0.3 arcseconds which results in a hundredfold gain.) Four times Hale built the largest telescope in the world: the 40-inch refractor at Yerkes Observatory in Wisconsin and the 60- and 100-inch reflectors at Mt. Wilson and the 200-inch reflector at Mt. Palomar, and he left a great scientific legacy in the discoveries made by these telescopes.

Edwin Hubble used the 100-inch Hooker telescope to solve the riddle of the mysterious nebulae that had been catalogued for more than 100 years. He showed that they were "island universes" and not gas clouds within our own Milky Way galaxy, thereby enlarging the known Universe by a factor of 100 billion. Hubble went on to discover the expansion of the Universe, revealing our big bang origin. The 200-inch was used to discover quasars, now known to be super-massive black holes powered by the accretion of matter. This discovery, featured on the cover of *Time Magazine* in March 1966, opened our eyes to the "extreme Universe" of relativistic objects like neutron stars and black holes.

Physicist Albert A. Michelson not only showed that the speed of light is frame independent, but he also introduced interferometry to astronomy. The use of an interferometer to combine the light from two telescopes to create a telescope of larger effective diameter–the separation of the two telescopes–vastly increases its resolving power. Today, optical interferometers are in operation at Mt. Wilson and on the European Southern Observatory's Cerro Paranal in Chile, where the light of four 8-meter telescopes can be combined. These interferometers will soon image distant planetary systems, black hole accretion disks, and the surfaces of stars.

Michelson interferometers are also being used in the quest to directly detect gravitational waves. At the heart of the two U.S. LIGO detectors (in Hanford, WA and Livingston, LA) are 4-km Michelson interferometers which are used to detect the tiny (10^{-15} cm) changes in the separation of the mirrors due to passing gravitational waves. Soon, LIGO and other gravitational-wave detectors around the world will be "listening" to the collisions of black holes and neutron stars across the Universe. By monitoring the coalescence of two black holes into one larger one, some of the most fundamental predictions of general relativity will be tested.

Nowhere has the impact of physics on astronomy been greater than with the introduction of spectroscopy. In the mid-nineteenth century, Sir William Huggins compared the spectra of the sun and distant stars and showed that both are made largely of Hydrogen, making clear that our sun is just a star up close and that we are made of the same stuff as the cosmos. The ability to remotely analyze the composition of objects across the Universe and thereby to begin to understand their inner workings created the field of astrophysics. It is an interesting footnote to history that in 1835, Auguste Comte, a prominent French philosopher, stated with great authority that "humans would never be able to understand the chemical composition of stars." Never say never when physicists are involved!

The first president of the APS, Henry Rowland, revolutionized spectroscopy with his gratings, still the workhorse of spectroscopy today. Astronomers take spectra of just about anything they can see (and even things that they can't see) in the Universe–from the brightest stars to the faintest galaxies. Spectra are used to determine velocities, compositions, and more generally to get at how things work. The redshift of a galaxy determines how big the Universe was when its light was emitted and through Hubble's law how far away it is; the spectrum of a supernova reveals the exploding shell of material and the newly formed heavy elements. Very stable spectrographs were used to detect the small (of order meters per second) periodic wobbles in nearby stars caused by the exoplanets that orbit them. Hundreds of planets have been discovered, and in the future, spectra of the exoplanets themselves may reveal the chemical signatures of life that exists on them.

Almost a factor of a million of the gain in sensitivity since Galileo's time has come from increasing telescope mirror size. Physicists Jerry Nelson and Roger Angel have made innovations in mirror design that have enabled today's large telescopes. Angel introduced molded honeycomb mirrors that reduce the weight of large mirrors dramatically, and Nelson devised a way to make a large mirror from many smaller and lighter segments. These two innovations are at the heart of the design of the two 30-meter telescope projects–the Thirty Meter Telescope with its four-hundred-ninety-two 1.8-meter hexagonal segments and the Giant Magellan Telescope with its seven 8-meter honeycomb mirrors. These giant telescopes will add another factor of 100 in sensitivity to our eyes on the sky enabling marvelous discoveries.

Even at the best high-mountain sites atmospheric turbulence blurs astronomical images and limits seeing. With the advent of adaptive optics–the use of flexible mirrors with real-time control systems–the blurring can be undone. The critical de-blurring information comes from having a bright guide star near the distant (usually faint) object of interest. Since there are not enough bright stars in the sky for this purpose, artificial guide stars are created by shining high-powered lasers towards the heavens; by exciting atoms in the atmosphere they create the needed guide stars. Next year physics celebrates the 50th anniversary of the invention of the laser.

Photographic plates only capture about 1% of the incident photons, whereas modern quantum devices–CCDs and the like–have efficiencies approaching 100%. Moreover, a digital image can be exploited in ways that a photographic image cannot. For example, the key to discovering the acceleration of the expansion of the Universe in 1998 was finding distant supernovae to use as cosmic mileposts. Supernovae are very bright–as bright as their host galaxies–but very rare–occurring only once in every 100 years or so. They can now be found routinely by taking two images of the sky containing 1000s of galaxies weeks apart; when the two images are digitally subtracted, the supernovae jump right out.

Equally important to the advance of our understanding of the Universe has been the addition of "new eyes" on the Universe which have revealed otherwise invisible objects and have led to stunning discoveries. In the 1930s physicist Karl Jansky of Bell Labs and amateur Grote Reber pioneered radio astronomy by detecting diffuse emission from our galaxy and a few bright individual sources. Today, radio eyes allow us to study rapidly spinning neutron stars, the jets created by the supermassive black holes at the centers of galaxies, and a host of other things invisible to the eye.

Radio astronomy's greatest hit is the discovery of the cosmic microwave background (CMB) in 1964 by physicists Arno Penzias and Robert Wilson. It revealed the hot beginning of our Universe and much more. Today precision measurements of its anisotropy (a part in 10^5 variations in its intensity across the sky) have given us a glimpse of the Universe when it was only 400,000 years old and before stars and galaxies existed. From measurements of CMB anisotropy the age, shape and composition of the Universe have been accurately measured and information about the earliest moments of creation has been gleaned (e.g., evidence for an early period of inflation).

Physicists Herbert Friedman and Riccardo Giacconi pioneered the field of x-ray astronomy. Without x-ray eyes we would not be able to see most of the baryons in the Universe which reside in hot x-ray emitting gas around galaxies and clusters of galaxies. Black holes of all sizes are studied by the x-ray emission from their accretion disks, and the highly asymmetric shape of the Iron lines seen allow the in falling material to be tracked as it approaches the event horizon.

Masatoshi Koshiba and Raymond Davis opened the field of neutrino astronomy with their large underground experiments which detected neutrinos from the sun and supernova 1987A. Gamma-ray astronomy was secretly born during the Cold War in 1967 with the detection of gamma bursts from black holes forming at the edge of the Universe by the Vela satellites, which were built to monitor the nuclear test ban on Earth. Physicists Robert Leighton and Gary Neugebauer were among the pioneers of infrared astronomy; today IR eyes allow astronomers to see through the dust surrounding the birth of stars and planets as well as the high-redshift universe where the expansion of the Universe has shifted most of a galaxy's visible light into the infrared. Without devices invented by physicists, x-ray, gamma-ray, infrared, neutrino and radio astronomy would not be possible.

Four hundred years ago the telescope and the microscope were essentially the same device, with one turned to outer space and the other turned to inner space. The paths deep into inner space and into outer space quickly diverged, with exciting, but seemingly unrelated discoveries in these vastly different realms of the physical world. Microscopes discovered microbes, cells and viruses and explored the worlds within them; and most recently, kilometer-sized accelerators revealed the world of quarks, leptons and gauge bosons. At the same time, bigger and bigger telescopes, employing more and more sophisticated detectors, took us to the edge of the Universe and back to the beginning of time. After nearly 400 years of divergence, inner space and outer space have come together again. Today, both astronomers and particle physicists are chasing after dark matter, dark energy, neutrinos, and the birth of the Universe, using telescopes and accelerators. The plenary, invited and contributed talks at the April Meeting illustrate this coming together of quarks and the cosmos with particle physicists talking about the search for dark matter (the particle, that is) at the Large Hadron Collider and astronomers using telescopes to get at the essence of nothing (dark energy, that is).

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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