APS NEWS
July 2004
Volume 13, No. 7
A Publication of The American Physical Society http://www.aps.org/apsnews

APS Joins Science Organizations in Urging Better Visa Regulations

In May, the APS joined more than 20 other science, higher education and engineering organizations in a joint statement urging the federal government to adopt six practical recommendations for improving the current visa processing crisis by removing unnecessary barriers to multi-national collaborations. Taken together, the group represents 95% of the US research community. It is the first time that US science and academic leaders have endorsed a comprehensive plan to address the visa-processing quagmire in the wake of heightened security concerns following the 9/11 terrorist attacks.

The statement is careful to express strong support for the US government's efforts to establish new visa policies while bolstering national security. "We are confident that it is possible to have a visa system that is timely and transparent, that provides for thorough reviews of visa applicants, and that still welcomes the brightest minds in the world," the statement reads. "It is not a question of balancing science and security... . These priorities are not mutually exclusive; to the contrary, they complement each other, and each is vital to the other."

There is ample evidence that the visa processing system is sinking under the weight of stricter security requirements. In 2000, only 1000 non-immigrant visa applications were flagged for review under the Visa Mantis program, one of several US screening systems. But by 2002, that number had jumped to 14,000. And by the spring of 2003, some 1000 cases were under review at any given time. An increasing number of cases are being set aside for even more detailed screening. The result is massive backlogs and delays that prevent students from attending university and scientists from participating in research and conferences.

In addition, a survey earlier this year by the American Council of Education, among other organizations, found a substantial drop in applications by international graduate students to leading US research institutions for the 2004-2005 academic year. "If action is not taken soon to improve the visa system, the misperception that the US does not welcome international students, scholars and scientists will grow, and they may not make our nation their destination of choice now and in the future," the statement says. "The US cannot hope to maintain its present scientific and economic leadership position if it becomes isolated from the rest of the world."

Six major problems are outlined

See VISA *on page 4*

What's a Nice Equation Like You Doing in a Cartoon Like This?

Earlier this year an animated feature called The Triplets of Belleville was playing in movie houses around the country. It got some attention from the critics, and garnered two Oscar nominations (for best animated feature film and best original song). Among its many interesting attributes is something that was probably noticed by only a very tiny segment of the audience: as the opening credits run, the bottom of the screen displays Einstein's field equations of general relativity (see illustration).

There is no obvious reason for this. Neither Einstein nor physics plays any role in the film itself. The film is a French/Belgian/Canadian collaboration, directed by Sylvain Chomet of France. What were they thinking? Or is this just an act of whimsy with no particular raison d'être? If any of our readers has either some inside knowledge, or a good theory as to why the equations are there, we would be eager to hear about it. We will even offer a copy of the coffee-table book "Physics in the 20th Century" for a particularly convincing explanation.

April Meeting Prize Recipients

Photo Credit: Cronin Photography

Front row (l to r): Arie Bodek, Suzanne Staggs, Herwig Schopper, Juan Maldacena, Ikaros Bigi, George Bertsch, Anthony Sanda. Back row (l to r): Dmitry Teytelman, Gabriele Veneziano, John Seeman, H. Jeff Kimble, Peter Onyisi, Andrew Steiner, Shahram Rahatlou, Katsunobu Oide. Not shown: Marc Ross, Peter D. Zimmerman, Wick Haxton.

APS Journals To Cost Less in 2005

By Ernie Tretkoff

For the first time in many years, the price for APS journal subscriptions will decrease for 2005, largely due to a technology-driven reduction in the cost of production.

As is the case for most scientific journals, the trend for APS journals, which include *Physical Review A-E*, *Physical Review Letters*, and *Reviews of Modern Physics*, has been increasing prices over the past several decades. In addition to normal inflation in the costs of production, the journals have been steadily growing in size every year, said Tom McIlrath, APS Treasurer/Publisher. The journals are expected to grow by 4% from 2004 to 2005.

While the size of APS journals has been increasing, the number of subscriptions has been decreasing. Large institutions have cancelled duplicate subscriptions because electronic access makes multiple print copies unnecessary, and smaller institutions have been forced to cancel subscriptions for financial reasons. This trend is seen throughout the journal publishing industry.

For 2005, APS will begin to reverse the trend of increasing prices by taking advantage of the cost reductions made possible by technology. For example, said McIlrath, software that automatically copyedits and formats manuscripts greatly reduces the manpower needed. Also, almost all manuscripts are now submitted on-line, saving the cost of having to reenter them. Outsourcing some of the production process to other countries accounts for some of the lowered costs, but technology is really the major factor in controlling costs, said McIlrath.

After hearing input from the Publications Oversight Committee, the APS Council set the journal prices for 2005, deciding to pass the cost savings on to libraries. Journal prices are set to cover costs with some margin to allow for uncertainty in predicting costs and revenue two years in advance. "It was a clear decision that in these

See JOURNAL COSTS *on page 5*

QKD, XFELs Highlight 2004 DAMOP

The latest research results in quantum key distribution, quantum entanglement, and next-generation free electron lasers (FELs) were among the technical highlights at the 35th annual meeting of the APS Division of Atomic Molecular and Optical Physics (DAMOP). It was held May 25-29 in Tucson, Arizona, in conjunction with the corresponding division of the Canadian Association of Physicists.

Among the special events was a welcoming reception Tuesday evening at the Arizona Historical Society Museum, and an after-dinner lecture by Rice University's Neal Lane, former director of both the National Science Foundation and the Office of Science and Technology Policy.

The conference also featured a public lecture on Wednesday evening by JILA's Eric Cornell, winner of the 2001 Nobel Prize in Physics for his contributions to realizing Bose-Einstein Condensation.

Searching for a Quantum Key. Quantum key distribution (QKD) uses single-photon communications to generate the shared, secret random number sequences that are used to encrypt and decrypt secret communications. The secret to the technique's security is based on the interplay between quantum physics and information theory, according to Richard Hughes (Los Alamos National Laboratory).

"An adversary can neither successfully tap the transmissions nor evade detection," he said, since eavesdropping raises the key error rate above a set threshold value. Hughes described a recent QKD experiment performed over multi-kilometer line-of-sight paths, serving as a model for a satellite-to-ground key distribution system. His system uses single-photon polarization states, with active switching, and is capable of continuous operation through day and night.

FEL's Generation X. Stanford Linear Accelerator Center's planned Linac Coherent Light Source is an example of the next generation of X-ray free electron lasers (XFELs).

These instruments will offer users the ability to study ultrafast time-dependent phenomena with resolutions at atomic length scales. But in order to take full advantage of this time resolution, users will need single-shot measurements, in real time, of the temporal characteristics of the bunches of electrons that power such sources, according to speakers at a Saturday morning session on new techniques for studying ultracold molecules. Electro-optic sampling

See DAMOP *MEETING on page 4*

Highlights

Members in the Media

"I don't think anybody's going to get the whole story. I am presenting some difficult subjects, like extra spatial dimensions. It's a little hard to visualize."
—John Schwarz, Caltech, on giving a public lecture about string theory, Los Angeles Times, May 13, 2004

✶✶✶

"I do what works. I see what causes people to fall asleep."
—Carl Wieman, University of Colorado, on giving public lectures, Los Angeles Times, May 13, 2004

✶✶✶

"If the universe was finite, and had a size of about 4 billion to 5 billion light-years, then light would be able to wrap around the universe, and with a big enough telescope we could view the Earth just after it solidified and when the first life formed. Unfortunately, our results rule out this tantalizing possibility."
—Neil Cornish, Montana State University, SPACE.com, May 24, 2004

✶✶✶

"I'm a theoretical physicist, and there are some problems for which there aren't any theories. You can only understand that science through simulations."
—Raymond Orbach, DOE Office of Science, Business Week, June 7, 2004

✶✶✶

"I always like to say that one of the compelling things about doing science is that all of us live with the knowledge that there is an ultimate truth and our mistakes will be discovered."
—Persis Drell, SLAC, San Jose Mercury News, June 1, 2004

✶✶✶

"It's tough to get an animal to lie still for 40 minutes. It's tough enough to get people to do it."
—Craig Woody, Brookhaven, on a device he's developing called RatCAP, a compact PET scanner for awake lab rats, Newsday, May 31, 2004

✶✶✶

"Always assume this is your last clear night on the telescope. Set aside time for things you'd be embarrassed not to have done."
—John Huchra, Harvard, on selecting projects for the Hubble telescope, New York Times, May 25, 2004

✶✶✶

"Maybe it's my age, but I'm really beginning to think I know what it feels like to be the Hubble telescope. One faces a finite future."
—Robert Kirshner, Harvard, New York Times, May 25, 2004

✶✶✶

"The equations that govern a violin string are pretty close to the equations that govern the strings we talk about in string theory. So although the notion of strings is metaphorical, it's pretty close."
—Brian Greene, Columbia University, New York Times, May 25, 2004

✶✶✶

"The cloudier the earth, the brighter the earthshine, and changing cloud cover is an important element of changing climate. Earthshine is a good sentinel, a good diagnostic tool for climate change."
—Steve Koonin, Caltech, San Francisco Chronicle, May 28, 2004

✶✶✶

Who's the Fairest of Them All?

Photo Credit: FocusOne Pictures

APS and the American Association of Physics Teachers jointly sponsor a special award at the International Science and Engineering Fair (ISEF), which took place in May in Portland, Oregon. One of the judges for this year's award was Jessica Clark, APS Public Outreach Coordinator, shown here at left in the front row. Shaking Jessica's hand and looking moderately happy is first place winner Yiyi Deng. Next to her in the front row are second place finisher Yun-Hsin Chao of Taiwan and third place winner Meredith MacGregor, a high school freshman. In the second row are (l to r) Michael Pizer, Evan Frank, and Kevin Claytor, each of whom received honorable mention.

This Month in Physics History

Making History

July 13, 1901: Santos-Dumont Flies Around Eiffel Tower

When we think of early aviation, invariably the Wright Brothers come to mind. But there were many others who made significant contributions to the realization of early flight, among them a Brazilian inventor and aviator pioneer named Alberto Santos-Dumont.

Born in Brazil in 1873, Santos-Dumont moved to Paris at 18, where his inherited wealth enabled him to live in luxury and pursue his passion. He became fascinated by the possibilities of flight, initially with balloons and so-called "dirigibles"—airships powered by steam engines, electric batteries, and eventually by gasoline engines.

Credits - © 2001 National Air and Space Museum, Smithsonian Institution (SI Neg. No. 94-578)

Alberto Santos-Dumont at the helm of one of his airships.

Santos-Dumont's best known plane, 'La Demoiselle.'

Santos-Dumont made his first successful dirigible flight in 1898, taking off from a botanical garden west of Paris and rising to 1300 feet. Unfortunately the machine lost gas pressure on its descent and crash-landed when the main envelope lost its shape. One year later, Santos-Dumont unveiled his second dirigible, which suffered the same fate as the first: losing pressure and folding in on itself. Undaunted, he replaced the sausage shape with an elliptical envelope that was thickest in the middle to keep it from folding up on itself.

A new incentive for success came later that year when a wealthy patron of the French Aero Club offered a prize of 100,000 francs for the first airship to complete the journey from the club's Parc d'Aerostation at Saint-Cloud to the Eiffel Tower and back in less than 30 minutes. This was a distance of 6.8 miles, requiring an average speed of 14 mph, which no flying machine had yet achieved. Eager to take up the challenge, Santos-Dumont built himself a hangar at Saint Cloud to conduct further experiments. He constructed his fourth flying machine by the end of 1900 and made several test flights with it the next summer, eventually incorporating what he learned into the design of his fifth machine. And he decided he was ready to take a shot at the prize.

On July 12, 1901, Santos-Dumont made three separate flights over the city of Paris, managing to reach the Tower and round it on the third attempt. But he was forced to land in a nearby garden because of rudder problems. The next day, he tried again, and succeeded in flying his hydrogen-filled airship around the Eiffel Tower and back in 40 minutes—ten minutes too long to earn the prize. On August 8th he made another attempt, again rounding the Tower, but was then forced down by a hydrogen leak, crash-landing into the Trocadero Restaurant. The airship's envelope was ripped to shreds and the framework dangled from the building's walls just long enough for Santos-Dumont to climb down to safety.

But the Brazilian was nothing if not persistent. He quickly constructed a replacement airship, ironing out the kinks, and by October 19, 1901, he was ready for his final attempt. On the way towards the Eiffel Tower the wind was in his favor, and he arrived a mere 9 minutes later. He narrowly missed colliding with it on the turn, and had to fight the wind head on during the trip back. He made it back to Saint Cloud only 40 seconds past the established time limit, and the judges somewhat grudgingly awarded him the prize, which he generously donated to Parisian charities. The feat demonstrated that the airship could be a practical vehicle, and Santos-Dumont became a familiar figure, even barhopping in a little dirigible that he tied to lampposts. In 1902 he tried to cross the Mediterranean Sea in an airship, but crashed en route.

Santos-Dumont then turned to designing and flying so-called "heavier than air" machines. On November 12, 1906, he succeeded in flying one of his inventions 772 feet in 21 seconds—three years and 150 feet short of the Wright Brothers' historic flight at Kitty Hawk in 1903. But the Wrights worked in secrecy to protect their patent rights, so news of their achievement did not reach Paris for several years. Santos-Dumont was still only the third man in the world to fly a powered aircraft. Some historians believe he may have even been the first man to get airborne with a heavier-than-air machine by means of its own propulsion. There is some debate on whether the Wrights used a rudimentary catapult system on an inclined plane to get their machine into the air. The pro-Wright camp claims that the brothers didn't invent the catapult system until 1904, one year after Kitty Hawk. They started using it later on to avoid damaging their aircraft.

One of Santos-Dumont's aircraft designs—the Demoiselle (Grasshopper), invented in 1909—became the forerunner of the modern light plane. He ended his days back in his native Brazil, increasingly depressed over the use of aircraft in warfare. He committed suicide in 1932. But his place in the First Flight Society's hall of fame remains assured.

APS NEWS
Series II, Vol. 13, No. 07
July 2004

Coden: ANWSEN ISSN: 1058-8132

Editor ..... Alan Chodos
Associate Editor ..... Jennifer Ouellette
Special Publications Manager ..... Elizabeth Buchan-Higgins
Design and Production ..... Stephanie Jankowski
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.

AIP Plans Outreach Programs for World Year of Physics

Physics societies, laboratories and other organizations around the world are gearing up for the upcoming World Year of Physics in 2005, with numerous planned activities to celebrate the 100th anniversary of Albert Einstein's "miracle year" and the three papers that revolutionized the field of physics.

The American Institute of Physics (AIP) is no exception, organizing a wide range of education and outreach activities to capitalize on the event. Among other activities, *Physics Today*—AIP's flagship publication—is planning monthly features throughout the year in honor of the World Year of Physics.

And AIP's Center for the History of Physics is revising and enhancing their immensely popular 1996 on-line exhibit on Albert Einstein [http://www.aip.org/history/einstein].

New features will include a new site design, a new bibliography, and reprints of five seminal essays by noted historians on various aspects of Einstein's thinking in 1905.

The various chapters of the Society of Physics Students around the country will be sponsoring physics department and public events to celebrate 2005, as part of a "physics department challenge."

Awards for the best proposals will be handed out and featured at the upcoming SPS Congress this October in Albuquerque, New Mexico.

The Marsh White Awards for Physics Outreach will also be geared towards the best physics outreach projects in 2005.

Meanwhile SPS will be putting together outreach catalyst kits around the theme of "Einstein in the 21st century." These will be disseminated to about 25 SPS chapters in the US this fall.

For more information about AIP's planned activities for the World Year of Physics, see http://www.physics2005.org/events/index.html

Washington Dispatch

A bi-monthly update from the APS Office of Public Affairs

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

ISSUE: RESEARCH FUNDING

Congress haggles over budget, science funding hangs in the balance. At press time, the Senate and House have so far failed to reach agreement on a budget resolution, which sets the overall framework for annual spending bills. In an atmosphere where science funding is already squeezed by war expenses and a growing deficit, the disagreement threatens to delay the budget process until after Election Day, throwing even more doubt on science agency budgets.

Senators express support for Office of Science. Although President Bush's February budget proposed a 2% cut for the Department of Energy's Office of Science, 55 senators have signed a letter to the Senate Appropriations Committee recommending a 10% increase for the agency. It is unlikely that such an increase will become a reality this year, but the letter is a strong statement of support. Instrumental in building such broad support for the letter were more than 4,000 e-mails urging support for the Office of Science sent to the Senate by scientists using the APS "Write Congress" Web page.

✶ ✶ ✶ ✶ ✶

ISSUE: DEFENSE

The APS Panel on Public Affairs Report on the Modern Pit Facility is now available. The Senate Defense Authorization Bill decreased pit facility funding by 50%, pending reports on stockpile size and production options. That is consistent with the recommendations in the POPA Report. (To read the full report, please go to the APS Office of Public Affairs website.)

✶ ✶ ✶ ✶ ✶

ISSUE: EDUCATION FUNDING

President Bush's proposal to move the peer-reviewed Math and Science Partnerships program at the National Science Foundation to the Department of Education has met with opposition on Capitol Hill, which has been fueled in part by over 1,100 APS March Meeting attendees who stopped by the "Contact Congress" kiosk to send e-mails opposing the transfer. APS continues to work to block this transfer.

✶ ✶ ✶ ✶ ✶

ISSUE: VISAS

Rep. Michael Capuano (D-8th MA) has submitted legislation to address one component of the visa problem. Citing reports from NSF and the Council on Graduate Schools indicating sharp declines in graduate applications from abroad, H.R. 4273, The FERMI Act (Furthering Education and Research through Mantis Improvements), would extend visa validity periods to three years and allow for multiple entries.

zero gravity
The Lighter Side of Science

The Physics of High Heels

By Stephen Strauss, Globe and Mail

England, the country that nurtured the genius of Isaac Newton, has now applied the brains of its physicists to a modern conundrum: What is the height of the heels that *Sex in the City's* Carrie Bradshaw could wear without falling over or cramping up in pain?

The answer, as calculated by Professor Paul Stevenson of the University of Surrey, is as complicated as contemporary dating. If Bradshaw, the show's fashion mad lead character, is wearing shoes she really likes, cost a lot, and are the latest thing, she can sashay about easily in a pair of her beloved Manolo Blahnik stilettos that top out at over five inches or almost 13 centimeters tall. If she has spent the night toasting the end of the television series, then she had better think about not wearing shoes with heels higher than about an inch because the alcohol will upset her equilibrium.

Stevenson made the calculation after Dianne Stilwell, a publicist with the London-based Institute of Physics, sat mesmerized before the next to last episode of the series, which ended in Britain last week and concludes on Friday here. "I sat there thinking: How can she wear heels that height? There must be some kind of formula that says you can only go so high before you fall over," Stilwell said.

She then went over to the physicists at Surrey with her curious question. Stevenson took up the challenge and came up with h=Q x (12+3s/8)—a formula that expresses the maximum heel height you can go without tipping over. In this case, **h** is the height of heel, **s** is the length of the shoe (as measured by the UK shoe size) and **Q** is a variety of sociological factors. The numbers express how changes in foot slope increase tippiness.

In essence, the formula says that the sharper the angle of the foot in the shoe—what Pythagoras described as the hypotenuse of a triangle in his mathematical studies in the sixth century BC—the more unsteady you become. "You have a small area that is supporting all your weight, and it is hard to keep your balance on a small area," is the simplified explanation of the formula, according to Stevenson. This translates into a situation where five inches is about the height at which an experienced high heel wearer could remain stable.

The British physicist acknowledges that a scientific publication would want an equation that more quantitatively expressed the pain that increasingly higher heels cause the wearer. As well, the equation is entirely based on a stiletto model for the heel. A broader heel would keep the wearer steadier.

What the quantification does not address is how much pressure a woman stumbling about in high heels would exert if she stepped on you. For that the British physics institute directs people to its web site where it records that a 100 pound woman in stilettos will exert pressure under her foot that is 20 times that of a 6,000 pound elephant.

Reprinted with permission from The Globe and Mail.

How High Can You Go?

The maximum heel height formula is based on shoe size and an elusive Q factor, which takes into account sociological factors such as how shoe stylishness increases a woman's ability to tolerate pain.

h=Q x (12 + 3s/8)

h is the maximum height of the heel (in cm).

Q is a sociological factor and has a value between and 1.

s is shoe size (UK ladies sizes).

Q is defined as:

Q=[p · (y+9)· L]/[(t+1) ·(A+1)· (y+10) · (L+£20)].

p is the probability that wearing the shoes will turn heads.

y is the number of years experience you have wearing high heels.

L is the cost of the shoes, in British pounds.

t is the time since the shoe was the height of fashion, in months.

A is unit of alcohol consumed.

SOURCE: INSTITUTE OF PHYSICS

Editor's Note: *This article first appeared on March 24, 2004, in "...the Globe and Mail, Canada's national newspaper." Reprinted with permission. Kudos to AIP's Inside Science News Service for finding it and posting the link on their website.*

Next-Generation Accelerator Could Hold Key to Dark Matter, Energy

At the dawn of the 21st century, physicists have attained a thorough knowledge of the particles and forces that characterize ordinary matter. Meanwhile, astrophysical and cosmological observations have revealed that our picture of the universe is incomplete: 95% of the cosmos is made not of ordinary matter, but of dark matter and dark energy.

In order to answer these fundamental questions, astrophysical observations of the relics of the Big Bang must be compared with data from physics experiments, and for that, we need to plan a new linear collider to operate concurrently with the Large Hadron Collider (LHC) currently under construction at CERN, according to speakers at a special session on the next generation of particle accelerators at the APS April meeting in Denver, Colorado.

"Cosmology and particle physics are joined at the hip," said Michael Turner (University of Chicago), currently on leave as assistant director for mathematical and physical sciences at NSF. He emphasized that the two fields share many of the same pressing questions. He believes that particle accelerators complement telescopes, the primary means of investigation in cosmology and astrophysics. The latter essentially use the universe itself as a laboratory and let Nature set up the experiments, since the enormous dynamical range of cosmological conditions can't be created on Earth. But accelerators provide controlled, repeatable conditions.

Turner outlined some of the knowledge gained from experiments conducted at accelerator facilities. Most notably, in the 1970s, quarks were found to be the basic building blocks of Nature. However, "There are still many questions that remain to be answered, and those answers will all require particle accelerators," he said.

Those questions include determining the exact nature of dark matter, hopefully by directly producing that particular brand of particle—an achievement that many scientists rank on a par with Copernicus' recognition in the 16th century that Earth was not the center of the solar system. String theory predicts seven undiscovered dimensions of space that may give rise to much of the apparent complexity of particle physics. Discovering those extra dimensions would change our understanding of the birth and evolution of the universe. And string theory could even reshape our concept of gravity. There is also the question of dark energy, most notably figuring out "why nothing weighs so little," said Turner.

According to Gerald Dugan of Cornell University, the particle physics community has reached a consensus that the next linear collider should be an electron-positron linear collider, with an initial center of mass energy of 500 GeV. This can be later upgraded to 1000 GeV, and ideally operated concurrently with the LHC. The International Linear Collider Steering Committee (ILCSC) was established to make a recommendation on whether the rf accelerating system should make use of superconductivity or should operate at room temperature. Each of these has its own benefits

See DARK MATTER *on page 5*

LETTERS

Shakespeare Would Have Blushed

Reading the haikus in the current *APS News* has reminded me of an amusing aspect of one of the limericks published in 1997. It dealt with the approach of a particle-antiparticle pair, upon which they both die in a blaze of glory. Perhaps not all of the readers of *APS News* realize that in earlier forms of the English language (*e.g.*, that used by Shakespeare), the verb "die" was also a euphemism for experiencing sexual climax.

So—the limerick was richer than might have appeared.

Larry Slifkin
Chapel Hill, NC

Editor's Note: *The verse in question was a finalist in the limerick contest that APS News ran in 1996/7. It was published in the March 1997 issue. For those whose recollection is not as good as Larry Slifkin's , it is reproduced below.*

Readers can find it, and most of the other limericks submitted to the contest, on the web at http://www.aps.org/apsnews/limericks.cfm.

And Then There Were Photons
By William Rolnick

An electron, while trav'ling in space,
Met a positron there "face-to-face."
The electron then sighed,
At the sight of his bride
And they "died" in a loving embrace.

Arts/Science Collaboration Does the Job

I was intrigued last night in reading the article on the Back Page, *APS News*, 8 May, by Olson et al., "The Blood-Red Sky of the SCREAM."

The painting by Munch is indeed interesting and different. But it is nice when some physicists and an English prof get together and analyze the origin of a work of art. It is like a detective story, and they are undoubtedly correct in surmising that the event was caused by the Krakatoa explosion, but they had to do a lot of work to get there.

Congratulations!

Jim Peterson
Palo Alto, CA

First Working Laser Due to Maiman

A. Laubereau's letter in the May issue about the first "working laser" reflects the limitations of relying entirely on formally published scientific papers. These problems are particularly evident in studying the origin of the laser. I have explored the problem in some detail in a book forthcoming from Oxford University Press (*Beam: The Race to Make the Laser*), but feel obliged to clarify the matter now.

Maiman's first laser used an imperfect ruby crystal which was the best he had available at the time. That was the basis of a manuscript he wrote and submitted to *Physical Review Letters* in June 1960, which the then-editor Samuel Goudsmit summarily rejected, either because he did not consider an "optical maser" distinct from a microwave maser or because he considered it serial publication with Maiman's earlier report of ruby fluorescence. Goudsmit refused to reconsider, so Maiman submitted a brief report to *Nature*, and announced his results at a July 7, 1960 press conference in New York. By that time, *Journal of Applied Physics* had accepted his full paper, but had a publication lag of six months.

In July Maiman obtained a better quality ruby crystal, which he used to obtain a beam of much better quality and threshold behavior on July 20. Those results are incorporated in the long *Physical Review* paper cited by Laubereau. Maiman does reference the Collins et al. paper cited by Laubereau, although that paper was written and published after Maiman began studying the better quality ruby. That inclusion may have been requested by the referees, since the Collins paper had already been published by the time Maiman submitted his.

Looking at the published papers alone does not give important points of context. The Collins et al. paper was the result of work stimulated by Maiman's press conference, although it cites the *Nature* paper. In fact, others also duplicated Maiman's laser, with Ron Martin's group at TRG Inc. probably the first to do so, although they never published. (They were working under a classified military contract.) According to Maiman's autobiography, he told Collins of his better laser before Collins submitted his paper. Maiman chose not to try to report his relatively incremental advance of threshold behavior in a separate paper; he had clear reason to doubt it would be published. (It is worth mention that Collins et al. took care to avoid the word "maser" in their paper.)

My research, including my own interviews and careful study of published papers, oral histories, recollections and other documents, has convinced me that Maiman deserves credit for the first working laser. The fact that it is not clear from the published record is an unfortunate consequence of the mistakes, misunderstandings, and misstatements that are inevitable when we first venture into a new realm in physics.

Jeff Hecht
Auburndale, MA

DAMOP MEETING *from page 1*

can be used to accomplish such characterization of electron bunches at SLAC, which are then used to produce ultrafast x-rays at the Sub-Picoscond Pulse Source experiment.

Entangled Photons. Entanglement consists of the correlations between quantum systems that cannot be described by a local hidden variable model, and is now widely recognized as a resource for information processing tasks in communication and computation.

Scientists at the University of Michigan reported observation of quantum entanglement between a single atom and a single photon.

The experiment constituted the first direct observation of entanglement between stationary and so-called "flying" qubits, and the team accomplished this without using the standard cavity-QED technique or a prepared nonclassical light source. The Michigan team's technique provides an entanglement source that could be used for a variety of quantum communication protocols, as well as for seeding large-scale entangled states of trapped ion qubits for scalable quantum computing.

John Chiaverini of NIST in Boulder, Colorado, is confining atomic ions in radio frequency traps, cooled and addressed with laser pulses. He reported that this constitutes a scalable system for bringing about and exploring quantum entanglement and information processing.

He is currently experimenting with superdense coding, quantum teleportation, and entangled state spectroscopy.

At the same Friday afternoon session, Eugene Polzik of the Niels Bohr Institute at Copenhagen University in Denmark described how he and his colleagues have recently demonstrated entanglement of two atomic ensembles at a distance of 0.5 meters. He believes it is possible to extend this distance to tens or even hundreds of meters.

Exposing Molecular Dynamics. The University of Maryland's Ill Hill has found that Coulomb explosion imaging provides a unique window into molecular structure and dynamics because it can capture all fragment ions after they've been dissociated from a highly-stripped molecular ion.

The technique was originally used in experiments with fast ion beams traversing thin foils.

At a Thursday morning session, Hill discussed some of the latest "tricks of the trade" using ultrafast lasers to increase the flexibility of preparing the initial state of the system and provide a way of inducing new dynamics before the explosion.

VISA *from page 1*

in the statement—including delays arising from repetitive security checks, an inefficient visa renewal process, and repetitive processing of visa applications—along with specific recommendations to address those issues.

For example, the proposed Student and Exchange Visitor Information System (SEVIS) could pose a potential new impediment to international students, scholars and scientists entering the US if its fee collection mechanism is not efficient.

The recommendation is that the US arrange for several options for quick, safe and secure payment of fees, including allowing an individual to pay fees after arriving in the US.

For the text of the complete statement, see http://www.aps.org/statements/03_1.cfm.

Slakey's Low-Key Approach Pays Off for APS Lobbying Efforts

APS Associate Director of Public Affairs Francis Slakey swore off Hill receptions and power lunches years ago in favor of more laid-back meetings over coffee with congressional staffers. And he found he was much more effective in representing the interests of APS members on Capitol Hill when he detached himself from the public face of lobbying. Now, in his new position directing the day-to-day activities of the APS Office of Public Affairs (OPA) in Washington, DC, his trademark low-profile approach continues to pay off.

The OPA devotes the equivalent of 2.5 full-time employees to working on budget issues, aimed at increasing federal funding for physics. Slakey focuses on what he terms "politically volatile" issues: climate change, nuclear weapons, and creationism, to name a few of the most recent. He has assisted in drafting federal legislation, written OpEds for Members of Congress, and helped write several APS studies, including the recently released APS Hydrogen Report (*See APS NEWS, May 2004*) and APS Modern Pit Facility Report.

"Slakey is creative, strategic and targeted in his approach to the Hill, which makes him particularly effective," says one senior Congressional staffer for a House representative who has worked with him on key issues.

Being effective on the more controversial issues frequently calls for unusual strategies. Take climate change, a problem with two basic components: reducing CO_2 emissions, and increasing domestic resilience to climate change—such as developing new crop strains that can withstand more severe droughts.

Francis Slakey

Nearly four years ago, Slakey found himself facing a new administration that was strongly opposed to placing any further limits on CO_2 emissions. Rather than beat his head against the wall, or give up on the issue altogether, Slakey took a different tack, choosing to focus instead on improving resilience to the climate changes that were already occurring.

The first step was fostering relations with pivotal Republicans in Congress who might be receptive to a program aimed at resilience. Slakey contacted and was ultimately successful in working with Rep. JC Watts (R-OK), who at the time was Chairman of the House Republican Conference, a top position in the House of Representatives.

Slakey also sought out unusual alliances: in this instance, the insurance companies, who have a vested interest in averting weather-related disasters. He was initially criticized by left-wing environmental groups for this strategy, which some thought undermined efforts to reduce CO_2 emissions, but most have now accepted the new focus on resilience.

Slakey used several examples to promote the issue. In Watts' case he focused on the recent and severe droughts affecting the wheat crop in Oklahoma. Another example was a town in West Virginia that began suffering routinely from floods because of shifting weather patterns. Their solution was to blast the top off a nearby mountain and pick up the entire town and move it across the river. "That's about the most uncreative solution they could have devised," says Slakey. "We needed a federal program that offered more creative problem solving."

It took a year to begin seeing results. First, Rep. Watts wrote an OpEd and gave a speech calling for more federal emphasis on climate change resilience. Then, Watts introduced the Weather Safety Act calling for a multimillion dollar program on resilience research.

It's that willingness to foster ties with both Democrats and Republicans that makes Slakey so effective on the Hill. "He works very well across the aisle to bring people together and find common ground on a given issue," says a senior Senate aide who has worked with Slakey in the past. "There's a saying on the Hill: 'Don't let the perfect get in the way of the good.' He recognizes it's more important to get things done, and he's able to gain people's trust over time."

Slakey also looks for new ways to communicate science and science policy to a broader audience, such as local newspapers and even new forms of media. For example,

See SLAKEY *on page 5*

Small Inequalities Can Influence Women's Careers

By Ernie Tretkoff

At the APS April meeting, speakers in a session on keeping women and girls in science addressed reasons for the persistently low numbers of women in physics and what physics departments can do to become more "female friendly."

With the Project Access study Gerhard Sonnert of Harvard University investigated the careers of women and men who received prestigious postdoctoral fellowships. The study covered women in many stages of their careers, from just after post doc to nearing retirement, trying to find small inequalities that might add up to account for the low numbers of women in physics.

Sonnert's study noticed that these women did not drop out of physics at a higher rate than men did, but they cited different reasons for leaving the field. Women were far more likely to say they left physics for family reasons.

The study found some possible differences in the collaboration patterns of women and men. Sonnert noted that men were more likely to seek out colleagues and self-promote, while women were less inclined to engage in such shmoozing and showing off. Some women also tended to be more perfectionistic, producing fewer papers, but perhaps higher quality.

None of the survey respondents said that women think differently from men, and marriage and parenthood appeared to have no effect on the careers of those who stayed in physics.

Sonnert also compared the GPA of women in physics with that of men, and found that women consistently had a higher GPA, possibly suggesting a difference in the self-confidence of women and men. However, departments with more women faculty had more women students, and those women had less of a GPA advantage over their male counterparts.

Although the Project Access study was carried out in the late 1980's, and there have been some positive changes since then, Sonnert said, progress has been slow.

Barbara Whitten of Colorado College discussed her visits to nine undergraduate physics departments that grew out of her work on the Committee on the Status of Women in Physics site visit program. Her study focused on undergraduate colleges. She compared the five schools in her study that produced a high proportion of women graduates with the four that were more typical of the national average.

Whitten found no one major difference between the successful and typical departments; rather, she said she noticed lots of little differences. The departments that produced more women graduates were more friendly, open, and welcoming to everyone, and did a good job of reaching out to introductory students. Opportunities for student-faculty research helped keep women in physics, as did mentoring. In Whitten's study, the successful departments did not necessarily have more women faculty, or more programs specifically aimed at women.

Some students in Whitten's study said they liked the "family atmosphere" in their departments, especially those students from the two historically black colleges Whitten visited. Historically black colleges have a record of turning out a high proportion of women physics graduates.

Whitten pointed out that physics lags behind other sciences in terms of participation of women. For instance, while less than 25% of physics bachelor's degrees are awarded to women, 40% of mathematics bachelor's degree recipients are women. This implies that "whatever it is that keeps women out of physics, it's not the math," said Whitten.

Patricia Rankin of the University of Colorado, Boulder emphasized the importance of strong leadership in keeping women in science. She reported on a program at her university called LEAP (Leadership Education for Advancement and Promotion), which aims to increase the number of women in leadership positions in science and engineering. Rankin said she believes there are still some small biases against women in science, and even a small bias can have a large effect. These biases can be hard to avoid, she said, but even small changes in a department can help.

Viewpoints...

National Science Board: Getting It Wrong Again?

By Roman Czujko

During the week of May 10th, the National Science Board (NSB) announced two new reports: the 2004 edition of *Science and Engineering Indicators* (a biennial publication) and a companion piece titled *An Emerging and Critical Problem of the Science and Engineering Labor Force*. I highly recommend the *Indicators* to anyone who wants to understand the trends in science and engineering both in the US and abroad.

The following are a few remarks on the three basic issues raised by the NSB in their report. You can read or download a copy of this report at: http://www.nsf.gov/sbe/srs/nsb0407/start.htm.

First, the NSB states that they "have observed a troubling decline in the number of US citizens who are training to become scientists and engineers." I have examined the data carefully and I see a very different pattern than the one they describe. Each of the S&E fields has been declining and increasing at different points and at different rates. In fact, the total number of bachelor's awarded in the natural sciences and engineering combined (life sciences, computer science, engineering, mathematics, and the physical sciences) has increased by about 18% over the last decade, an even larger increase than during the decade of the 1980's. Similarly, even if we exclude the biological sciences because of their startling growth rate during the 1990's (54%), we still see that 10,000 more students (7%) earned bachelors in the physical sciences, engineering, and computer science combined in 2001 than in 1991. Where is the declining number?

Second, the NSB reports that "the number of jobs in the US economy that require science and engineering training will grow." The NSB's assumptions are based on projections developed by the Bureau of Labor Statistics (BLS). While projections of future demand are always fragile at best, these are particularly problematic.

The BLS projections were developed before the recent "dot com bust," and their projected increase in total S&E demand was driven largely by their assumptions about the continued high growth rate in the computer science and IT workforce.

In addition, the NSB appears to have ignored problems in the current S&E job market. The data for the first quarter of 2004 recently released by the BLS indicate that unemployment for electrical engineers is 5.3%, for computer scientists and systems analysts is 6.7%, and for computer programmers is at 9.0%. These data are troubling for the physics community since most physics bachelors who enter the labor force after graduation usually find employment in engineering and the IT workforce.

Third, the NSB is concerned that "the availability of people from other countries who have science and engineering training will decline." They cite visa problems for students and S&E workers as well as global competition for people with these skills. Regarding the latter, the NSB notes that many developed countries have increased investment in S&E education and research jobs at a much faster rate than the US, and the US now lags behind both Europe and Asia in the total number of S&E doctorates awarded.

I generally agree with this part of the report and believe that, in the near future, the S&E enterprise in the US may well face increased international competition at the advanced degree level.

Encouraging US citizens to pursue engineering and science careers is a noble goal. I believe that scientists and engineers make an essential contribution to economic development, health, and national security. However, the NSB based their arguments on flawed analyses and they ignored the current economic realities, *e.g.* virtually every state is experiencing severe budget problems. I fear that this report comes very close to emulating the unfounded cries of shortage that emanated from the NSF about 16 years ago.

I remember when the scientists and engineers graduated during the bleak economic times of the early 1990's. Many of them turned their anger against the members of the community who, just a few years earlier, had led them to believe there was an impending shortage.

More importantly, their disappointment and distrust turned many potential students away from graduate study in engineering and the physical sciences.

I think we can do better than to unrealistically raise expectations of the next generation of scientists and engineers. If the NSB truly believe in the value of science and engineering, then let them lead the push for a broad R&D investment strategy in academe, government, and the private sector to ensure both that we will have more graduates and that those graduates will have an increased likelihood of finding employment.

Roman Czujko is the Director of the Statistical Research Center of the American Institute of Physics.

JOURNAL COSTS *from page 1*

times of great pressure on libraries we would like to share the savings," said McIlrath

Journals are priced according to a five-tier system, in which larger, more research-intensive institutions pay more than smaller, less research-intensive schools.

This pricing structure, which has been in place for several years, eases the burden on small, primarily undergraduate colleges, which use the journals less and are less able to carry the costs. Smaller schools may also join together with larger institutions to form a consortium.

These individually negotiated deals also help reduce the burden on small schools that might not otherwise be able to afford access to the journals.

The smallest institutions will get most of the benefit of the falling costs for 2005. These tier 1 schools, which account for 35% of all subscriptions, will see prices decrease 3%, while tiers 2 and 3, (54% of all subscriptions) will get a 1% decrease, and the largest institutions, tiers 4 and 5, will receive a smaller decrease of .5%. "Everyone gets at least something," said McIlrath.

These price decreases will apply to print-plus-on-line and on-line-only package subscriptions. Prices of individual journals have changed to account for differences in growth. For instance, the price of *Physical Review E*, which covers statistical, nonlinear, and soft-matter physics and interdisciplinary research, has increased for 2005, reflecting the especially rapid growth of these fields.

More information, including a full list of prices, is available at http://librarians.aps.org/institutional.html

SLAKEY *from page 4*

the hydrogen report wound up with a link on AOL's daily news page. It was seen by more than 30 million AOL subscribers—a larger audience than that for "American Idol."

As adjunct professor of physics and biology at Georgetown University, Slakey is also helping train the next generation of politically savvy scientists with a unique class on science policy. "The students come in knowing almost nothing about politics," says Slakey. The students break into teams, identify a social problem with a scientific component, develop a political solution to the problem, and then go to Capitol Hill and lobby. He grades them on what they accomplish on the Hill.

Not surprisingly, the approach he advocates in the classroom is a microcosm of the one he so successfully employs on behalf of the APS: focusing on building a grassroots contingent and looking for provocative alliances. The students have roughly four months to develop that solution, but often that's all it takes. This past semester, one team drafted their own bill to replace mercury thermometers with alcohol thermometers in schools across the country. On May 6, Rep Tammy Baldwin (D-WI) introduced the "Safe Schools Mercury Reduction Act" into the House of Representatives (H.R. 4260).

"Slakey knows exactly what he wants and exactly which Member or Senator is most likely to champion his causes," a Capitol Hill staffer said. "And his personal style is easygoing and ego-less—a rarity on Capitol Hill!"

DARK MATTER *from page 3*

and drawbacks. A decision will be made by the end of 2004.

ILSCS will then establish a conceptual design, followed by a detailed engineering design. The new machine will cost significantly more than the LHC—most of that cost was for the magnets, with little need to build a surrounding infrastructure, since the CERN facility already existed. The current estimated cost is about $6 billion, and roughly 10% of that will need to be spent upfront just to determine the feasibility of the project. The more advanced design studies will enable scientists to nail down a more exact price range.

Duggan admitted that ITER, for instance, is experiencing a political site selection problem. The future linear collider will face similar challenges, and hopefully the scientific community can learn from the ITER experience. For one thing, the focus is on making it a truly international effort from the very beginning. In fact, international collaboration is almost a necessity because of the high cost of building the new facility. "These machines are very big and very expensive, and one nation alone cannot bear the cost," said Turner. "The next accelerator will be financed by the world, and the case for it must be extremely well made in order to justify the expenditure."

The first step is convincing other physicists. Unity is essential. And ultimately, chemists, biologists, Congress and the general public will also have to be won over. The particle physics community can only accomplish this by effectively communicating to all of those groups the importance of the scientific questions to be answered by the new collider, Turner said.

Did Gamma Rays Cause Ordovician Mass Extinction?

By Ernie Tretkoff

A gamma ray burst may have caused the Ordovician extinction, suggests Brian Thomas and colleagues at the University of Kansas. This mass extinction, the second largest ever, took place about 440 million years ago and wiped out about two-thirds of all species.

Scientists have blamed the extinction on a sudden ice age that occurred at the end of the Ordovician period. Thomas agrees that the ice age clearly contributed to the extinction, but suggests that a gamma ray burst could account for both the onset of the ice age and other effects such as ozone depletion that may have also been a factor in the mass die-off. Thomas and colleagues first reported their hypothesis in a paper posted on-line last September (astro-ph/0309415). They presented further details at the April Meeting.

Gamma ray bursts, the most powerful explosions known, are believed to come from supernovae, and are observed about once a day. A gamma ray burst within about ten thousand light years of Earth would pose a threat to life, Thomas and colleagues estimate. He believes such an event occurs about once in a billion years.

The intense radiation of a gamma ray burst could have depleted about forty percent of the ozone layer, according to Thomas's recent calculations, presented at the April Meeting. The ozone layer would take about ten years to recover from such a blast, said Thomas.

The loss of such a large fraction of the protective ozone layer would have allowed harmful ultraviolet radiation to reach Earth. Because ultraviolet flux is attenuated through water, marine organisms that dwelt closest to the surface would have received the most UV radiation, and thus would have been killed at higher rates than those that lived deeper, said Thomas. Indeed, geological evidence confirms that species living near the top of the water column were hit hardest in the Ordovician extinction.

In addition to depleting the ozone layer, a gamma ray burst may have initiated the sudden episode of global cooling that began at about the time of the Ordovician extinction. Gamma rays break up nitrogen and oxygen molecules in the atmosphere and convert them to nitrogen dioxide. Nitrogen dioxide, the brown gas that makes up smog, blocks out sunlight, thereby darkening and cooling Earth, and possibly setting off an ice age.

Some fossil evidence suggests that some species, including surface-dwelling plankton, began to die off before the ice age began, lending support to the idea that something other than cooling contributed to the mass extinction, said Thomas.

Thomas and colleagues considered other possible causes for the Ordovician mass extinction, such as an asteroid impact like the one believed to have killed the dinosaurs. But no evidence has been found for such an event at the end of the Ordovician period.

Thomas admits that there is also no "smoking gun evidence" for a gamma ray burst at that time, but he believes a gamma ray burst is a good explanation for the pattern of extinction and the cause of the sudden ice age.

Life's Building Blocks Are Found All Over Galaxy

By Ernie Tretkoff

A class of molecules that make up the building blocks of life is widespread in the galaxy, Emma Bakes of NASA/SETI reported at the April Meeting.

All known life depends on this class of molecules, called nitrogenated aromatics, which are part of DNA, RNA, and other chemicals critical to life, including the oxygen-producing photopigments in plants and the oxygen-storing pigments in animals. "They form the very foundations of all terrestrial life," said Bakes.

Scientists have recently discovered that these molecules are present throughout the galaxy, said Bakes. Observations have turned up nitrogenated aromatics in the interstellar medium, in comets, in protoplanetary disks around stars, in planetary atmospheres, and in objects in the outer solar system.

These molecules are made up of nitrogen attached to a ring of carbon, with alternating single and double bonds. This class of molecule includes purines, pyrimidines, pyrroles, and other chemicals. They are known as aromatics because many of them have distinctive odors.

Nitrogenated aromatics form in a variety of environments, including planetary atmospheres and the surfaces of icy dust grains in the interstellar medium.

Bakes suggests that these molecules could also have formed in the atmosphere of early Earth. Her recent work, mainly with computer simulations, has focused on the atmosphere of Titan, which is thought to resemble that of early Earth. Titan is Saturn's largest moon and the only moon in our solar system with an atmosphere. The dense, smog-like haze around Titan contains nitrogen, methane, and hydrocarbons, but little oxygen. Bakes' simulations indicate the presence of nitrogenated aromatics in Titan's atmosphere, suggesting that these chemicals might also have been produced in the early Earth's atmosphere.

To confirm the composition of Titan's atmosphere, the European Space Agency's Huygens probe, currently on its way to Titan aboard NASA's Cassini spacecraft, will sample Titan's atmosphere in early 2005.

Some scientists are also considering the possibility that a comet delivered the chemicals necessary for life on Earth, but Bakes said that aromatic molecules are fragile and might not survive an impact.

Though scientists acknowledge the importance of nitrogenated aromatics, they have no idea how to get from the molecules to life, said Bakes. "The million dollar question is, 'How do we get from them to us?' "

Bakes said she would bet on life being widespread in the universe because these molecules are found in so many environments. "If they are made everywhere, perhaps life is everywhere," she said. It might also be possible to have life based on an entirely different chemistry, she added.

Sakurai Prize Celebrates 20 Years

Photo Credit: Cronin Photography

This year marked the twentieth anniversary of the Sakurai Prize for Theoretical Particle Physics, established in 1984 as a memorial to and in recognition of the accomplishments of J. J. Sakurai.To commemorate the occasion, Mrs. Noriko Sakurai, the widow of J. J. Sakurai, was present at the April meeting in Denver, and she is shown here with this year's Prize recipients, Ikaros Bigi of Notre Dame and Anthony Sanda of Nagoya University in Japan. Both Bigi and Sanda had known J. J. Sakurai personally.

Students Compete in Physics Olympiad Boot Camp

By Ernie Tretkoff

After an intense nine days filled with physics problems and lab experiments, five team members and one alternate were selected to represent the United States in the 2004 International Physics Olympiad.

The traveling team was chosen from the 24 high school students participating in the annual "physics boot camp," held at the University of Maryland, College Park from May 21 to May 30.

The traveling team members are: Eric Mecklenberg (Gates Mills, OH); Anson Hook (Princeton, NJ); Elena Udovina (Shaker Heights, OH); Jeffrey Middleton (Austin, TX); and Yi Sun (San Jose, CA). Also chosen was alternate Daniel Whalen (Andover, MA).

The two dozen students attending boot camp were selected on the basis of their scores on two competitive exams, as well as recommendations from their teachers.

"These 24 students represent the crème de la crème of high school physics students," said Bernard Khoury, executive officer of the American Association of Physics Teachers, which co-sponsors the US physics team along with the American Institute of Physics.

During boot camp the students' schedule is jam-packed with physics problem-solving sessions, labs and exams. The opportunity to use the university's laboratory resources is especially valuable, said Khoury. Labs had in the past been a weakness of US physics teams, in part because many high school students do not have the chance to become familiar with laboratory equipment and procedures. The boot camp program also includes a visit to NASA, and the students get some free time during the week for socializing and playing games.

These students will travel to Pohang, South Korea to represent the US in the 35th International Physics Olympiad, from July 15-23. The first Olympiad was held in 1967; the United States has been participating since 1986. This year, students from 72 countries plan to attend.

The US students will compete in a difficult series of theoretical problems and laboratory experiments, similar to what they practiced at the boot camp.

Crucial to the team's success will be the hard-working group of coaches, consisting of Academic Director Mary Mogge, Senior Coach Robert H. Shurtz, Coaches Nicholas Park and Paul Stanley, Junior Coach Andrew Lin, Lab Coach Warren Turner, and Lab Assistant Violeta Prieto-Gortcheva.

MEETING BRIEFS

New England Section, March 26-27. The APS New England Section held its annual spring meeting March 26-27 at Phillips Exeter Academy in Exeter, New Hampshire. The meeting was held in conjunction with the corresponding regional section of the American Association of Physics Teachers (AAPT). Among the plenary highlights on Friday was a talk by John Bahcall (Institute for Advanced Study) on the history and future of solar neutrino research, along with lectures on physics history and EUV imaging of the Sun's corona. Friday night's banquet featured an after-dinner lecture by Harvard University's Robert Kirshner on the accelerating universe—a discovery dubbed "Science Breakthrough of the Year" by *Science* in 1998. On Saturday, there were lectures on X-ray imaging of astronomical objects and NASA's Mars Exploration Program.

Texas Section, April 1-3. The APS Texas Section held its annual spring meeting April 1-3 at Tarleton State University in Stephenville, Texas, along with the Texas Section of the AAPT. The program focused heavily on physics education, with talks on inquiry-based teaching methods, photon quantum mechanics for undergraduates, science Olympiads as a competitive teaching tool, and using Java-based material for learning enhancement. Friday evening's banquet speaker was George Kattawar of Texas A&M University, who lectured on sky archaeology. The TSU Planetarium provided free shows for attendees throughout the conference, and participants were also given tours of the university's physics research labs. In addition, the AAPT sponsored 13 hands-on workshops for physics teachers.

Ohio Section, April 16-17. The APS Ohio Section held its annual meeting April 16-17 at Ohio University in Athens, Ohio, focusing on the theme of extragalactic astrophysics and the new era of high-energy astronomy. Fred Adams of the University of Michigan gave a special plenary lecture on "The Five Ages of the Universe." Other lecture topics included X-ray astronomy, the physics of blazars, ultra high-energy cosmic rays, and large scale structures and the early universe.

Northwest Section, May 21-22. The APS Northwest Section held its annual meeting May 21-22 jointly at the University of Idaho in Moscow, Idaho and at Washington State University in Pullman, Washington. In addition, there were numerous contributed sessions in such subfields as astrophysics and gravity, atomic and molecule physics, condensed matter, nuclear physics, physics education, and industrial physics. Among the topics covered in the plenary lectures were using neutron stars as laboratories for relativity; quantum turbulence; studies of molecular orientation in spider silk; and exploring interaction symmetries with laser traps. Friday evening's banquet featured a lecture by Ruprecht Machleidt of the University of Idaho on grand unified theory. It was followed by the opportunity to visit WSU's Jewett Astronomical Observatory, which boasts an historic refracting telescope.

2004 APS General Election Preview — Members to Elect New Officers, Councillors from 2004 Slate of Candidates

Once again, the APS Nominating Committee has put together an outstanding slate of candidates. The election runs from June 15 to September 1, and members are encouraged to vote on the web but paper ballots will be provided on request. Those who are elected will begin their terms in January 2005. Each candidate's biographical information is provided below. Expanded information, including candidates' statements, can be found at: http://www.aps.org/exec/election2004/

FOR VICE-PRESIDENT

JOHN HOPFIELD
Princeton University

Hopfield received his PhD from Cornell in 1958. He joined the theoretical group at Bell Laboratories for two years, and maintained a strong and fruitful connection there for 35 years as a consultant and as a part-time member of the research staff. He began his teaching career in the physics department at Berkeley in 1961, and in 1964 returned east to Princeton as a professor of physics. He did research on the interaction of light with solids, and the interpretation of absorption and emission spectra, receiving (with D. G. Thomas) the Buckley Prize from the APS in 1969. His research interests having turned toward the interface between physics and biology, he resigned his Higgins Professorship in 1980 to go to Caltech as the Dickinson Professor of Chemistry and Biology in order to help build the multidisciplinary interface. In 1996, he returned to Princeton, where he is the Howard A. Prior Professor of Molecular Biology. His research focused on how a nervous system carries out its 'computations', and his work helped create the engineering field of 'neural networks'. He received the APS Biophysics Prize in 1985. Present research continues the thrust of a physics-based understanding of neurobiology.

FOR VICE-PRESIDENT

CHARLES V. SHANK
Lawrence Berkeley National Laboratory

Shank has been Professor of Physics at the University of California, Berkeley, and Director of the Lawrence Berkeley National Laboratory in Berkeley, California, since September of 1989. He received the Ph.D. degree in 1969 all from UC-Berkeley and joined the staff at AT&T Bell Laboratories. During his 20-year career at Bell Laboratories, he held various leadership positions, including Director of the Electronics Research Laboratory, before returning to Berkeley. At Bell Labs, he made pioneering contributions to the study of ultrafast events that occur in a millionth of a billionth of a second using short laser pulses. He contributed to fiber optic communications with the co-invention of the distributed feedback laser, a component in high data rate transmission systems. Currently, his research focuses on investigating ultrafast processes using time-resolved x-ray techniques. Shank has received the George E. Pake Prize and Arthur L. Schawlow Prize from the APS. He chaired the National Research Council's Committee on Optical Science and Engineering, which published its report, "Harnessing Light," in 1998.

FOR CHAIR-ELECT, NOMINATING COMMITTEE

VENKATESH "VENKY" NARAYANAMURTI
Harvard University

Narayanamurti is currently the John A. and Elizabeth S. Armstrong Professor of Engineering and Applied Sciences and Professor of Physics at Harvard University. He also currently serves as the Dean of Engineering and Applied Sciences and Dean of Physical Sciences. Narayanamurti obtained his PhD in physics from Cornell University in 1965. He spent a major part of his scientific career at Bell Laboratories, Murray Hill, NJ where he did work in low temperature physics, ballistic phonon transport, non-equilibrium superconductivity, 2D electron systems and amorphous materials. His current research is focused on the study of ballistic electron transport and imaging of semiconductor nanostructures using scanning tunneling microscopy-based techniques. Narayanamurti has held a variety of management positions. He served as Director of Solid State Electronics Research at Bell Labs from 1981 to 1987 and as Vice President of Research and Exploratory Technology at Sandia National Laboratories from 1987 to 1992. He moved to the University of California at Santa Barbara in 1992 where he served as Richard A. Auhll Professor and Dean of Engineering until 1998.

FOR CHAIR-ELECT, NOMINATING COMMITTEE

THOMAS F. ROSENBAUM
University of Chicago

Rosenbaum is the James Franck Professor of Physics and the Vice President for Research and for Argonne National Laboratory at the University of Chicago. His research interests center on the quantum mechanical nature of materials at low temperature, where the mix of statics and dynamics leads to a new class of phase transitions and to states with unusual excitation spectra. In his administrative role, he oversees $800 million of research activities as well as the University's technology transfer efforts. Rosenbaum conducted research at Bell Laboratories (Murray Hill, NJ) and at IBM Watson Research Center (Yorktown Heights, NY) before he joined the Chicago faculty in 1983. He directed the NSF Materials Research Laboratory from 1991 to 1994 and the James Franck Institute, an interdisciplinary research institute focused on problems at the intersection of physical chemistry and condensed matter physics, from 1995 to 2001. Rosenbaum received his bachelor's degree in physics with honors from Harvard University (1977) and both an MA (1979) and PhD (1982) in physics from Princeton University.

FOR GENERAL COUNCILLOR

ANN OREL
University of California, Davis

Orel works in the area of theoretical atomic and molecular physics. She received her BS from California Institute of Technology in Chemistry in 1977. She then attended University of California, Berkeley, receiving her PhD in Chemistry in 1981. She worked in the Laser Program at Lawrence Livermore National Laboratory as a staff scientist from 1981 to 1985. She was then employed at the Aerospace Corporation in El Segundo, CA as a member of the Technical Staff until 1988. In 1988 she accepted a position as an assistant professor in the Department of Applied Science. She currently serves as the chair of the department and is the Edward Teller Professor of Applied Science at UC Davis. Her research interests are in the area of theoretical molecular physics, particularly the study of low-energy collisions between electrons and molecules and molecular ions. She is particularly interested in systems where there is a strong interplay between the electronic and nuclear degrees of freedom, for example dissociative recombination and attachment.

FOR GENERAL COUNCILLOR

RICHART SLUSHER
Lucent Technologies, Bell Laboratory

Slusher is director of the Quantum Information and Optics Department at Lucent Technologies, Bell Laboratories in Murray Hill, New Jersey. Slusher received his Ph.D degree in physics from the University of California at Berkeley in 1965. His present research interests include nonlinear photonic crystals, nonlinear optical waveguides and fibers, quantum optics and quantum c omputation. He has contributed to a broad range of optical physics research including light scattering in semiconductors, Raman scattering from phonons in solid and liquid helium, self-induced transparency, photon echoes, laser annealing, and new nonlinear materials. In the early 1990s he and his collaborators demonstrated microdisk lasers in semiconductors as well as nonlinear optics and lasing in organic materials. He has pioneered experiments in nonlinear photonic crystals including the observation of optical solitons in fiber Bragg gratings. He received the 1995 Arthur Schawlow Prize in laser spectroscopy from the APS.

PAUL STEINHARDT
Princeton University

Steinhardt is a professor in the Department of Physics at Princeton University and also on the fac ulty of the Department of Astrophysical Sciences. He received his BS in physics at Caltech in 1974; and PhD in physics in 1978 at Harvard University. From 1981-98, Steinhardt was a member of the Physics Department at the University of Pennsylvania, and a long-term consultant at the Thomas J. Watson IBM Research Lab. Steinhardt is a theoretical physicist whose research spans particle physics, astrophysics, cosmology, general relativity and condensed matter physics. He played a central role in the development of the inflationary model of the universe, producing some of the first viable models and showing how inflation can generate the density fluctuations that seed the formation of galaxies and large-scale structure. He has explored models for dark matter and dark energy. Recently, he has co-authored the "cyclic model" of the early universe, a radical alternative to the big bang picture in which cosmic evolution can be described in terms of the periodic collision of branes. In condensed matter physics, he co-invented the concept of quasicrystals and studied the elastic and electronic properties of quasicrystals and glassy solids.

HERMAN WHITE
Fermilab

White has been a particle physics researcher at Fermilab for the past 30 years. He completed undergraduate studies at Earlham College, graduate studies in Nuclear and Accelerator Physics at Michigan State, and Elementary Particle Physics at Florida State University and Yale. He was a Resident Research Associate in Nuclear Physics at Argonne National Laboratory for a period in 1971, an Alfred P. Sloan travel fellow at CERN in 1972, and University Fellow at Yale from 1976-78. His research has covered a range of topics in Particle and Nuclear Physics, as well as work with Accelerators and Particle Beams. In addition to his Scientist position on the Fermilab staff, for the past 10 years he has also served as an Illinois Research Corridor Fellow and Adjunct Professor of Physics at North Central College in Naperville, IL. As an elected member of the Fermilab Users Executive committee in 1999, he has led and maintained involvement with many communication efforts to bring information, concerns, and focus about Physics and physical science research to many members of the US Congress and governmental agencies in Washington and elsewhere. He has also been engaged in Physics and science education for a number of years. He is a member of the APS Forum on Education, past member of the APS Committee on Minorities, and a member of DPF and the DPF Governmental liaison committee.

The Back Page

Illicit Trafficking of Weapons-Usable Nuclear Material

By Lyudmila Zaitseva and Friedrich Steinhausler

The issue of covert trade in nuclear material gained public prominence when it was erroneously claimed by British intelligence sources that the former Government of Iraq under Saddam Hussein had tried to obtain uranium from Niger. The far reaching consequences of such assessments for society were clearly demonstrated by US President George W. Bush in his speech on January 28, 2003, using this incorrect information as one of the reasons why terrorists and countries belonging to the "Axis of Evil" posed a potential nuclear threat.

In view of the occurrence of such significant errors even in the intelligence community, it is not surprising that information in the media on the topic of illicit trafficking of nuclear material is frequently flawed by errors.

Examples of such errors include failure to differentiate nuclear weapons-usable material from other radioactive material, incorrect use of physical units of activity and dose rate, and misquotation of isotopic characteristics and enrichment levels.

Since the terror attacks on September 11, 2001, many publications envisaged doomsday terrorism scenarios, including the deployment of a nuclear device as a potential threat to society. Although this possibility can no longer be excluded, the probability for it to actually happen is relatively low.

Nevertheless, the issue of losing control over weapons-usable nuclear material has gained prominence in the debate on national security in several countries. Positions in this debate are frequently based on questionable intelligence rather than facts.

This undesirable situation is largely due to the fact that information on illicit trafficking of nuclear material is often associated with a high level of secrecy. In addition, there is a noticeable lack of sharing of relevant information among all parties involved due to the security-sensitive nature of the data and the justified concern by the security community not to reveal any weakness in the physical protection system for nuclear material.

The Facts

The probability for losing control over nuclear material depends on the amount of material to be secured, the number of storage sites, and the level of physical protection provided by the facility operators. Large quantities of nuclear weapon-usable material are stored at each of several hundred facilities worldwide. About 1,665 tons of highly enriched uranium (HEU) and 147 tons of plutonium are stored for military uses worldwide.

Comparable amounts are stored at facilities under civilian control. Physical protection practices at these facilities vary significantly.

The Database on Nuclear Smuggling, Theft and Orphan Radiation Sources (DSTO), which combines state-confirmed information with unconfirmed open source data, contains 25 highly credible trafficking incidents involving weapons-usable nuclear material, i.e., highly-enriched uranium (uranium enriched to 20% U-235 and more) and plutonium-239.

Seventeen of these incidents were confirmed by member states to the International Atomic Energy Agency (IAEA) (*See table 1*). Eight other highly credible cases were not officially reported to the IAEA Database Program for reasons unknown to the authors, although they have been publicly confirmed by state officials.

A total of 39 kg of HEU and plutonium were intercepted during illicit transit, sale, and diversion attempts since 1992. In addition, a cache of 90% HEU reportedly disappeared from a research facility in Abkhazia, a break-away province of Georgia, during the military hostilities between 1992 and 1997. The whereabouts of the material are still unknown. In most of the 25 incidents, the material was stolen or is suspected to have originated from nuclear facilities in Russia.

The first theft of weapons-usable material was noted in Russia in 1992, soon after the collapse of the former Soviet Union, accompanied by an economic downturn and impoverishment of the nuclear sector. An engineer involved in the material weighing and accounting procedures at Luch Scientific Production Association diverted almost daily gram amounts of 90% uranium, which were below the detection limits.

Over a four month period of the nuclear facility. He had accumulated 1.5 kg of the material. He was arrested by pure chance at a train station in Podolsk on his way to Moscow, where he intended to find a buyer for the HEU. The thief admitted that he had hoped to sell the material for about US$500, so he could buy a new stove and a refrigerator.

Once an elite of the Soviet society, nuclear scientists were suddenly faced with dramatically decreased funding, low wages delayed for months, and bleak prospects for the future. As a result, the security of nuclear material became very vulnerable to the so-called "insider" threat from facility employees, who wanted to improve their financial situation by stealing the material and trying to sell it. In all credible thefts of weapons-usable material known to date, the material was diverted by insiders with access to fissile nuclear material acting both on their own initiative and upon requests by other individuals.

In five out of the six thefts, the material was stolen with the purpose of selling it for profit, although, like in the Podolsk case, the perpetrators had only vague ideas as to where to find a buyer.

Involvement of organized crime groups could be a key factor in a successful transfer of diverted weapons-usable material to the end-user in view of their logistical capabilities in the smuggling of weapons, drugs, and people. Therefore, it is very encouraging that no apparent links to organized crime have been identified in any of the 25 smuggling cases. Also, no hard evidence has been found to link any of these cases to specific end-users, such as rogue nations or terrorist organizations, which remain the least known link in the nuclear smuggling chain.

Inherent Uncertainties

In order to judge the validity of the current threat assessment, it is essential to also address the inherent uncertainties in the data used for the analysis, such as:

• *Corruption to defeat the physical protection system:* The black market value of weapons-usable nuclear material ranges from a few hundred to several thousand US dollars per gram, which is the equivalent of at least several months' wages for nuclear scientists and security guards in the former Soviet Union or in developing countries. Since corruption is officially acknowledged as a serious problem in many of these countries, it is safe to assume that corruption among personnel guarding and working at nuclear facilities cannot be excluded.

This undesirable situation is largely due to the fact that information on illicit trafficking of nuclear material is often associated with a high level of secrecy.

• *Flaws in the material accounting system:* Accounting practices for nuclear material face two major limitations: *(a) The mass of radioactive material is derived indirectly from counting events of radioactive decay with its inherent statistical uncertainties.* This is generally acknowledged in the fuel production by defining a certain percentage of the nuclear material involved in the process as "material unaccounted for" (MUF)—a potential loophole for covert diversion of material which has already been successfully used in Russia; *(b) containers holding nuclear material are equipped with seals of various degree of sophistication.* Irrespective of the type of seal, these seals can be successfully faked, *i.e.*, material can be diverted without any apparent tampering with the seal. Provided that material accounting practices rely predominantly on checking the integrity of such a seal rather than the actual content of the container, diversion of nuclear material may remain undetected for extended periods of time.

• *Inadequate equipment for detecting trafficking:* The characteristic radiation emitted by nuclear material is of a type that most border guards and customs officers cannot detect. Provided that they are equipped with a detection device at all, it is usually a simple gamma radiation detector.

The situation is more dire still in case of traffickers familiar with the technical specifications of suitable radiation shielding, since their knowledge enables them to successfully bypass even the checkpoints equipped with alpha- and neutron radiation detectors.

• *Limited prevention of illegal border crossings:* Despite major technological and logistical efforts, no country has been able to stop the illegal flow of drugs, immigrants, weapons, or stolen art across its borders.

Since the physical amount of nuclear material subject to smuggling is comparatively small, it can be safely assumed that illicit trafficking of the amount of nuclear material needed for a crude nuclear device—about 50 kg of 90% HEU—can be achieved by transporting it across borders on foot or boat using the services of illegal immigrants.

• *Deliberate underreporting of diverted material:* Any report about diversion or interdiction of nuclear material highlights the fact that local and national authorities had lost control over the material due to inadequate material accounting and/or physical protection.

This fact in itself may be sufficient reason for some countries not to report each and every such incident. This suggests that there might have been other such incidents, which were not reported by states and therefore went unnoticed by the general public.

Table 1. Government-confirmed cases involving weapons-usable material.

Date of Seizure	Location of Seizure	Type & Amount of Material
24 May 1993	Vilnius, Lithuania	100 g of 50% HEU
10 May 1994	Tengen, Germany	6.2 g of Pu-239 (99.75%)
June 1994	St. Petersburg, Russia	2.972 kg of 90% HEU
13 Jun 1994	Landshut, Germany	795 mg of 87.7% HEU
25 Jul 1994	Munich, Germany	240 mg of Pu-239
10 Aug 1994	Munich airport, Germany	363 g of Pu-239
14 Dec 1994	Prague, Czech Rep	2.73 kg of 87.7% HEU
6 Jun 1995	Prague, Czech Rep.	415 mg of 87.7% HEU
7 Jun 1995	Moscow, Russia	1.7 kg of 21% HEU
8 Jun 1995	Ceske Budejovice, Czech Rep.	17 g of 87.7% HEU
28 May 1999	Rousse, Bulgaria	4 g of 72.65% HEU
2 Oct 1999	Kara-Balta, Kyrghyzstan	1.49 g of Pu
19 Apr 2000	Batumi, Georgia	920 g of 30 (±3)% HEU
16 Sep 2000	Tbilisi airport, Georgia	Pu (0.4 g)
2 Jan 2001	Liepaja sea port, Latvia	6 g of Pu in Pu/Be sources
28 Jan 2001	Tessaloniki, Greece	3 g of Pu-239 in anti-static devices
22 Jul 2001	Paris, France	2.5 g of 72.57% HEU

Conclusions

Until now, only 25 highly-credible cases of illicit trafficking in weapons-usable nuclear material have become known since recording of such incidents was started in 1991. By comparison, there have been over 800 cases involving illicit trafficking in other nuclear and radioactive material, such as low-enriched uranium, yellowcake, and medical and industrial radiation sources, during the same period of time.

The inherent uncertainties in our current knowledge on nuclear smuggling make it difficult to judge whether trafficking in weapons-usable nuclear material is really such a relatively rare phenomenon, or whether it was and still is carried out in such a clandestine, professional (in criminal terms) manner that it remains largely undetected.

In either case, it is essential to improve our current understanding of the true magnitude of illicit trafficking in nuclear material, since national security and international stability heavily depend on the correct threat assessment.

[A slightly longer version of the above article appeared in the January 2004 issue of *Physics and Society*, the APS Forum on Physics and Society's newsletter.]

Lyudmila Zaitseva established jointly with Friedrich Steinhauslern the Database on Nuclear Smuggling, Theft and Orphan Radiation Sources (DSTO) as a Visiting Fellow at the Center for International Security and Cooperation (CISAC), Stanford University. Friedrich Steinhausler, chair of biophysics and physics at the University of Salzburg, Austria, is Director of the Government Radiological Measurements Laboratory, Salzburg.