APS NEWS

March 2002
Volume 11, No. 3

A Publication of The American Physical Society http://www.aps.org/apsnews

INSIDE
Prizes and Awards Insert

Physicists Descend on the "Indy City" for 2002 APS March Meeting

Approximately 5,000 physicists will descend on Indianapolis this month for the annual APS March Meeting, the largest conference sponsored by the Society. The APS last visited the city for its April meeting in 1996, and since then Indianapolis has undergone a significant revitalization campaign that has resulted in a vibrant downtown, including an expanded convention center, several new, first-class hotels, as well as many new restaurants in all price ranges.

Concentrating as usual on condensed matter and materials physics, this year's array of technical sessions will include such topics as superconductors, proteins, conjugated polymers, nanoclusters, semiconductors, multiferroics and magnetoresistive oxides, among others. There will also be five sessions and more than 70 papers devoted to the latest research results on magnesium diboride, a newly discovered superconductor treated at length at last year's March meeting in a mammoth all night session dubbed "Woodstock II." [See *APS NEWS*, May 2001] There will also be numerous sessions on topics in applied physics, such as complex "small world" networks, the future of information technology, science policy, international cooperation, climate change mitigation, and science education. A sampling of session highlights is below. The complete program epitome and abstracts can be found online at http:\\www.aps.org, under meetings.

"Smart Paint" and Cellular Sensors

Revolutionary advances in microfabrication and bioengineering are beginning to undercut some long- standing scientific assumptions about constructing and program-

See MARCH MEETING on page 3

Don't Lose Your Marbles

Photo courtesy of Ed Lee/APS

Here Charles De Leone, Ray Conser, and Melissa Hamilton are engineering an aluminum foil boat to hold as many marbles as possible. They performed this activity as part of the APS-sponsored Lead-Scientist Institute, held in Washington, DC from January 5 through January 9 of this year. This institute brought together 47 scientists and teachers to learn the basics of systemic science education reform in grades K-8. It was the final event in the eight-year run of the Teacher Scientist Alliance project, funded by the Campaign for Physics and directed by Ted Schultz. See APS News, *November 2001; http://www.aps.org/apsnews/1101/110112.html*

Australian David Harris is New Media Relations Head

Photo courtesy of Alan Chodos/APS

As part of its continued effort to communicate physics research to the general public, the APS has appointed David Harris to be the new Head of Media Relations.

The media relations position was first created on the recommendation of the APS Task Force on Informing the Public in 1999. Randy Atkins, now at the National Academy of Engineering, held the position from 1999 to 2001.

Harris began his career as a physicist before "crossing over to the dark side" of journalism and media relations. He earned his BSc with first class honors and the University Medal (*summa cum laude*) in theoretical physics from the Australian National University in 1994. After completing a graduate diploma in scientific communication (ANU), he went on to graduate studies in theory of Bose-Einstein condensation and quantum information theory at the University of Queensland.

Since 1997, Harris has presented a weekly science radio program for the Australian Broadcasting Corporation including a popular question and answer component in which listeners would attempt to stump

See MEDIA RELATIONS on page 7

Lower Funding Shocks Education Advocates

by Richard M. Todaro

The decision by House and Senate conferees last December to fund a newly-established program to improve the quality of math and science education in elementary and secondary schools at just 5% of the amount spent last year by Congress for such improvements has been greeted with surprised disappointment from math and science education advocates. But the head of one of the advocacy groups said he plans to work with a coalition of business, professional, and education groups for full funding of the new program in the years to come.

On December 18, 2001, House and Senate members of the appropriations committee overseeing fiscal year 2002 funding for the Departments of Labor, Health and Human Services, and Education appropriated $12.5 million for the Math and Science Partnerships program. Like its more generalized predecessor, the Eisenhower Professional Development program, the new Math and Science Partnerships program is the main vehicle by which the federal Department of Education provides money – either directly to nationwide pilot programs or through grants to individual state programs – to improve the quality of math and science education. Such improvements are made chiefly through teacher training programs that are designed to improve the knowledge and skills of teachers in math and science.

Advocates of such improvements were surprised and disappointed by the amount the conferees approved because it was just 5% of the $250 million spent by Congress in fiscal year 2001 for such improvements. They expressed concern that recent progress in math and science education may be jeopardized. "I'm very worried that the $12.5 million in this year's appropriations will put an end to the strides we have made in the past decade in the area of teacher improvement," said Fred Stein, APS director of education and outreach.

In addition, advocates were disappointed because the amount appropriated accounted for less than 3% of the $450 million authorized for math and science education improvements under the provisions of the Elementary and Secondary Education Act (ESEA).

"It was certainly not what we wanted or hoped we might get," said Jack Hehn, director of education for the American Institute of Physics.

J. Patrick White is the executive director of the Triangle Coalition for Science and Technology Education (TCSTE), a Washington DC-based non-profit organization that supports math, science, and technology education at the kindergarten through 12th grade levels. "I was disappointed that it wasn't funded at a higher level, but I was glad to see that there was strong support for professional development," he said, referring to the $2.85 billion authorized by the conferees for a component of ESEA called the Teacher Quality Grant program. This program is designed to improve teacher quality in many different areas, including potentially in math and science education, through an assort-

See EDUCATION, on page 3

HEPAP Presents Final Long Range Planning Report to DOE, NSF

by Richard M. Todaro

The advisory panel on high energy physics presented its long range planning report to the federal government on January 28th at a conference in Washington, DC The report urged that the US should host the next-generation electron-positron linear collider that many in the particle physics community view as the linchpin to the next 20 years of high energy physics research. The two leading particle physics groups within the APS echoed this sentiment in a statement released on the day of the conference.

The High Energy Physics Advisory Panel (HEPAP) presented to the US Department of Energy (DOE) and the National Science Foundation (NSF) the plans for a variety of large and small scale projects in the area of high energy physics research envisioned over the next 20 years. Written by the HEPAP Subpanel on Long Range Planning for US High Energy Physics, the report is designed to serve as a roadmap that prioritizes what the panel feels are the most important projects for the international high energy physics community.

Fred Gilman, chair of HEPAP and a physicist at Carnegie Mellon, said that high energy physics research is at the brink of an "extraordinary" period of discovery that will answer some of the most fundamental and profound questions about the

See LONG-RANGE on page 7

Highlights

Members in the Media

"The earth is not a great clock. It's a good clock, but atomic standards are much better."
— Len Cutler, Agilent Technologies, New York Times, January 17, 2002

✶✶✶

". . . literally bolted to the side of the telescope, so when the telescope moves, the laser goes with you. You create your own reference star."
—Deanna Pennington, Lawrence Livermore National Laboratory, on how adaptive optics can improve imaging, Los Angeles Times, January 28, 2002

✶✶✶

"The Cardassians are aliens in Star Trek whose ambition is to take over the world as quickly as possible, *i.e.*, accelerated expansion. The new Cardassian term to us looks alien and generates accelerated expansion."
—Katherine Freese, University of Michigan, explaining how the universe is expanding, Dallas Morning News, January 28, 2002

✶✶✶

"We might even be able to see Hawking radiation with the naked eye"
—Fulvio Melia, University of Arizona, on constructing a desktop model of a black hole, Nature Science Update, January 24, 2002

✶✶✶

"These are phenomenal temperatures, yet they are being achieved only one metre from the wall of the device."
—Edward Doyle, UCLA, on reducing turbulence in super-heated plasmas inside a tokomak, The Irish Times, January 24, 2002

✶✶✶

"Africa has an enormous reservoir of brains, and physics always needs bright, excited people. With the right encouragement anyone can participate in physical science, and you need one bright generation to change the state of science on the continent."
—David Gross, UC Santa Barbara, Cape Argus News, January 31, 2002

✶✶✶

"They're a three-dimensional phenomenon and the tissue of chicken cells is essentially two-dimensional,"
— Mark L. Spano, Naval Surface Warfare Center, on modeling electrical human heart irregularities, Toronto Star, February 1, 2002

✶✶✶

"I had become head of physics at 35, and the thought of 20 more years was not appealing. I asked the vice-chancellor if I could switch my research to improving teaching and learning in universities and he agreed. It kept me young. I'd always been interested in teaching and research. In the 1960s I belonged to a physics group who were writing quite a lot about teaching. I had certainly reflected on how orthodox methods did not work."
—Lewis Elton, University College London, The Times Education Supplement, January 4, 2002

"People hear 'nuclear' and 'power' and they think 'fission'. That's not what we are doing — we are not splitting uranium."
—James P. Blanchard, University of Wisconsin, on making micro- and nano- nuclear batteries, New York Times, January 10, 2002

✶✶✶

"With all my respect to Evgeny-san, our ceramics is better and we got 8.79% of the weight reduction. Our programme of research has already shown much better efficiency."
—Takashi Nakamura, Tokyo Institute of Technology, on his claims to verify the Podkletnov effect, New Scientist, January 12, 2002

✶✶✶

"Where are all these zillions of states hiding in a black hole ? It is quite literally incomprehensible."
—Emil Mottola, Los Alamos National Laboratory, on why gravastars make more sense than black holes, New Scientist, January 19, 2002

✶✶✶

"The uranium deal is the only thing that stands between anarchy and stability in the Russian nuclear weapon complex."
—Thomas L. Neff, MIT, on the sale of Russian enriched uranium to the US, Los Angeles Times, quoted in The Moscow Times, January 21, 2002

✶✶✶

"It didn't explain everything. But you don't expect that on the first try."
—Mark Shegelski, University of Northern British Columbia, on attempts to understand the motion of stones in the sport of curling, Salt Lake City Tribune, January 24, 2002.

See IN THE MEDIA on page 4

This Month in Physics History

Circa March 1935: Schroedinger's Paradoxical Cat

Austrian born theoretical physicist Erwin Schroedinger made profound contributions to quantum theory with the formulation of the wave equation that bears his name. But ironically, his most famous work is a 1935 thought experiment that has piqued the interest of philosophers and appalled cat lovers ever since: the paradox of Schroedinger's cat.

Schroedinger was born in 1887 in Vienna, Austria, the son of the owner of a small linoleum factory. He was schooled at home until he was 10, at which time he entered the Akademisches Gymnasium, quickly demonstrating superior proficiency in physics and mathematics. A former classmate recalls that the young Schroedinger comprehended material presented during class so well that immediately following the lecture, he was able to go to the blackboard and begin solving problems with playful facility. He graduated in 1906 and entered the University of Vienna, where he studied theoretical physics. He was awarded his doctorate in 1910 with a dissertation on the conduction of electricity on the surface of insulators in moist air.

After a brief stint of voluntary military service, Schroedinger was appointed to an assistantship at Vienna in experimental physics, where he worked on radioactivity, proving the statistical nature of radioactive decay. He later cited his experimental work as an invaluable asset to his theoretical work. His academic career was interrupted briefly by the outbreak of World War I, but he made substantial contributions to color theory and published his first results on quantum theory in 1917.

Schroedinger then became chair of theoretical physics at the University of Zurich, which is where he made his most important contributions. His papers at that time dealt with specific heats of solids, with problems of thermodynamics, and of atomic spectra; in addition, he indulged in physiological studies of colour. His great discovery, Schroedinger's wave equation, was made during the first half of 1926, as a result of his dissatisfaction with the quantum condition in the Bohr's theory of the atom and his belief that atomic spectra should really be determined by some kind of eigenvalue problem. For this work

Photo by Francis Simon, courtesy AIP Emilio Segre Visual Archives, Francis Simon Collection.

he shared with Dirac the Nobel Prize in 1933.

In was early in 1935 that Schroedinger began to develop the concepts underlying his famous feline paradox, with the first of a three-part essay published in the spring. It contained a pivotal thought experiment to illustrate one of the predominant contradictions between quantum theory and our experiences in reality: put a cat inside a box, add a container of poison gas, which is activated by the decay of a radioactive atom, and close the box. Schroedinger used the analogy to demonstrate the limitations of quantum mechanics: quantum particles such as atoms can be in two or more different quantum states at the same time, but surely, he argued, a classical object made of a large number of atoms, such as a cat, should not be in two different states.

The radioactive atom has a 50% probability of decaying within one hour, and if this occurs, the vial of cyanide will be broken and the cat will be killed; if not, then no cyanide is released and the cat will live. The radioactive atom obeys the rules of quantum mechanics, and since its state is indeterminate until measured by an outside observer, opening the box and observing the atom inside instantly determines the status of the cat. The beleaguered feline is neither alive nor dead until the radioactive atom is measured by an observer. So during the period before the lid is open, the cat exists in two superposed states: both dead and alive.

While the thought experiment is impossible to carry out for a number of reasons – including the fact that the quantum properties of a system tend to wash out in an object made of many atoms and molecules, such as a cat – the basic underlying principles were finally experimentally demonstrated just a few years ago. In 1996, four researchers at the National Institute of Standards and Technology (NIST) in Boulder, CO, carried out the "Schroedinger's Cat" test using not a live feline, but a positively charged ion (i.e., a "cation") of beryllium.

The group confined a charged beryllium atom into a tiny electromagnetic cage, then cooled it with a laser to its lowest energy state so that its position and spin could be determined to a very high degree of accuracy. The workers then stimulated the atom with a laser such that it now had a 50% probability of being in a "spin up" state in its initial position, and an equal probability of being in a "spin down" state in a position about 80 nm away. In effect, the atom was in two different places, as well as two different spin states, at the same time — the atomic equivalent of having a cat both living and dead. The clinching evidence was their observation of an interference pattern, a telltale sign that a single beryllium atom produced two distinct wave functions that interfered with each other.

APS NEWS

Series II, Vol. 11, No. 3
March 2002

Coden: ANWSEN ISSN: 1058-8132

©2002 The American Physical Society

Editor .... **Alan Chodos**
Associate Editor .... **Jennifer Ouellette**
Special Publications Manager .... **Elizabeth Buchan-Higgins**
Design and Production .... **Stephanie Jankowski**
Forefronts Editor .... **Neville Connell**
Proofreaders .... **Ken Cole, Edward Lee and Sue Otwell**

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 20749-3844, 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: domestic $105; Canada, Mexico, Central and South America, and Caribbean $105; Air Freight Europe, Asia, Africa and Oceania $120.

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.

APS COUNCIL 2002

President
William F. Brinkman*, *Bell Labs-Lucent Technologies (retired)*

President-Elect
Myriam P. Sarachik*, *City College of New York - CUNY*

Vice-President
Helen Quinn*, *Stanford University (SLAC)*

Executive Officer
Judy R. Franz*, *University of Alabama, Huntsville (on leave)*

Treasurer
Thomas McIlrath*, *University of Maryland (emeritus)*

Editor-in-Chief
Martin Blume*, *Brookhaven National Laboratory (emeritus)*

Past-President
George H. Trilling*, *Lawrence Berkeley National Laboratory*

General Councillors
Jonathan A. Bagger, Philip Bucksbaum*, L. Craig Davis, Stuart Freedman*, Frances Houle, Leon Lederman*, Gerald Mahan, Margaret Murnane*, Cherry Ann Murray, Philip Phillips*, Jin-Joo Song, James Trefil

International Councillor
T. Maurice Rice

Chair, Nominating Committee
Susan Nan Coppersmith

Chair, Panel on Public Affairs
James C. H. Tsang

Division, Forum and Section Councillors
Harold Metcalf (*Atomic, Molecular & Optical*), Robert Eisenberg (*Biological*), Sylvia Ceyer (*Chemical*), E. Dan Dahlberg*, Allen Goldman* (*Condensed Matter Physics*), Steven White (*Computational*), Jerry Gollub* (*Fluid Dynamics*), Peter Zimmerman (*Forum on Education*), Gloria Lubkin (*Forum on History of Physics*), Stuart Wolf (*Forum on Industrial and Applied Physics*), James Vary (*Forum on International Physics*), Ed Gerjuoy (*Forum on Physics and Society*), Timothy P. Lodge, (*Polymer Physics*), W. Carl Lineberger (*Laser Science*), G. Slade Cargill, III (*Materials*), Bunny C. Clark (*Nuclear*), Sally Dawson, Peter Meyers (*Particles & Fields*), Stephen Holmes (*Physics of Beams*), Richard Hazeltine (*Plasma*), Kannan Jagannathan, (*New England*), Joe Hamilton (*Southeast Section*)

ADVISORS

Representatives from Other Societies
Christopher J. Chiaverina, *AAPT*; Marc Brodsky, *AIP*

International Advisors
Michael Thewalt, *Canadian Association of Physicists*, Gerardo C. Puente, *Mexican Physical Society*

Staff Representatives
Alan Chodos, *Associate Executive Officer*; Irving Lerch, *Director of International Affairs*; Fredrick Stein, *Director of Education and Outreach*; Robert L. Park, *Director, Public Information*; Michael Lubell, *Director, Public Affairs*; Stanley Brown, *Editorial Director*; Charles Muller, *Director, Journal Operations*; Robert Kelly, *Director of Journal Information Systems;* Michael Stephens, *Controller and Assistant Treasurer*

Administrator for Governing Committees
Ken Cole

*** Members of the APS Executive Board**

APS Goes Global with Two International Conferences

The APS is continuing its tradition of fostering international exchanges between physicists by helping to put together two upcoming conferences this spring. The first International Conference on Women in Physics (IUPAP) is sponsored by the International Union of Pure and Applied Physics (IUPAP), and will be held March 7-9 at UNESCO's headquarters in Paris, France. It is intended to explore the severe under representation of women in physics in Europe and elsewhere in the world and to develop strategies and actions to increase their participation. And an International Conference on Medical Physics (ICMP) will be held April 8-10 in Havana, Cuba, one of several workshops and symposia organized as part of the Cuban Physical Society's ninth annual symposium.

The IUPAP conference will bring together physicists — mostly, but not exclusively, women — to review data on women in physics, discuss barriers, share success stories, suggest ways to improve participation globally, and help develop appropriate strategies to improve the status of women in physics in their home countries. Teams of at least three people from each of 65 countries will be participating, with a total of about 300 attendees expected. It is hoped that the conference will help establish a robust international support network that will help boost the systemic change needed and reduce the sense of isolation often felt by individual women physicists.

"We expect the conference to increase the awareness of the need for more women in physics, to improve the understanding of the problem through a comparative analysis of the causes, and to identify possible corrective measures that will be effective in different regions of the world," says Judy Franz, APS Executive Officer and Associate Secretary-General of IUPAP. "Existing and future local initiatives will gain strength from the support of a favorable international climate as well as national and international networking."

According to APS Director of International Scientific Affairs Irving Lerch, the ICMP conference is the latest in a series of APS efforts to expand interaction with the physics community in Cuba, despite strict US embargos on travel to the country. [The Society has hosted representatives of the Cuban Physical Society at past meetings,] Contrary to what some may believe, Cuba has a thriving scientific community, with about 200 PhD physicists, many working in university research environments. Medical physics was chosen as the conference topic in orderto work around US embargo policies, and a second similar conference on physics education is planned for 2003.

The ICMP conference's technical program will feature sessions on nuclear medicine as well as therapy. The latter will cover such topics as new developments in radiation oncology, advances in applied radiology, and advances in applied radiobiology. In addition, there will be four sessions on special focus topics, including teaching and education of medical physicists, radiological protection of patients, laser physics and biomedical physics, and future directions of medical physics.

MARCH MEETING, *from page 1*

ming computers. MEMS components are becoming less expensive, such that it may soon be possible to combine logic circuits, microsensors, actuators, and communications devices integrated on the same chip to produce particles that could be mixed with bulk materials, such as paints, gels and concrete. "Imagine coating bridges or buildings with smart paint that can sense and report on traffic and wind loads and monitor structural integrity of the bridge," says MIT's Gerald Sussman, one of the featured speakers in a session on the future of information technology. And thanks to the astounding progress in understanding the biochemical mechanisms in individual cells, it may soon be possible to construct digital logic circuits out of cells that function as sensors and actuators as programmable delivery vehicles for pharmaceuticals and as chemical factories for the assembly of nanoscale structures.

Paul Horn of IBM's TJ Watson Research Center, this year's recipient of the APS George Pake Prize, will kick off the session with a discussion of the role of basic research in the information technology industry. Other speakers will address the topics of silicon based quantum computing, and whether our thoughts may one day control machines through cortical prosthetics that could extract and utilize motor and sensory commands. According to DARPA's Alan Rudolph, these commands have already been shown to drive a peripheral device in the control of a robotic arm.

[Session M2, Wednesday, March 20]

Sweet Smell of Success

Basic physics research has yielded numerous breakthrough technologies that have revolutionized the modern world around the globe and provided substantial economic benefit in the process. Speakers at a Wednesday morning session will describe several examples of such industrial success stories. For example, the Global Positioning System (GPS) has given rise to host of commercial consumer applications that generate billions of dollars each year, and is changing the way we determine where we are, as well as revolutionizing many fields of scientific research. Other speakers will discuss the economic impact of liquid crystal displays, optical fibers for telecommunications, automotive emissions control and physics applied to oil and gas exploration.

[Session L7, Wednesday, March 20]

It's a "Small World" After All

Life is the most complex physical system in the universe, exhibiting an extraordinary diversity of form and function over a broad range of size scales, and yet many of its most fundamental and complex phenomena scale with size in a surprisingly simple fashion. "Regardless of size, almost all life is sustained, and ultimately constrained, by fractal like hierarchical branching networks, optimized by the forces of natural selection," says Geoffrey West of Los Alamos National Laboratory, who will lead off a session on complex real world networks with a description of his quantitative unified theory explaining the origin of universal scaling.

He will be joined by Luis Nunes Amaral of Boston University, who has studied the statistical properties of a variety of real world, so called "small world" networks, including the neural networks of C. Elegans, food webs for seven distinct environments, transportation and technological networks, and numerous social networks.

[Session L5, Wednesday, March 20]

That Darn Carbon

Climate change advocates extol the virtues of developing alternative energy sources to ultimately replace fossil fuels. But Princeton University's Robert Socolaw believes that the global energy system can continue to be dominated by fossil fuels throughout the 21st century without an unacceptable rise in the concentration of atmospheric CO^2. The key lies in capturing and storing a substantial fraction of the CO^2 by-product of burning fossil fuels, such as in geological formations like deep saline aquifiers. Other speakers include John Stringer of EPRI, who will discuss carbon management in the electric power industry, and Exxon Mobil's Brian Flannery, who will approach the subject from the perspective of the oil industry. John Turner of the National Renewable Energy Laboratory will close the session with a counterpoint discussion of renewable energy technologies.

[Session G7, Tuesday, March 19]

Trafficking in Complexity

Anyone who has ever experienced the frustration of being stuck in a traffic jam will be pleased to learn of the existence of researchers like Michael Schreckenberg of Germany's University of Duisberg, who specializes in the physics of transport and traffic. Over the last decade, the investigation of the complex behavior of traffic dynamics has become an active field of interdisciplinary research, due in part to an influx of experimental data from sensor measurements, as well as improved modeling techniques from statistical physics. The detailed knowledge of traffic dynamics is not only of scientific interest, it is necessary for practical applications. With the help of online data from measurements of flows and speeds, it is possible to construct a complete picture of the actual traffic state with real time simulations, according to Schreckenberg, and a reliable traffic forecast should be possible, although the impact of driver reaction on the forecast remains unclear.

[Session U7, Thursday, March 21]

Putting a New Face on Physics

Roman Czujko, director of the American Institute of Physics' Statistical Research Center, will give the latest data on education trends for African Americans and Hispanic Americans with bachelor's and PhD degrees. Czujko will identify the physics departments that produce the most such degrees and describe the characteristics that successful departments have in common. He will be joined by Fernando Ponce of Arizona State University who will address the integration of hispanics in physics.

[Session D4, Monday, March 18]

Communicating with Congress

Now more than ever, in an uncertain economy and domestic terrorist threats, the scientific community needs to make itself heard on such issues as federal funding, climate change, and ballistic missile defense. But many physicists have no idea how to get started. Introducing scientists to the whys and wherefores of the American legislative process is the focus of a special panel discussion featuring Washington insiders who will present the best techniques for communicating with Congress and the Executive Branch. Topics to be discussed include the differences between the science and policy worlds, how decisions are made in the policy world, and the best way scientists can provide input for those decisions, as well as opportunities for the scientific community to participate in Congressional visits.

Special Events

SUNDAY, MARCH 17

Management Problems of the Technical Person in a Leadership Role
(Professional Development Seminar)
8:00 am-1:00 pm
Location: TBA

Workshop on Survival Skills for Successful Women Physicists
1:30 pm – 6:00 pm
Capital Ballroom III (Westin Hotel)

Career Workshop
3:00 pm - 6:00 pm
Room 120

COM/CSWP Reception
6:00 pm-8:00 pm
Congress I and II (Westin Hotel)

MONDAY, MARCH 18

5th Annual Run-for-Health
6:30 am-7:30 am
(runners assemble at 6:15am at Convention Center)

CSWP/FIAP Networking Breakfast
7:00 am-9:00 am
State Room (Westin Hotel)

Awards Program
5:30 pm - 6:30 pm
Convention Center

Welcome Reception
6:15 pm - 7:30 pm
Convention Center
Location: 500 Ballroom

TUESDAY, MARCH 19

Panel Discussion with PR/PRL Editors
2:00 pm-3:00 pm
Location: TBA

MGM Award Winners Panel Discussion/Reception
3:30-4:30 pm (Reception 4:30-5:30 pm)

Cameral Room, Westin Hotel
Meet the Journal Editors of AIP and APS
3:30 pm - 5:30 pm
(Location to be announced)

Alumni Reunions
6:00 pm - 8:00 pm
Location: Westin Hotel

WEDNESDAY, MARCH 20

Students Lunch with the Experts
1:00 pm - 2:30 pm
Ballroom 500

EDUCATION, *from page 1*

ment of professional development programs.

TCSTE is comprised of about 100 component organizations, and brings together businesses, professional societies, and education groups. Among businesses are AT&T, Dow Chemical, DuPont, Ford Motor, Texas Instruments, and Verizon. The organization is part of a much larger group, called the K-12 Science, Mathematics, Engineering, and Technology (SMET) Education Coalition, which has been the major player in the extensive efforts that were carried out this past year to boost funding for math and science education.

> *Improvements are made chiefly through teacher training programs*

"A large number of people in the science and math community, in particular the K-12 SMET Education Coalition, worked very hard for a year to maintain or increase the emphasis on preparing and supporting science and math teachers," Hehn said.

"We are disappointed by the amount of money in the appropriations bill, but we are encouraged by all the discussions through the year about science and math education and by our interactions with the legislators and their staff," he continued, emphasizing the work of Rep. Vernon Ehlers (R-MI) and Rep. Rush Holt (D-NJ), the only two physicists in Congress. Both Ehlers and Holt succeeded in getting Rep. Ralph Regula (R-OH), the chair of the House appropriations subcommittee, to reiterate on the House floor language that urges states receiving money from the Teacher Quality program to utilize these funds for math and science education improvements.

White said a major goal in the upcoming year will be to get Math and Science Partnerships funding over the $100 million mark because that is the level at which the program transforms from a direct federal one to a state-run grant one. "We are strongly supporting increasing that funding [because] in the [conference report] language,

See EDUCATION, on page 7

LETTERS

Good Marketing and Self-Delusion Won't Do

A wide variety of articles discussing the relationship between the physics community and society appear to have similar problems, and the recent article by Bo Hammer which is summarized in *APS News* by this quote: "Our challenges are reduced to a marketing problem." is another example of this trend.

The problem is in dealing with facts and perceptions. The perception I have is that countless thousands of undergraduates take a wide variety of courses taught by physics faculty. Nearly all of them (to two significant figures, 100%) leave the course with a very bad attitude towards the physics community. This perception I have is based upon the facts I've reviewed concerning course evaluations and course enrollment patterns. It is very easy for the community of physics instructors to say that undergraduates aren't prepared, or aren't willing to work, or that better marketing must be done. It is rather more difficult to critically examine your teaching performance and improve it.

I recently talked with a tenured professor with a long history of "successfully" teaching introductory Astronomy courses. This instructor has received many awards for teaching excellence, and has "high" or "good" student evaluations. Out of over a thousand students, not one has gone on to take more advanced courses. And the instructor is convinced (from his personal experience) that very little true insight was given to students, and the lasting impact the course had on students was nil. Even "great" teachers seem to fail routinely.

I believe that many poorly prepared students are forced to take courses that are poorly taught. This has gone on for decades, and as the population of Undergraduates expands, the problem gets worse. More and more people, who eventually vote or run Human Resource Departments or become president of the country, endure this situation, and blame the "system" in general, and the physics community specifically. This learned disgust with the physics community is long lasting. I think the situation requires more than good marketing and self-delusion. The facts need to be understood first.

Russell Youmans
Alexandria, Virginia

Upon Reflection, Spin is not Reversed

I enjoyed reading your article on the fall of parity conservation in the December 2001 issue of *APS NEWS*. However, I must point out that both the Figure inserted at the lower left of the article and its caption contain a rather fundamental error, namely, that the direction of spin is reversed by the parity operation. This is not correct. The nuclear (or electron) spin, as any other angular momentum, is a parity-even, time-odd axial vector. It is not reversed by the parity operation. What actually is reversed is the linear momentum vector of the emitted beta particle.

The parity operation corresponds to changing the sign of all three (cartesian) space coordinates. Representing space inversion graphically by simple reflection in a mirror (or plane) can, according to the physical situation and to where one places the mirror, be misleading. By placing the mirror perpendicular to the beta decay axis, instead of parallel to it (as in the Figure), one would see that the axial spin vector is indeed conserved, whereas the linear momentum vector of the emitted particle is inverted.

Georges H. Wagniere
Zurich, Switzerland

Extremist Left-Wing Views Corrected

The statistical distribution of women, Hispanics, and African Americans in physics seems to be a topic reported on in most issues of *APS News*. Are your readers supposed to assume that this "issue" is either a problem or has some relevance as anything other than trivia?

Is this issue analogous to the dearth of whites in the National Basketball Association and professional boxing? Or is it analogous to the lack of Jews in law enforcement, the ranks of pop, rock, and/or rap musicians, and throughout professional sports? Perhaps it is related to the quotas that used to exist at some American universities which limited the number of Jews (including American citizens) who were permitted to enroll.

Is it related to the fact that not one of the world's top paid fashion models is male? Or the fact that there are more sources of aid from the federal government for female entrepreneurs than for male entrepreneurs? Does it have something to do with the fact that most US high school dropouts are male? Or the fact that in divorce proceedings, fathers are very rarely granted primary custody of the children.

Perhaps you, the staff and management of *APS News*, should re-examine your peculiar, left-wing extremist point of view.

Jonathan K. Mines
Pittsburgh, Pennsylvania

More on Plurals

Arne Reitan (November 2001 issue) says that the plural of kelvin is kelvin, not kelvins. He mistakenly thinks that the international system of units implies an international language with its own grammar. Physics is international, but the words in which it is expressed belong to a language, English, Norwegian, Hindustani, or whatever, and must follow the grammar and usage of that language. Agreed, papers in PR and PRL do not always do so, say some purists. Anyway, in English I write one kelvin or 273 kelvins, but in German I write ein Kelvin or 273 Kelvin. Note incidentally the capitalizing of nouns in German! In English, it is 230 volts, 10 amperes, 55 kilometres, 28 teslas, ...need I go on?

B.S.Chandrasekhar
Groebenzell, Germany

zero gravity
The Lighter Side of Science

The Story of Schroedinger's Cat (An Epic Poem)

Editor's Note: The following paradoxical verse was created by syndicated columnist Cecil Adams ["*The Straight Dope*"®] in response to a query from a reader... also written in verse. Reprinted with permission.

Dear Cecil:

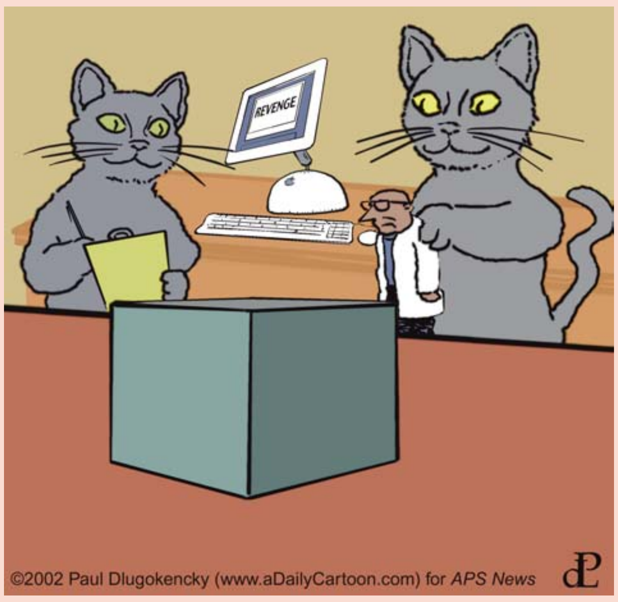
Cecil, you're my final hope
Of finding out the true Straight Dope
For I have been reading of Schroedinger's cat
But none of my cats are at all like that.
This unusual animal (so it is said)
Is simultaneously live and dead!
What I don't understand is just why he
Can't be one or other, unquestionably.
My future now hangs in between eigenstates.
In one I'm enlightened, the other I ain't.
If you understand, Cecil, then show me the way
And rescue my psyche from quantum decay.
But if this queer thing has perplexed even you,
Then I will and won't see you in Schroedinger's zoo.
—*Randy F., Chicago*

Dear Randy:

Schroedinger, Erwin! Professor of physics!
Wrote daring equations! Confounded his critics!
(Not bad, eh? Don't worry. This part of the verse
Starts off pretty good, but it gets a lot worse.)
Win saw that the theory that Newton'd invented
By Einstein's discov'ries had been badly dented.
What now? wailed his colleagues. Said Erwin, "Don't panic,
No grease monkey I, but a quantum mechanic.
Consider electrons. Now, these teeny articles
Are sometimes like waves, and then sometimes like particles.
If that's not confusing, the nuclear dance
Of electrons and suchlike is governed by chance!
No sweat, though—my theory permits us to judge
Where some of 'em is and the rest of 'em was."
Not everyone bought this. It threatened to wreck
The comforting linkage of cause and effect.
E'en Einstein had doubts, and so Schroedinger tried
To tell him what quantum mechanics implied.
Said Win to Al, "Brother, suppose we've a cat,
And inside a tube we have put that cat at—
Along with a solitaire deck and some Fritos,
A bottle of Night Train, a couple mosquitoes
(Or something else rhyming) and, oh, if you got 'em,
One vial prussic acid, one decaying ottom
Or atom—whatever—but when it emits,
A trigger device blasts the vial into bits
Which snuffs our poor kitty. The odds of this crime
Are 50 to 50 per hour each time.
The cylinder's sealed. The hour's passed away. Is
Our pussy still purring—or pushing up daisies?
Now, you'd say the cat either lives or it don't
But quantum mechanics is stubborn and won't.
Statistically speaking, the cat (goes the joke),
Is half a cat breathing and half a cat croaked.
To some this may seem a ridiculous split,
But quantum mechanics must answer, "Tough @#&!
We may not know much, but one thing's fo' sho':
There's things in the cosmos that we cannot know.
Shine light on electrons—you'll cause them to swerve.
The act of observing disturbs the observed—
Which ruins your test. But then if there's no testing
To see if a particle's moving or resting
Why try to conjecture? Pure useless endeavor!
We know probability—certainty, never.'
The effect of this notion? I very much fear
'Twill make doubtful all things that were formerly clear.
Till soon the cat doctors will say in reports,
"We've just flipped a coin and we've learned he's a corpse."'
So saith Herr Erwin. Quoth Albert, "You're nuts.
God doesn't play dice with the universe, putz.
I'll prove it!" he said, and the Lord knows he tried—
In vain—until fin'ly he more or less died.
Win spoke at the funeral: "Listen, dear friends,
Sweet Al was my buddy. I must make amends.
Though he doubted my theory, I'll say of this saint:
Ten-to-one he's in heaven—but five bucks says he ain't."
—*CECIL ADAMS*

"Copyright 1984 Chicago Reader, Inc. Reprinted by permission. 'The Straight Dope by Cecil Adams' is a registered trademark of the Chicago Reader, Inc. – www.straightdope.com"

To Kill a Cat



Schroedinger's famous quantum paradox has inspired not just physicists, but artists, writers, and musicians — there's even an a cappella vocal band in Texas that calls itself "Schroedinger's Cat" — not to mention a plethora of online "experiments" using random number generators, wherein the user can find out for himself whether the "cat" is "alive" "or dead" by clicking on the appropriate icon to "run" the experiment. One of the best is the "Schroedinger's Cat Massacre Page," created by those cheeky Brits at Oxford University. The creators claim that Schroedinger's theory was more than a mere mental exercise to demonstrate the non-intuitive nature of quantum mechanics. It was also a macabre plan to kill a lot of cats, thus supplying the (fictional) family furrier's shop with handy fresh pelts. To play, see http://users.ox.ac.uk/~jsw/Schroedinger.hmtl.

MEDIA, *from page 2*

"They've been thinking about this a long time. And so, the question is when did they start in earnest to learn how to make a nuclear explosive?"
–*David Albright, Institute for Science and International Security, on whether al Qaeda is making nuclear weapons, CNN, January 24, 2002.*

***

"If you compare what the thing looks like and all the numbers, all the numbers match up. To be as careful as possible, it's either a Scud or someone's replica of a Scud."
—David Wright, Union of Concerned Scientists, on what kind of missiles the Army was planning to test in Alaska, Anchorage Daily News, January 24, 2002

***

"The priority is to get everyone dancing and celebrate life through dance."
—Doug Jensen, Fermilab, on the Silk and Thistle Scottish Country Dance group, which used to meet at Fermilab before increased security in the wake of September 11, Chicago Daily Herald, January 24, 2002

***

SPOTLIGHT on the Profession of Physics

How Scientists Can Help With K-12 Education

by Diandra Leslie-Pelecky

Did you know that only 10% of Americans can explain what a molecule is? Fewer than 50% know that the Earth takes a year to circle the Sun, and only 75% realize that the Earth goes around the Sun and not vice-versa. [The entire questionnaire from which these data are taken can be found at http://www.nsf.gov/sbe/srs/seind00, See especially figure 8-4.] The physics community usually treats these statistics as a sad curiosity; however, they represent a significant threat to our future. One need only look to one's elected representatives, college presidents and CEOs to realize that important decisions impacting science often are made by people who don't understand science. Even those with the resources to judge questions on their scientific merit must justify their decisions to an increasingly science-illiterate public. If we don't address the general lack of science knowledge by the public, we are jeopardizing our own future.

One of the most effective approaches for improving public science literacy is to team with K-12 schools, teachers, and the people who educate K-12 teachers. Less than 30% of high-school students take physics and, out of the 1.2 million first-year college students, only about 320,000 (27%) take an introductory physics course. If we wait until students reach college classrooms, we've already lost nearly three quarters of our potential audience. The one experience common to most people is that virtually all of them pass through the 5th grade. Creating science-literate (and science-interested) students also broadens the pool from which to draw physics majors, which in turn creates future scientific and technical employees and graduate students.

The traditional involvement of scientists in the classroom is the demo visit, in which scientists wow students with liquid nitrogen and beds of nails. These activities are great for stimulating kids' interest in science; however, we need students who are not only interested and enthusiastic, but who also have the knowledge and skills necessary for understanding science. Once-a-semester visits from scientists addressing random topics is not enough. We must have more sustained involvement, which means establishing long-term collaborations between scientists, teachers, school districts and Colleges of Education.

My experience collaborating with Gayle Buck (a University of Nebraska Teachers' College faculty member) and Suzanne Kirby (a 4th grade teacher with Lincoln Public Schools) has been a good lesson for me in the benefits and potential pitfalls of scientists' involvement in K-12 education. Our collaboration resulted in our current NSF-funded "Project Fulcrum", which links science, math and engineering graduate students with an elementary or middle school for an entire year. [See http://www.physics.unl.edu.]

I mention this explicitly to emphasize that the only way to bring about long-term change is to involve scientists, teachers and teacher educators as equal partners. Collaborations are not always easy. The disparity of cultures and vocabulary and the stereotypes we hold about each other can get in the way of accomplishing anything. Even the social conventions and styles of communication familiar to one group can be alienating to another group. It is important to find collaborators you trust and whose work you respect.

> *Collaborations are not always easy. The disparity of cultures and vocabulary and the stereotypes we hold about each other can get in the way of accomplishing anything.*

For example, there is an assumption that placing scientists from underrepresented groups in the classroom will change student stereotypes. We analyzed interactions between physics graduate students working on electric circuit and magnetism units with fourth graders. Our volunteer students, most of whom were female, introduced themselves as scientists, showed videos of their research labs, and described their research to the students. The graduate students worked with the fourth graders two hours a week over eight weeks building and analyzing series and parallel circuits, and exploring the properties of magnets. We all were impressed by how much and how quickly the students learned, and especially by how they were able to suggest new experiments based on their observations.

About halfway through the project, Gayle pulled me aside to update me on the results of her student interviews. She said, "You know, the kids don't believe you're scientists." The female graduate students didn't fit the fourth graders' stereotypes of scientists, as expected. What I didn't expect was that, instead of rejecting their existing stereotypes, the students concluded that the graduate students must not be scientists. (Sadly, student stereotypes included not just that scientists wear lab coats, but also that 'real' scientists wouldn't be able to communicate with kids, and wouldn't be interested in whether the students were learning.) The teacher of this class interviewed parents of the students and found that one parent was under the impression that the visitors were the scientists' wives. If I had executed this project by myself, I would not even have thought to ask the students whether they believed that their visitors were scientists.

Many collaborations are short circuited by the assumptions scientists have about teachers (and vice-versa). Scientists who have visited K-12 classrooms sometimes complain that collaborating with teachers is impossible because the teachers 'don't know any science', 'aren't smart enough to learn science' or 'don't want to teach science'. The vast majority of teachers want to teach science and want to teach it well; however, many of them need assistance in understanding content, using equipment and relating science to everyday life. Although scientists can assist with these missing elements, we need educators' expertise in how to deal with kids, parents, school district, state and federal rules and requirements, and the politics of K-12 education. Neither group can accomplish this task alone.

Before setting foot in a classroom, scientists must understand the constraints under which teachers teach. Teachers have very little latitude in the topics they teach due to the adoption of National and State Science Education Standards. Debating whether the standards are right or wrong is a moot point: they are in place and teachers are accountable for meeting them. The emphasis on standards is so high that teachers' raises (and sometimes jobs) can be strongly impacted by their students' performance on standardized tests.

Ignoring science is not an option for teachers. The stake are even higher because content, (students must be able to distinguish between reflection and refraction) and process standards, (students must be able to design and execute an experiment, and communicate the results) must be satisfied. Their students must not only be able to state that like poles repel, but must also be able to design an experiment that tests the assertion and graph the results. These goals are consistent with what physicists would like to see: students with good problem-solving skills, a decent base of knowledge on which to build, and a desire to learn science.

I think that physicists can be most useful in teaching problem-solving skills and building enthusiasm for science. One of ur Project Fulcrum fellows – a geoscientist – accompanied a group of fourth graders on a field trip to a restored prairie. She brought her field notebook and took notes. The students were fascinated by how carefully she observed, and how she recorded all of her observa-

See SPOTLIGHT on page 6

The Con-Artist Physics of "Ocean's Eleven"

Before most moviegoers walk into the hit comedy "Ocean's Eleven," starring George Clooney and Julia Roberts, they don't realize that the Las Vegas con-artist caper contains some physics in its plot. In the film, eleven con artists employ a physics device, called "the pinch," – to help them rob a vault containing the riches of three casinos. Set off in the middle of Las Vegas, the pinch detonates an intense "electromagnetic pulse" that blacks out the city's power grid for a few moments.

© 2001 Warner Bros.

As it turns out, some physics labs really do have devices called "pinches"-the movie's website touts the reality of the concept—but can they really produce such impressive effects? "I enjoyed the movie and the 'pinch' was an amusing twist but had little to do with science," says Jeff Quintenz, a physicist at Sandia National Laboratories in New Mexico. Quintenz should know-he works on a real-life pinch device. A 100-foot 20-foot tall cylinder-shaped machine, Sandia's "Z-pinch" is the world's most powerful electrical generator.

"I can confirm the Sandia Z-pinch is the inspiration for the movie's gimmick," says Neal Singer, a science writer in the Sandia media communications group. A year or two ago, Singer spent several hours talking to the prop people from the movie about the Z pinch, which creates lightning-like tangles of startling color for a few billionths of a second as it fires-making it a very colorful, if bulky, piece of work. "We discussed Z's possibilities as a plot mechanism," says Singer. "I explained it might be hard to move the Z machine to the top of a stationwagon and fire it off in mid-Vegas; that didn't stop them, obviously."

Sandia researchers have still more news: even their colossal Z-pinch doesn't generate a very strong electromagnetic pulse. The pinch is "a poor EMP source," says Quintenz. "We have on occasion interfered with the sensitive electronics in cameras and computers located in the same laboratory space," he says, but "to my knowledge we have never caused a problem with any electronics or electrical system outside the accelerator building itself."

Instead, the Z mainly produces x rays, which have a variety of scientific uses. The Z pinch gets its name from the fact that an initial burst of electricity creates a magnetic field that compresses or "pinches" a gas of charged particles along the vertical direction, denoted by scientists as the "z" direction. Creating a bunch of hot, moving charged particles generates a rainbow spectrum of intense x-rays, but a feeble EMP.

In the end, nuclear weapons are probably the only existing devices that could really create electromagnetic pulses with a blackout punch. EMPs from a nuclear blast would contain intense electric and magnetic fields. These fields would generate in power cables, overwhelming electrical currents which would trip circuit breakers and temporarily shut down a city's power grid. But this byproduct of a nuclear blast would be the least of a city's worries.

What's more, perhaps even the filmmakers themselves did not realize that their pinch pulls off the ultimate swindle. As portrayed in the movie, the pinch apparently violates the most fundamental principle of physics, the conservation of energy, which says that energy can be converted from one form to another, but never created out of thin air. Any van-sized electricity source, not just a pinch, says Quintenz, is just too small to store the energy required to produce a blackout-generating EMP.

Still, with many other films flouting reality much more blatantly, it would be unfair to hold "Ocean's Eleven" to a tougher standard. And although the movie's fictional pinch is far different from Sandia's Z-pinch, It didn't detract from my enjoyment of the movie," Quintenz says.

—Ben Stein, Inside Science News Service

©2002 Paul Dlugokencky (www.aDailyCartoon.com) for *APS News*

PHYSICS AND TECHNOLOGY FOREFRONTS

Plastic Electronics : Going Where Silicon Can't Follow?

By Hendrik Schön, John Rogers, and Zhenan Bao

Editor's note: This is the second of two articles on advances in electronics. The first, by P. M. Solomon on the future of CMOS technology, appeared in the February issue.

Essentially all of today's microelectronic devices are made from inorganic materials such as silicon. Why would one even think of using organic molecules or polymers, plastic-like materials renowned for their excellent mechanical properties, such as strength and flexibility, rather than for being exceptional electrical conductors? However, some of them, so-called *'conjugated'* materials can be made into semiconductors or full conductors of electricity. The Nobel Prize in Chemistry 2000 has honored these developments. Recently, even superconductivity has been observed in a conjugated polymer demonstrating that a full spectrum of electrical properties, from insulating to superconducting, can now be achieved with plastics, even though previously this was thought to be possible only with inorganic materials. Investigations of high-quality organic single crystals of these carbon-based materials also allowed for the observation of the Fractional Quantum Hall effect, a phenomenon till then restricted only to the purest inorganic semiconductors such as Si or GaAs.

Besides the many similarities there are significant differences between these organic and conventional inorganic materials. Weak van der Waals rather than covalent bonds dominate the interaction between the molecules resulting in narrow energy bands for charge transport and in charge carriers that find it more difficult to move from one molecule to another. Nevertheless, at room temperature, mobilities in the range of 1-5 cm^2/Vs are observed. These are slightly higher than in amorphous silicon but significantly lower than in poly- and single-crystalline silicon where mobilities reach several hundred cm^2/Vs. Hence, organic electronics will never be able to compete with silicon CMOS (complementary metal – oxide – semiconductor) technology in terms of speed. So you probably will not expect a computer made of plastic chips any time soon in your near-by computer store.

While silicon chips have superior switching speeds and durability, plastic chips might have the edge on one crucial point: *the price*. This derives from their ease of handling. They do not require high vacuum equipment. They can be deposited at room temperature from solution, giving hope for low-cost, lightweight, rugged, flexible electronics: *plastic electronics*.

> *That the display is also only several millimeters thick and* bendable *reveals the unique capabilities of plastic electronics.*

Organic semiconductors should therefore tap a new market, involving applications that demand little from the speed of the circuits, but require that they can be produced in large quantities over large areas and at a low price. Organic, carbon-based materials combine their good semiconducting properties with mechanical properties that permit flexible, lightweight, and distributed electronic and optoelectronic applications ranging from low-end data storage, electronic tags and labels (*'electronic barcodes'*) to smart cards, displays, and toys. Even wearable or disposable computing might be possible. Such low-cost applications represent a formidable challenge for single crystal, polycrystalline, or even low-temperature amorphous silicon technology. Consequently, organic electronics might be able to go where silicon can't follow,

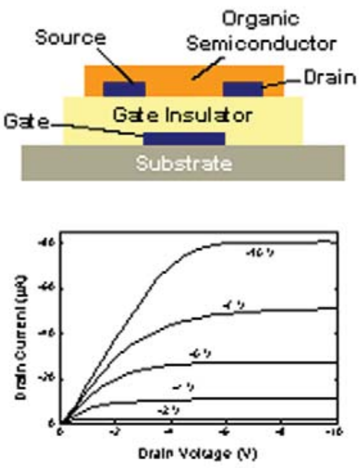


Figure 1 : *Schematic of an organic thin film transistor (OTFT).*

The workhorse of plastic electronics is the so-called organic thin film transistor (OTFT) (see Figure 1), which is very similar to the metal oxide semiconductor field-effect transistor-based (MOSFET) silicon technology. The nominally undoped organic semiconductor film is insulating. A negative voltage on the gate electrode attracts electrons to its surface and positive charge carriers (holes) to the interface between the semiconductor and insulator to form an 'accumulation layer'. If a voltage is applied across the source and drain electrodes, a current will flow between them. In this way a small voltage change at the gate electrode can result in a large current change between the source and drain. Consequently, OTFTs can switch and amplify electrical signals as needed for logic operations.

Most of the early organic materials allowed only for p-channel devices, where holes are the major charge carriers, but careful synthetic, organic chemistry and molecular engineering successfully demonstrated n-type transistor materials of similar performance. More recent studies of devices made of high quality single crystals revealed that unintentional dopants and defects were mainly responsible for limiting OTFTs to one type of charge carrier and today several molecular materials have been shown to be capable of p- as well as n channel activity. This could be useful for the development of complementary logic circuits, similar to CMOS technology in silicon devices. The morphology of the organic semiconductor film also has an important impact on the overall device performance, mainly by limiting the charge carrier mobility. However, by optimizing deposition techniques and making use of alignment layers and the self-organizing properties of molecular solids, mobilities in the range of 0.1 - 1 cm^2/Vs have been obtained in various materials. This is already in the right ballpark for the targeted applications but more progress might be expected from advances in materials processing or synthesis of new molecularly engineered materials.

Besides the performance of the semiconductor materials, the right choice of the gate insulator can also play a crucial role for OTFT performance. Both inorganic and organic materials have been used. Organic-based insulators, such as spin-on glass or polyimides, are especially attractive because they are compatible with solution processing on flexible, plastic substrates and their use has led to the demonstration of all-organic transistors.

In order to define the critical device dimension of the OTFT, the channel length or distance between the source and drain electrodes, several low-cost patterning techniques can be used. Some examples are screen-printing, photochemical patterning, microcontact printing, and inkjet printing. These printing techniques are much less sophisticated, and therefore much less expensive, than the optical lithography used in silicon technology. Though the pattern resolution achieved is not as high as with the photolithography employed in fabricating standard CMOS silicon devices, channel lengths of 5 mm and even less have been achieved on plastic substrates. As most of these techniques allow reel-to-reel processing, high throughput is possible in production. But their versatility also allows for rapid prototyping and the possibility of customized flexible, electronic circuits.

While transistor performance sufficient for the envisioned applications can be achieved using these low-cost processing and patterning techniques, logic circuits based on individual OTFTs must be prepared in order to commercialize 'plastic electronics'. So far, various companies have demonstrated the integration of a few thousand transistors. In one prototypical application of OTFTs, electronic paper (see Figure 2), plastic electronics are used to drive an electrophoretic display. This was first demonstrated through a collaboration of Bell Laboratories, Lucent Technologies, and E Ink and has now been reproduced by other companies. High voltages and rather low currents are needed to switch the electronic ink pixels, requirements that nicely match the characteristics of the organic transistors. That the display is also only several millimeters thick and *bendable* reveals the unique capabilities of plastic electronics. With continued progress in materials engineering, processing, and ultra-low cost fabrication techniques, commercial products may become possible and an evaluation of the full potential of plastic electronics would evolve.

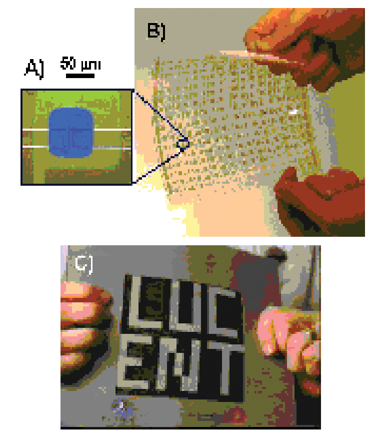


Figure 2 : *Electronic Paper, an example of a potential application for flexible, organic electronics. Organic thin film transistors (a) are prepared on a flexible backplane (b) of an electrophoretic display. They allow switching of the pixels of the paper-like display (c).*

The molecular nature of these carbon-based materials offers an intriguing final opportunity - molecular electronics in which logic circuits are based on single molecules or on a single layer of molecules! Recent results on carbon nanotube and self-assembled monolayer-based devices show that transistor action and voltage gain can be achieved in single molecular devices with channel lengths as short as 1 or 2 nm. At these dimensions, the speed of the transistors and number of them per unit area might permit Moore's Law to extend beyond its limits for silicon CMOS technology. Of course, many issues must be addressed before this dream might become a reality. Nevertheless, the future for carbon-based electronics appears very bright indeed!

Hendrik Schön is a Member of Technical Staff in the Nanotechnology Research Department of Bell Laboratories, the research arm of Lucent Technologies. John Rogers is Department Director of the Nanotechnology Research Department. Zhenan Bao is a Distinguished Member of Technical Staff in the Materials Research Department.

SPOTLIGHT, *from page 5*

tions. They knew scientists did experiments, but they didn't associate documenting observations, recording data or communicating results with 'science'. They didn't realize that science might be done anywhere except in a lab. The fourth graders started recording observations in their own 'science notebooks' and students who thought that their love of writing precluded science as career learned that this is not necessarily so. These unplanned lessons emphasize the value of having scientists in the classroom: there is no replacement for students experiencing real-time problem solving. Students learn that science is not a body of facts, but a way of thinking.

If our effectiveness increases when we reach students early in their education, we must also ensure that future teachers are equipped with the skills they need to teach science before they enter a classroom. In most states, working with future teachers requires collaboration with the education college. The importance of this issue demands that we make a serious effort to overcome past history, turf battles and culture differences so that we can productively collaborate with teacher educators. We cannot treat K-12 science education as someone else's problem; however, it is not our responsibility alone. I am explicitly not suggesting that physicists should teach future teachers how to teach physics. Our responsibility is to ensure that they know enough about physics and scientific thinking that teachers can learn new material on their own and can troubleshoot experiments that aren't working. Remember that we spend a career developing and honing problem-solving skills. The skills a teacher can develop taking a limited number of science classes cannot replace what students will learn and experience interacting with scientists in the classroom. *[Editor's note: APS is spearheading the PhysTEC program, designed to enhance physics teacher preparation. See APS News, November 2001, http://www.aps.org/apsnews/1101/110102.html]*

> *Students learn that science is not a body of facts, but a way of thinking.*

Although improving K-12 science education is a critical issue, we must recognize that not everyone is interested in or has the skills to work with K-12 students, teachers and teacher educators. It is important that - just as in research - you invest your time in doing those things about which you are passionate, and that you believe you can make an impact doing. In the end, it isn't nearly as important what you do as it is that you do something.

Diandra Leslie-Pelecky is an assistant professor of physics at the University of Nebraska and a former chair of the APS Committee on Careers and Professional Development.

ANNOUNCEMENTS

FULBRIGHT AWARDS

The following Fulbright awards are viewed as among the most prestigious appointments in the Fulbright Program. Lecturing is usually in English. Candidates must be US citizens and have a prominent record of scholarly accomplishment. Consult CIES Web site http://www.cies.org/cies/us_scholars/DisChairs/ for information about application procedure and current updates. To apply, send a letter of interest (up to 3 pages), c.v. (up to 8 pages) and a sample syllabus (up to 4 pages) to Daria Teutonico, Fulbright Distinguished Chairs Program; Council for International Exchange of Scholars; 3007 Tilden Street, NW; Ste. 5-L; Washington, DC 20008-3009 (phone 202/686-6245). Materials must arrive on or before the May 1 deadline.

CANADA: FULBRIGHT-SIMON FRASER UNIVERSITY CHAIR IN AIRBORNE REMOTE SENSING:
Grantee will conduct research in area of specialization and conduct occasional graduate seminars. Specialization includes airborne remote sensing research in an applied environmental context. Open to junior or senior faculty. Center for Scientific Computing, Simon Fraser University. Four to nine months. www.sfu.ca

ITALY: NAPLES CHAIR IN PHYSICS:
Grantee will offer one course in signal analysis techniques for gravitational wave detection and conduct tutorials for students. Opportunities for collaborative research are available. University of Naples, Federico II. Three months, starting October 2003, March 2004 or May 2004. www.unina.it

Visit APS News Online

http://www.aps.org/apsnews/

2001 APS Fellowship Nomination Deadlines April 1, 2002

DIVISIONS
Atomic, Molecular, Optical
Biological Physics
Laser Science
Nuclear Physics
Particles & Fields
Plasma Physics

FORUMS
Physics & Society
History of Physics
International Physics

ALL TOPICAL GROUPS

Proposed Amendment to APS Bylaws Regarding Committee Chair Appointments by the APS President-Elect

First Vote APPROVED by the Council November 18, 2001

The APS Constitution and Bylaws Committee has discussed and recommended an amendment to the APS Bylaws that would change the responsibility of appointing the chair of various standing Bylaws committees from the President to the President-Elect. The purpose of the amendment is to allow the incoming President to appoint the incoming committee chairs. In practice, this is what has been done for several years. Approval of this amendment will bring the bylaws into conformance with current practice.

The APS Council voted to approve this amendment on its first vote at the November 18, 2001 Council meeting.

APS Washington Office Summer Internship

Applications are now being accepted for the 2002 Summer Internship. The opening is for a ten-week summer internship during the period of June 3 to August 30, 2002 (specific dates negotiable).

More information about the position can be found at http://www.aps.org/public_affairs/intern-summer.shtml

2002-2003 APS Member Directory

The 2002-2003 APS Member Directory will be printed in late March 2002. To receive one copy of either the paper or cd-rom directory, you must contact the Membership Department, 301-209-3280 or membership@aps.org, no later than March 22, 2002. You may also make your selection at http://www.aps.org/memb/2002dir.html. Please note: **No directory will be mailed unless you notify APS of your choice by March 22, 2002.**

LONG-RANGE, *from page 1*

nature and origins of the Universe. These range from the existence of unseen dimensions and the nature of dark matter and dark energy — which are believed to comprise fully 96% of the mass of the universe and hold the key to its ultimate fate — to the existence of the Higgs particle, which is believed to give particles their mass.

The APS Divisions of Particles and Fields (DPF) and of the Physics of Beams (DPB) both issued statements supporting and praising the HEPAP report. The DPF statement also urged that the US host the linear collider. The report estimates building the linear collider in the US would cost between $5 billion and $7 billion, with one third of the financing coming from international contributions and between $1 billion and $2 billion coming from the existing US particle physics program.

"We support the construction of a high energy, high luminosity, electron positron linear collider as the next major international particle physics initiative," said DPF spokesman Chris Quigg. "Although an international linear collider laboratory will be an essential component of the US research program wherever it is built, we feel that the US should offer to host it. It would complement the Large Hadron Collider (LHC) being constructed in Europe to exploit the scientific opportunities ahead of us."

DPB Executive Committee member Ron Davidson applauded the strong endorsement by the Subpanel of a vigorous long-term accelerator R&D program. "If the panel's vision comes to fruition, it will result in the most advanced accelerator facility ever built," he said. "We remain strongly committed to the tradition of active partnership in the development of major accelerator based initiatives."

Among the highlights of the report is for the creation of a new planning mechanism for establishing research priorities in particle physics in the form of a panel. The Particle Physics Project Prioritization Panel – dubbed the "P5" – would assess and prioritize proposed experiments and other research initiatives to ensure the highest scientific return on public funding for particle physics. At present, public funding in the form of US Government grants totals between $750 million and $780 million per year with the lion's share – about $700 million – coming from the DOE and the remainder coming from the NSF.

Under the timetable envisioned by the report, the electron positron linear collider would become operational around 2012, about six years after the LHC, (a proton proton circular collider now under construction at CERN in Switzerland), is scheduled to go on line. The LHC will have energies on the order of 14 Tera electron volts, seven times more powerful than the Fermilab Tevatron, currently the world's highest energy accelerator.

One change between the original draft report released last October and the final report released on January 28th involves a small project called BTeV, which is designed to probe for new quark physics at the electro weak scale by studying "flavor changing processes" and probing for CP violations. With a total price tag of $250 million and delayed funding, the draft said "we regret that we cannot recommend funding BTeV as a line item at this time." The final report instead states that the BTeV project, whose total cost estimate was cut to $165 million, "cannot be funded with the scope and timetable originally envisioned." It said revised plans "should be brought to P5 for evaluation this year."

Joel Butler of Fermilab, one of the lead scientists on the BTeV project, welcomed the new language and praised the new P5 process for evaluating "mid size" projects during a time that will, he said, be dominated by huge projects. "It is expected that P5 will observe and monitor the progress of each proposal as it moves through the laboratory and agency reviews (and) will provide advice on how to fit the best mid size projects into the constraints of the overall program," he said. "P5 is expected to be a mechanism for helping mid size projects, which are so important to the diversity, vitality, and progress of high energy physics, find a way to proceed in an era dominated by the construction of very large new facilities, such as the LHC."

MEDIA RELATIONS, *from page 1*

him with queries about the scientific world. He also provided reports for Radio Australia, an internationally broadcast station.

Having written extensively online, Harris has been employed as About, Inc.'s physics specialist since 2000. He still maintains one of the most-visited physics sites on the web at physics.about.com.

When a commercial television network was planning a children's science program, Harris was called on to research, write and co-produce the 65-episode series *Y?*, now in its fourth series. Recently, he has been working as a journalist and public information officer for the University of Queensland identifying, reporting on and pitching science stories for the Australian and international media.

He has been an elected member of the national committee of Australian Science Communicators, the professional science communication body, and was Director of the inaugural Australian Science Writers Festival.

"David came for an interview at APS just before September 11, and was stranded for several days until he could get a flight back home," said Alan Chodos, APS Associate Executive Officer. "We were afraid that after that experience he might just decide to stay in Australia. We're delighted that he accepted our offer, because, with his background and his skills he's the perfect person for the job."

Harris's focus at the APS will be to foster physics coverage in national and international media, extending the usual reach of physics stories. He will also contribute to APS education, outreach and policy activities.

"There is great public interest in physics research despite its specialty nature and, as physicists, we need to be open to new possibilities for communicating our work to new audiences," said Harris. He has already had some success in convincing publications that have no regular science content to include physics-related stories.

Harris sees his work as that of an intermediary who can make communication between physicists and the media simpler and more efficient.

"One of the greatest impediments to communication between physicists and journalists is lack of time. Journalists often don't have the time to learn all the background to a story and physicists often don't have time to walk a journalist through a new result. A key function of media relations is to ensure that sufficient accurate information is communicated in an appropriate manner without the process getting bogged down in unnecessary details."

In some cases, communication difficulties arise from the very different ways in which physicists and journalists work. Having been in both situations, Harris is in a good position to ensure that everybody involved in the development of a story gets the assistance they need in the manner best suited to them.

Harris will work closely with the AIP Media and Government Relations team to engineer broad and effective coverage of all types of physics and physical science stories.

APS members seeking help or advice in dealing with the media can contact Harris at 301-209-3238, or at harris@aps.org.

EDUCATION, *from page 3*

there is a catch," White said. "At $100 million, they become state-funding. We want funding for fiscal year 2003 at a minimum level to trigger state level programs... Anything under $100 million is administered by the Department of Education." State-level programs typically reach far more people than small, federally-run pilot programs.

As part of its commitment to the issue, the K-12 SMET Education Coalition met in Washington on January 15. One of the attendees said the meeting was a strategizing session on where to go from here, and a consensus emerged on a two-pronged approach. The first part would involve an "uphill battle" of getting increased appropriations in a climate of renewed budget deficits. The second part involves "educating" the rank-and-file members of the participating organizations that $2.85 billion in generic Teacher Quality money is already out there and available for professional development in math and science education.

THE BACK PAGE

The Role of Science in the National War on Terrorism

by John Marburger

Recently there have been murmured concerns in the scientific community about the Bush Administration's level of interest in science, and the value it places on federal investment in science and technology to stimulate a flagging American economy in the wake of the tragic events of the September 11 terrorist attacks.

I can assure you that this administration is determined not to let terrorism deflect America from its trajectory of world leadership in science. Our nation's prowess in technology, especially information technology and instrumentation, have opened extraordinary new vistas in science. It has made it possible to visualize and manipulate matter on the atomic scale, leading to unprecedented understanding and control of the processes of life as well as of inanimate matter. Having produced the means for great strides in science, and in accompanying technologies for improved health care, economic competitiveness, and quality of life, it would be foolish to turn aside now from the course of discovery while we engage the monster of terrorism — an evil force that denies the benefits of progress and the search for truth.

Thus I expect that science in America and the world will forge ahead relatively unaffected by the war against terrorism. I expect the President's prior commitment to increase funding for health related research to be realized. I expect the tremendous momentum in the information sciences to roll forward. I expect the technologies of measurement and analysis — atomic scale microscopy and manipulation, light sources, probes, detectors and analyzers — to continue to win new ground on the frontiers of complexity as well as of scale. Science has its own intrinsic imperative and this nation will continue to pursue it.

This administration is equally determined to win the war against terrorism, and President Bush is mobilizing all the talents and resources of our immensely strong society to that end. He is doing this through the conventional mechanisms of American government, and he is drawing upon much previous work that prepared us for this struggle. It is too easy to criticize — after the fact — a prosperous peace-time nation for unpreparedness in the face of danger. A better criterion for defensive health would be the speed with which a nation under attack can respond effectively. There is no question that the steps New York took after the first world Trade Center attack in 1993 saved numerous lives in the second attack eight years later, and expedited a response that limited the scope of its evil consequences. Nor is there doubt that lessons learned from attacks on US embassies and federal buildings limited the damage to the Pentagon, portions of which had been remodeled with designs based upon these lessons.

Our consciousness of the biowarfare work of troubled regimes elsewhere in the world had led to studies of biodefenses and to exercises designed to teach us where our greatest vulnerabilities lay before September 11. Many of the means required for a war against terrorism were already available to us, and only needed to be enlisted in a systematic way to support the effort. This readiness is most visible in the technologies now in play in the war beyond our borders. But significant readiness of homeland technology is also apparent, though not yet fully mobilized. We are not starting "from scratch" in the technology of homeland defense. We have much relevant technology, and the challenge is to deploy it effectively.

Prior to World War II, science had reached a monumental turning point. Quantum physics had flung open the gates to a staggering vista of opportunity that was not to be realized until after the war. Our understanding of chemistry, of materials, of nuclear phenomena, of optical properties, of the processes of life, began to expand at an explosive rate. The wartime scientific effort labored urgently to apply this new capability to applications of the highest leverage for military operations, such as radar and nuclear weapons.

Prior to the war on terrorism, the modern era of science had matured, and a wealth of knowledge and technique now lies at hand. In nearly every area where technology can be applied to homeland defense, the basic knowledge exists, and the need is for engineering to turn known phenomena into devices, and to embed the devices into practical systems. The single greatest exception to this rule is in the response to bioterrorism, where additional research is needed on the mechanisms of diseases likely to be exploited by terrorists.

Some have spoken of the need for a "Manhattan Project" to satisfy the needs of homeland security. The analogy is wrong-headed. Cleverness is needed less now than a national will to use what we have to strengthen the infrastructure of our daily lives, to bolster public health systems, to equip properly our first responders, to use more effectively the information technology, the detection technology, the biotechnology that we already possess to render the way we live less vulnerable to what the military scholars call "asymmetric threats." We need to plan, and to carry out our plans. And that is one of the functions of the Office of Homeland Security, created by President Bush in the aftermath of September 11, and headed by Pennsylvania Governor Tom Ridge.

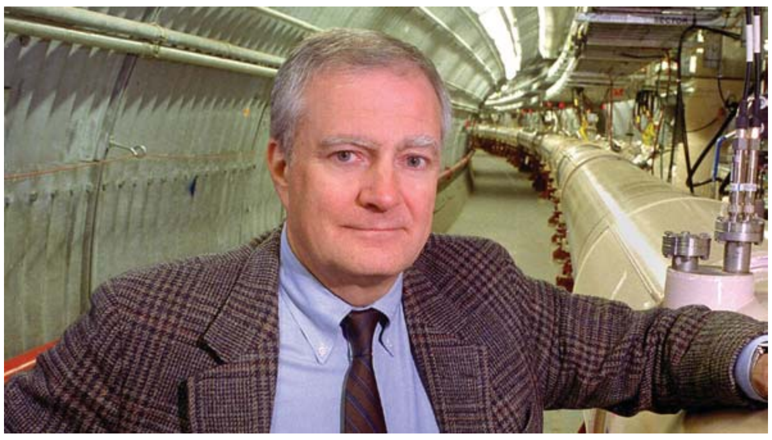
For several years the federal government has been concerned that such attacks might occur. For decades the Departments of Defense, Health and Human Services, Energy and Agriculture have engaged in anti-terrorism activities that have contributed to the protection of our Homeland and the creation of technologies which have benefitted our everyday security and existence. The attacks of September 11 forced us to view all these preparations in a new light. How do we think systematically about this new kind of war?

When President Bush introduced the notion of a War Against Terrorism, my first thought was how a map for such a war would differ from a conventional battle map. Conventional wars are fought for territory, easily measured on a chart with latitude and longitude, but the fronts in the war against terrorism cover multiple dimensions. How can we detect an unprotected flank in this complex territory? How do we measure progress? We need a taxonomy and a common language to assess threats, avoid duplication, and facilitate interagency cooperation and coordination.

OSTP has executive and legislative mandates to coordinate federal science and technology activities, and is consequently in a position to call on organizations, internal and external to the federal government, as we provide support to the Office of Homeland Security, and other offices responsible for aspects of the war on terrorism. We have been focusing our energies on short-term issues such as mail security, baggage screening, and civilian preparedness. But we are also taking steps to identify long-term S&T opportunities that will help the US win the war against terrorism.

So, how can science help? Science and engineering have critical roles to play in the war on terrorism. We need improved tools with which to prevent, detect, protect, and treat victims of chemical, biological, radiological, nuclear, and conventional terrorist attacks. Additionally, we will need new and improved tools to recover facilities from those same types of attacks, should they ever occur. Many cases call for a "systems approach," rather than simply perfection of a single device.

In late October 2001, Director Ridge asked that OSTP provide technical support for the treatment of US mail potentially contaminated by *Bacillus anthracis*. This led to an interagency technical team that, within days, began evaluating the irradiation facilities at Lima, Ohio, and Bridgeport, New Jersey. By mid-November, with strong scientific data on the use of electron beam technology to irradiate the mail and the establishment of sound standard operating procedures, I endorsed an advisory to the US Postal Service that the procedures being used were able to rid the mail of *Bacillus* contamination. We continue to work with this scientific team to refine the irradiation process and to explore other available technologies to rid the mail of potential pathogens.



An example where a systems approach is needed is airline security. Right now, our chief tool is the transmission X-ray. Other technologies can significantly improve our capabilities to detect weapons of terror, develop these detection technologies for rapid deployment, and think carefully how to integrate the ones adopted, as a coherent package, into airline routines. We must do this in such a way that they not create unpleasant delays and unaffordable expenses, but do enhance both security and passenger confidence. Potential technologies range from dogs that can sniff out explosives to computer-based biometrics to resonant gamma ray imaging of concealed explosives, and laser interrogation of trace compounds.

Fire was critical in the collapse of the World Trade Center buildings and contributed to damage to the Pentagon buildings, but current building design practice does not consider fire as a design requirement. Current emergency response procedures could not adequately cope with the events in those buildings. Buildings today are not immune from chemical, biological, and radiological threats. Efforts are underway to protect military buildings through DARPA's "immune building" program, but there are no standards and practices or civilian buildings. Prior to 9/11 the Corps of Engineers helped design several modifications to the Pentagon as part of a completed renovation. Analysis of past attacks, data from experimental detonations and super computer simulations led to structural hardening innovations including a strong steel support matrix, a Kevlar wrap to contain shrapnel-like fragments, and blast resistant windows. That work saved many lives.

Let me turn now to the more delicate subject of how the war on terrorism, and the fear of terrorism, may impact the conduct of science. Increased security measures are, of course, helpful if they actually decrease the chances that unauthorized people will gain access to classified material, and they do not adversely impact the missions of those implementing the measures. Security measures implemented without adequate forethought can backfire if they do not significantly improve security and have a negative impact on science and agency missions. We need to identify systematically where additional security measures are needed and develop thoughtful responses sensitive to the importance of activities they might impede.

Many people come from around the world to study in US undergraduate and graduate programs. Some come from the same countries that we believe generate terrorists. It is important that international students continue to come to the US to study and contribute to our science and technology enterprise. They are a major factor in our nation's world scientific leadership. They also learn to appreciate the advantages of our educational system and acquire skills that will enable them to contribute quality of life in their own countries. But we do need better ways of identifying the few that come to enhance their effectiveness as terrorists. We are currently grappling with what new measures should be introduced, both to identify terrorists before they receive visas, and to identify potential terrorists by their activities after they come to the US

Finally, our nation today is a science superpower. The scope of our scientific activity, both basic and applied, is breathtaking and unmatched. We are not, however, a science monopoly, and we have much to learn from colleagues elsewhere in the world. Science thrives on open discourse. Measures that inhibit discourse will impede progress. We cannot limit scientific interactions with other nations without paying a scientific price.

John Marburger is the newly appointed presidential science advisor and head of the White House Office of Science and Technology Policy. The above is adapted from his speech at a December 18, 2001, symposium on the war on terrorism sponsored by the American Association for the Advancement of Science.

***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.*