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IN THIS ISSUE: Physics News in 2000

Council Statement Underpins APS Education Lobbying Effort

The importance of improving national science and math education is especially apparent in the wake of a new TIMSS report showing marginal improvement in the science and math scores of US eighth-graders compared to their peers in other countries (see story, page 5). And the new APS Council Statement on K-12 science and math education approved in November is an important first step in setting APS policy in this area, according to APS Public Affairs Fellow Christina Hood.

"The APS Office of Public Affairs deals with the federal government trying to promote the interest of physics," she says. "However, we are only able to talk about things that are official APS policy. The Council's statement on K-12 science and math education gives us the authorization to talk about and lobby for these issues."

The full text of the statement follows:

Policy Statement on K-12 Science and Mathematics Education

In an age of rapid technological advances, a strong educational program in science and mathematics is essential for the United States. Despite the heroic efforts of many teachers and the large investments of school districts, in too many places we currently fail to provide it. Too many citizens leave school without the scientific literacy necessary to deal with new technologies, and their far-reaching societal implications. Our country is not educating enough technologically skilled and knowledgeable workers, a situation that will compromise our competitive advantage in

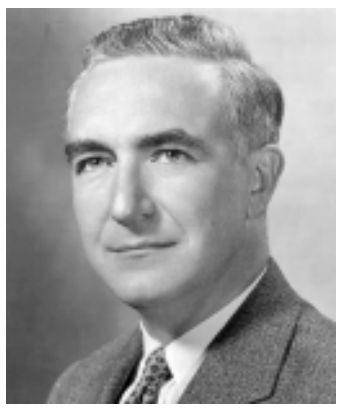
See EDUCATION *on page 3*

Delegates Convene at World Congress

Judy Franz, APS Executive Officer; Frank Franz, President of the University of Alabama, Huntsville; and member of the local organizing committee Christian Thomsen attend the banquet of the Third World Congress of Physical Societies in Berlin. *See story, page 6.*

New APS Prize Targets Under-30 Physicists

The APS has established a new prize with a new mission: to recognize the achievements and the potential of a physicist under the age of 30. Named the George E. Valley, Jr. Prize in honor of a generous bequest from the estate of George E. Valley, Jr., the prize will be given every two years and will carry with it a cash award of $20,000, making it the largest single prize that the Society gives.



George E. Valley, Jr.

Nominations are now being solicited for the first recipient, who will be chosen by a selection committee consisting of the President and two immediate past-Presidents of the APS, as well as a chairperson to be elected by the APS Council. A fifth, non-voting, member of the committee will be George C. Valley, son of George E. Valley, Jr. and, like his father, a physicist. The Prize is open to candidates in any field of physics. The deadline for submission of nominations to the APS is July 1, 2001. Nominees must be less than 30 years of age at the time of their nomination. Further details may be found on the APS web site, http://www.aps.org, under the Prize and Awards button.

George E. Valley, Jr. received his PhD in physics from the University of Rochester in 1939. He was named a National Research Fellow in nuclear physics in 1940 and was Project Supervisor and senior staff member of the Radiation Laboratory at MIT from 1941 to 1945. He was on the faculty at MIT from 1946 to 1974, was one of the founders of MIT Lincoln Laboratory, and was Chief Scientist of the Air Force in 1957-58. His areas of research included: Artificial Radioactivity, Mass Spectroscopy, Cosmic Rays, design of Radar Systems and invention of the SAGE Air Defense System. Valley developed the idea for the prize in discussions with then-APS Treasurer Harry Lustig in the years shortly before his death in 1999.

The prize was authorized by Council at its November meeting, and the bequest was received by the APS shortly thereafter. "This is an exciting new direction for the APS honors program," commented APS Treasurer Thomas McIlrath. "We anticipate receiving many outstanding nominations, and we hope the Prize will make an important difference to a young researcher with great potential early in his or her career."

Internal and External Reviews Address Problems at Department of Energy

In the waning months of his tenure as Secretary of Energy, Bill Richardson commissioned a prestigious panel to study the science and security functions of the department. Calling on the resources of a bi-partisan mix of eminent scientists and experts in security, the study is being conducted by the Center for Strategic and International Studies (CSIS). It is headed by John Hamre, President of CSIS and former Deputy Secretary of Defense, and includes two former presidents of the APS. The panel is expected to present its final report by April of 2002.

Meanwhile, eleven distinguished scientists and science policy makers, assembled under the aegis of the APS but acting as an independent group, have addressed concerns specific to the Office of Science in DOE, and, in a document circulated widely on Capitol Hill, have proposed alternative organizational structures for the Office should it either remain within the Department or be reconstituted outside the DOE.

John Hamre will be speaking at a special session on Scientific Freedom and National Security at the APS April Meeting in Washington, DC April 28 – May 1, 2001.

In an appearance on ABC's Nightline on December 21, Secretary Richardson described the Hamre Commission's charge as "to strike a balance for the new administration between science and security."

The commission has already held preliminary meetings, and members of the commission have visited some of the national laboratories, which are the focus of much of DOE-sponsored research. At a reception at the National Academies in December, some of the commission members commented on what they hoped the commission would achieve.

Hamre called the current arrangement, which involves a quasi-independent agency within DOE, headed by Undersecretary for Nuclear Security General John Gordon, "a sub-optimal solution to a serious problem", and hoped that the commission could be helpful to the new Secretary of Energy as well as to General Gordon.

D. Allan Bromley, science advisor to President George Bush the elder and president of APS in 1997, remarked that the national labs, which "used to be considered the gems of our scientific enterprise, have fallen on harder days", and promised to "use our best efforts to come up with recommendations for the new administration." Burton Richter, Nobel-Prize winning former director of SLAC and president of APS in 1994, thought that "the system is badly broken. The commission may be the last shot to fix it. It's either fix it or break it up."

John Hamre, President of CSIS

Among the other members of the Hamre commission are former Senator Howard Baker and former Representative Lee Hamilton, co-authors of the Baker-Hamilton report that studied security policies at Los Alamos, and found that "the combined effects of the Wen Ho Lee affair, the recent fire, and the continuing swirl around the hard-drive episode have devastated morale and productivity."

See DOE REVIEWS *on page 6*

APS Creates Email Alias System for Members

APS members who struggle with constantly updating their email addresses as they change employment will be pleased to learn that the Society will now provide all active members with an electronic mail alias to be used for forwarding email to a personal email (target) account. The target account of the alias can be changed at any time, allowing the member to switch email providers, employers or account names without the need to notify multiple contacts of the new email address.

Tracy Alinger, Director of Information Technology, stresses that the service is not an email account. Messages are not stored by the APS, but rather passed through to an email account specified by the member. "This allows a member to permanently maintain an email address of [name]@mailaps.org, as long as that individual remains an APS member," she says, adding that the Society will not sell such email address lists or allow them to otherwise be used for commercial purposes,.

To establish an email alias with the APS, visit http://www.aps.org/memb/mailalias.html. (Have your APS membership number handy.) Alternatively, members may call the APS Membership Department at (301) 209-2180.

HIGHLIGHTS

Alan Chodos/APS

"Members in the Media"

"Without quantum fluctuations there would have been no little wrinkles to grow into the structure we observe. It would have been a pretty boring universe."

—Fermilab astrophysicist Rocky Kolb, Dallas Morning News, December 11, 2000

✶✶✶

"Polygraphs are not scientific. They don't belong in the same universe as science. They are an emotional upset detector."

—Brad Holian, Los Alamos, ABC's Nightline, December 21, 2000.

✶✶✶

"These are things that would have been considered metaphysics when I was in grad school."

—Fermilab Director Mike Witherell, on the possibility of accelerators detecting evidence for extra dimensions, LA Times, December 28, 2000

✶✶✶

"This is a beautiful development that gives us much higher confidence that we will soon detect gravitational waves,"

—Rainer Weiss, MIT, on improved sensitivity of gravitational wave detectors, AP Net, December 6, 2000

✶✶✶

"There is no theoretical limit to their accuracy, which is one of the things that makes them such an exciting challenge."

—Kurt Gibble, Yale University, on possible improvements to atomic clocks, USA Today, December 18, 2000

✶✶✶

"For Fermilab, it's a chance to cement its place in physics for the next 20 years, based on what we do in the next five. If we don't succeed, we can't claim that we need to be here."

—John Womersley, Fermilab, on the possibility of finding the Higgs Boson, LA Times, December 5, 2000.

Bridging the Gap Between Science and the Media

Steven P. Mielke

Blake Likins

Two physics students received a crash course in science and the media when they spent ten weeks last summer as APS Mass Media Fellows. The APS program enables physics students to work full-time over the summer as reporters, researchers and production assistants in mass media organizations nationwide. Blake Likens, a recent graduate of the University of California, Berkeley, spent her summer internship at the *Albuquerque Tribune* in New Mexico, while Steve Mielke, a graduate student at the University of Toledo, spent last summer at CNN.

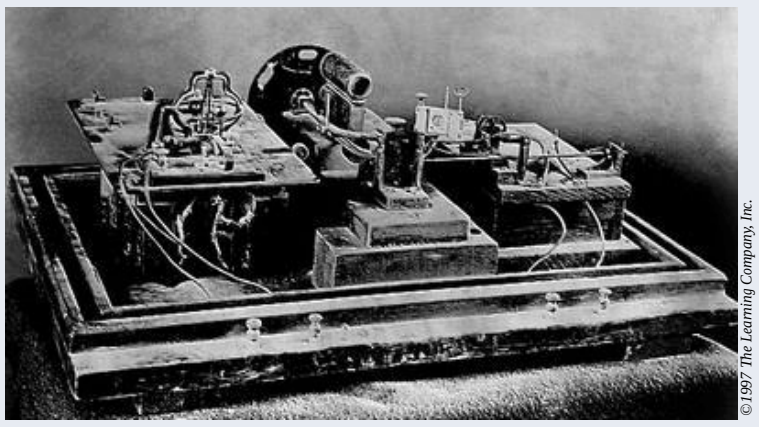
Likens was completing her undergraduate degree in astrophysics at Berkeley when she mentioned her interest in pursuing a career in science writing to some faculty members who suggested she apply for the APS fellowship. She was assigned to the *Tribune* in part because of her scientific background: New Mexico is something of a physics and astronomy hub because of Los Alamos and Sandia laboratories and the Very Large Array (VLA) telescope.

Working for a small local paper had its advantages, especially since Likens arrived in Albuquerque at the time the story broke about the missing hard drives at Los Alamos, along with ongoing coverage of the fires that broke out. "All the regular reporters were off covering the fires and the missing hard drives, so I ended up doing all the science reporting because everyone was busy covering the scandals," she says. She wrote stories on topics in astronomy, biology, ecology, physics, math, and health, as well as a controversial front page series on nuclear waste stewardship at Sandia National Laboratories. "I got to travel all around the state, and learned a lot about the government role in science, so I lucked out."

See MEDIA FELLOWS *on page 3*

This Month in Physics History

February 2, 1893: Edison Records First Sneeze on Film



The kinetograph was developed by Thomas Edison.

The millions of viewers who flock to movie theaters every weekend to view the latest Hollywood blockbusters rarely stop to consider the technological roots of the entertainment industry we now take for granted. Although many scientists and inventors experimented with moving pictures in the latter part of the 19th century, it was famed American inventor Thomas Edison who patented one of the earliest motion picture cameras (which he called a kinetograph), using his invention to make short films to be viewed with a companion invention: the kinetoscope.

Born in 1847 in Milan, Ohio, Edison grew up in Port Huron, Michigan, evincing early on a strong curiosity about the world around him, and making new discoveries through books and homemade experiments. In 1869, when he was 22 years old, Edison patented his first invention (the electrographic vote recorder) and thereafter devoted his life to accumulating more than 1,000 different inventions, drawing on his own initiative and that of his employees at the Edison Manufacturing Company.

By 1878, Edison had been granted a patent for a phonograph, and ten years later had become interested in extending that technology to include combined moving pictures and sound. "I am experimenting upon an instrument which does for the eye what the phonograph does for the ear, which is the recording and reproduction of things in motion," he wrote in 1888. Decades before Edison began his work on what would become the first kinetoscope and kinetograph, people were fashioning crude hand-drawn motion pictures, similar to today's animated cartoons.

Eventually British photographer Eadweard Muybridge helped pioneer a process in which a series of pictures would be taken of a subject in motion and then shown back in sequence. Muybridge set up 700 cameras in sequence to photograph a trotting horse, which yielded a mere 60 seconds of motion picture when all the photographs were viewed back in sequence. In 1888, Edison met with Muybridge to discuss adding sound to his moving pictures. Muybridge declined, but Edison was undaunted and set about inventing his own motion picture machine. "My plan was to synchronize the camera and the phonograph so as to record sounds when the pictures were made, and reproduce the two in harmony," he recalled in 1925.

The basic concept of Edison's kinetograph and kinetoscope was to employ a cylinder similar to those used in the phonograph, place it inside a camera and then coat it with a light sensitive material. Every time a picture was taken, the cylinder rotated slightly, taking another picture. The crude film was then processed and run through a viewer in slow motion.

Serendipitously, it was about this time that George Eastman introduced a new celluloid film which began to replace the old system of using light sensitive plates and large bulky cameras (which eventually led to the manufacture of the "Brownie" camera). In 1889, Edison ordered some of the new film cut into long strips. His assistant, William Dickson, developed a sprocket system for a camera that would move the film past the lens when turned by a crank (the kinetography). In order to view the films, Edison's team invented the kinetoscope. Edison applied for a patent on these inventions in 1891, which was granted six years later.

One of the first films Edison made was of a laboratory worker in his Newark, NJ, laboratory, named Fred Ott, who acted out a sneeze on February 2, 1893. The sound of the sneeze was recorded on a phonograph to be played back with the film, and the experiment proved to be a success. Encouraged, Edison's team began producing movies in a studio at his West Orange Laboratory, dubbed "Black Maria." Essentially a large structure covered with tar paper, the studio featured a hole in the ceiling to allow the sun to shine through and illuminate the stage. The entire building was built on a set of tracks to enable Edison's team to move it around as the sun moved through the sky over the course of a day.

These films — which initially lasted only a few seconds — were shown on kinetoscopes placed in arcades around the county. For a nickel, patrons could view short films of circus performers, dancers or animals. Eventually the team produced a 15-minute thriller, "The Great Train Robbery," and went on to develop more that 2,000 other short films. In 1913 Edison unveiled the first talking motion picture, as well as the first color motion picture, achieved by hand-painting each frame of a black and white film. Since then the motion picture industry has far outstripped these humble technological beginnings, but it was the pioneering advances of Edison and his crew that provided the foundation for all the technical developments that came after.

For more information about the life and work of Thomas Edison, see http://www.hfmgv.org/histories/edison/invents.html.

Birthdays for February:

11 J. Willard Gibbs (1839)
14 Galileo Galilei (1564)
18 Alessandro Volta (1745)
19 Nicolaus Copernicus (1473)
20 Ludwig Boltzmann (1844)

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Ehlers to Reintroduce Controversial Science Education Bill

This article was written for APS News by Richard M. Todaro.

When the House of Representatives surprised even itself last October and voted down a popular bill to provide money and personnel for elementary and middle school science and math education, it represented a stunning display of the power of the country's largest teachers' unions. The defeat also set the stage for a further escalation in the battle over school vouchers, with the bill's chief architect, Rep. Vernon J. Ehlers (R-MI), vowing to reintroduce the bill in the first session of the new 107th Congress. Ehlers is one of two members of the House who hold PhD's in physics, and is a Fellow of the APS.

Introduced by Ehlers in April 2000, the National Science Education Act (NSEA) had 16 original co-sponsors, a number that grew to include 62 Republicans and 45 Democrats by the time it was brought out of committee and to the full House in September. So confident were its sponsors of overwhelming, bipartisan passage that the bill was fast-tracked under so-called suspension of the rules, meaning the bill had to get a two-thirds majority.

But on October 23rd, just one day before the scheduled vote, the National Education Association (NEA), the American Association of School Administrators, and several other influential teachers' unions discovered a funding provision in the bill that they consider to be unacceptable. This was the so-called "master teacher" provision that directed the National Science Foundation to make federal money available to any schools, public or private, to hire someone to oversee the development of science education classroom curricula.

"We oppose giving federal monies to private schools," said Diane Shust, the manager of federal relations at NEA, who oversees lobbying activity. "It was the provision that provided [private] schools with direct money. That is a voucher."

When the vote came on October 24, the bill got a simple majority but failed to get a two-thirds majority, the final tally being 215 to 156. Voting no were 140 Democrats, including 30 of the 45 Democratic sponsors. Moreover, of the 22 Democrats on the House Science Committee, which had unanimously cleared the bill in late-July, 10 voted no, three voted "present" and one did not vote.

"In the end, many of the Democratic members on the science committee voted against the very bill they had sponsored."

Ehlers introduced NSEA as H.R. 4271 last April, along with two other bills designed to improve science and math education. These were H.R. 4272, the National Science Education Enhancement Act, and H.R. 4273, the National Science Education Incentive Act.

The first two acts deal with science, math, engineering, and technology (SMET) education. The third would amend the tax code to provide tax incentives for private companies and individuals participating in SMET educational activities.

The NSEA would amend the 1950 law that established the National Science Foundation (NSF) to include new grant programs related to improving SMET education. Chief among these is the Master Teacher Grant Program, which provides federal money directly to public and private schools in order to hire a "master teacher." The master teacher would provide support to up to 10 classroom teachers, and be "responsible for in-classroom assistance and oversight of hands-on inquiry materials, equipment, and supplies, including supplying and repairing such materials," according to the text of the bill. The bill provides $50 million a year to fund various grants, including the Master Teacher Grant Program.

After being introduced on April 11th, NSEA was sent to the House Committee on Science where, according to a knowledgeable source, it was bottled up for several months because of Republican opposition to a provision inserted by Rep. Lynn Woolsey (D-CA), providing money for the GO Girl program, which encourages girls to go into science education. Nevertheless, Ehlers, who spent nearly two years developing the bill in conjunction with educators and legislators, managed to get the bill brought to a floor vote.

"Ehlers talked to enough people and convinced [House Science Committee Chair F. James] Sensenbrenner [Jr., (R-WI)] that the bill should go to a floor vote," the source said.

The bill was voted unanimously out of committee on July 25th and brought to the full House for a vote scheduled for Oct. 24th.

The first sign of trouble came on Oct. 23rd when a Democratic aide noticed the master teacher provision language.

"We were sitting around during a lull in [unrelated] negotiations when I saw the language and said, 'Whoa! There's a church-state entanglement here,'" the aide said, as quoted in the Nov. 10th edition of *Science*.

Rep. Vernon J. Ehlers (R-MI)

The NEA and other teachers' union lobbyists were alerted and phones began ringing in the offices of Democratic House members.

In the end, many of the Democratic members on the science committee voted against the very bill they had sponsored, thus ensuring its defeat. Overall, only eight of the 22 Democrats on the committee voted for the bill. Only 44 of 187 House Democrats voted for the bill.

The bill's reversal of fortunes was so stunning that it surprised even the NEA. Lobbyist Joel Packard, who admitted that his organization had not read the bill until Oct. 23rd, said in the *Science* interview, "To be honest, we thought it would pass and we'd have to take our case to the Senate."

Shust said the problem was not spotted because this education-related bill didn't follow the normal route and go to the House Committee on Education and the Workforce.

"I can assure you that if had gone through the usual committee, everyone would have been alerted to this [language] much sooner," Shust said.

Opponents of the bill insist that the master teacher provision is a violation of the separation of church and state, as expressed in the 1971 Supreme Court case of Lemon v. Kurtzman, which struck down state programs that provided public money to teachers of secular subjects in private schools. The issue revolves around the distinction between programs providing money to private schools for educational materials and professional development, which are permitted, and programs providing money to private schools to hire teachers.

"[Ehlers] has a real commitment to the issue of science and math education, and we hope we can work with him."

"We oppose giving federal monies to private schools."

—Diane Shust, NEA Federal Relations Manager

In the *Science* interview, Ehlers disputed such a distinction on the grounds that NSF includes private school teachers in training and curriculum development programs. He also plans to reintroduce the bill in the current Congress with no modifications.

"I don't see any reason to modify my position, and I resent the last-minute effort to dismantle [the bill]," Ehlers said in the *Science* interview.

Shust said that the NEA would drop its opposition if Ehlers modifies the bill's funding provision.

"There is a mechanism in the current education law that could have been used and which we hope will be used, when Mr. Ehlers reintroduces the bill, that provides the money through the local education agency," Shust said.

She also praised Ehlers for his overall efforts.

"He has a real commitment to the issue of science and math education, and we hope we can work with him."

Media Fellows, *from page 2*

The experience was so positive Likens still has strong interest in eventually pursuing a career in science journalism, augmenting her prior experience writing for Berkeley publications, as well as the *Lunar Prospector*, published by NASA Ames Research Center. For the time being, however, she is focusing on graduate studies at Wesleyan University, expecting to complete her master's degree in astronomy in 2002. "At that point, it's a fork in the road," she says. "Either I go on and pursue a PhD and research career, or I head towards science writing. Either way, writing will always be a big part of what I do."

Mielke had some prior experience in writing and journalism. He earned a master's degree in English from Kent State University, and wrote several short articles on science and technology for local magazines based in northwest Ohio. But the APS fellowship was his first experience at a major broadcast news organization. He worked with producers and writers in the CNN features unit, assisting with their projects, and also had the chance to produce his own news segment from start to finish: a feature on CERN's Large Hadron Collider.

Mielke received his MS in physics from the University of Toledo, Ohio, in December 2000, and has since transferred to the University of California, Davis, to pursue his PhD studies. Since his experience as an APS mass media fellow, his future plans have wavered between a career in science broadcast journalism and a more traditional career in physics, although he has yet to make a decision. "But no matter what I decide, ultimately the fellowship was an invaluable experience. I learned a lot about science and the media, and I really enjoyed myself," he says. "The great thing about the program is that even if a fellow decides to stay in physics, you still have scientists who know intimately how the media reports science, so it improves communication between the two communities."

The APS Mass Media Fellowship was established in November 1995 to improve public understanding and appreciation of science and technology, and to sharpen the ability of the fellows to communicate complex technical issues to non-specialists. Priority is given to graduate students in physics or closely related fields, although applications are also considered from outstanding undergraduates and postdoctoral researchers.

Education, *from page 1*

an increasingly global environment. Particularly in the physical sciences, too many students receive instruction from teachers insecure in their subject area knowledge.

Some progress is being made. The efforts of experts in science, mathematics, and education have yielded appropriate learning standards that are being increasingly adopted by teachers and school districts around the country as a first step toward improvement. Yet further steps are necessary. To support a vision of science and mathematics education that ensures that all students receive high quality instruction, the APS recommends that policy makers:

- Enhance support for the preparation of prospective science and mathematics teachers, particularly those programs that involve collaborative efforts of college or university departments of science and mathematics with their departments of education.
- Recognize the critical importance of professional development activities for science and mathematics teachers, particularly by increasing investment in sustained in-service programs.
- Support sustained efforts to develop and implement high quality instructional materials for science and mathematics.
- Increase research on how students learn science and mathematics, and develop and disseminate strategies and conditions that promote effective teaching, learning and appropriate assessment.
- Provide increased resources and incentives to enhance science and mathematics teacher recruitment, retention and professional status.
- Support efforts to increase the participation and achievement of under-represented groups in the sciences, mathematics and engineering to foster a strong, diverse workforce.
- Provide incentives for partnerships among the private sector, universities/colleges and school systems to develop quality educational programs.
- Support specific, targeted funding of national programs to improve the quality of science and mathematics, such as the Eisenhower Professional Development Program.
- Encourage coordination of efforts among federal agencies that provide support for K-12 science and mathematics education.

LETTERS

APS Should Be Neutral in Religion

The Viewpoint by Freeman Dyson entitled "Science and Religion can Work Together" (*APS News*, November 2000) makes a good point. Science and religion should work together. However, I would like to make a few observations.

As a professing Christian, I see no opposition between science and religion, between the Bible and the theory of evolution. God uses both general revelation (science) and special revelation (the Bible) to communicate with his creatures, and there can be no contradiction between them. Some Christians do a better job of harmonizing these revelations than do others.

But the issue lurking in the background is whether or not God exists, and if I had to make a choice between six-day creation with god and evolution without god, I would choose the former. Furthermore, whether "the scientific revolution brings benefits to everybody rather than widening the gap between rich and poor" depends entirely, in my mind, on belief in the existence of God.

I would like the APS to maintain a neutral position on this matter, as has the Constitution of the United States. These issues should be worked out in the private sector.

George A. Kuipers
Pittsford, New York

Website Borders on Racism

Thank you very much for printing Dwight Walsh's letter ("Help for Displaced Scientists," *APS News*, December 2000), which brought to my attention the fascinating website on US underemployment at http://www.zazona.com. As a Canadian citizen currently doing post-doctoral research here in the States (on a TN visa), I particularly enjoyed the "severed head dripping blood" graphics and the extensive, almost completely anecdotal, evidence.

Although I have a great interest in fair labor practices, and certainly would not support the wholesale transfer of American jobs to foreign economies, I must admit that the web site seemed more concerned with communicating that a large number of H1 visa holders were Asian, than with showing what impact the H1 visa has on the overall job market. I heartily encourage the APS to use APS News to stimulate debate. However, I must question their decision to publish this particular letter, which advertises a web site whose alarmist and almost exclusively non-quantitative content seems to run counter to the very ideals that the APS has recently enshrined in their mission statement. Indeed, the web site Mr. Walsh mentions seems to me (a male Caucasian of North American descent) to border on racist.

I would remind Mr. Walsh that the H1 visa comes with time limits. Furthermore, the same NAFTA agreement which allows me to work in the States, allows him to work in Canada - which, I believe, is in need of technical workers at the moment. In any event, I'm certain Mr. Walsh will be relieved to know that I'm presently looking for a permanent job - and that, despite the wonderful and informative years I've spent here in the States, that job will almost certainly be in Canada.

Brian King
NIST

Lane Will Be Missed

Neal Lane's Back Page article on the new security environment in the January *APS News* was insightful, forthright and very much to the point. He will be greatly missed in Washington, not only for his exemplary service as head of the NSF and as Presidential Science Advisor, but also as one of the few physicists whose first and last names are anagrams of one another. The new administration would do well to find someone with this rare attribute to succeed him.

Andrew Warden,
Loco Road, Colorado

Religious Insights Purely Metaphorical

Stephen Brush's thought provoking article scared the daylights out of me in as much as it illustrates the extent to which human error and lack of precision of thought can have potentially dire consequences for large segments of mankind. The examples given by Professor Brush of 'creationist' thought and motivations must make us wonder how fragile human reason really is.

It does not seem reasonable to argue with people who have no wish to discuss matters with a modicum of logic. Another gaping fallacy of many creationists (from the 'Bible belt') that Professor Brush does not discuss is that they seem to think that the Bible is the only true authority about the 'facts' that govern the Universe and the beings that live in it! Surely Hindu, Buddhist, Islamic, Mayan and a myriad other cultures past and present would have a thing or two say about such narrow-minded dogmatism, and advance their own vision of Creation and 'Supreme Being' as the 'real theory' of the Universe? Are various Educational Boards required to decide who is right by majority voting? This lack of uniqueness of description alone should be sufficient reason for regarding religious 'insights' (from whatever religion) to be regarded as purely metaphorical in content, possibly valuable as illustrating the depth and complexity of the human psyche, but not directly to do with the nuts and bolts of the Universe.

The beauty of scientific theory lies in the fact that it is governed only by the criteria of Occam's Razor, predictive power and the ability to withstand all experimental tests of falsification designed specifically to interrogate its validity. In the past, scientific theories (subsequently shown to be invalid) have sometimes been propounded and defended with religious zeal by misguided enthusiasts. Some of them (eg. racial supremacy of 'aryans', or Lysenkoism) have even inflicted incredible suffering on millions. The well-known instance of zealots harming the proper development of mathematical education in Eighteenth century England (in comparison with the rest of Europe) by a mistaken and slavish adherence to Newton's notation of 'fluxions' tells us that people can do lasting damage to a whole generation if allowed to go unchallenged.

The problem then has little to do with the obvious fallacies of creationism but about what people can do in a democracy when a small bunch of committed people start hijacking the educational system by practising a form of intellectual intimidation and terrorism sustained by spreading propaganda of the crudest nature among the non-specialist public. A political/educational system which is unstable to such perturbations surely needs to be looked at again from a critical point of view, and if necessary, redesigned to avoid egregious outcomes such as those mentioned.

Anantanarayanan Thyagaraja
UKAEA Fusion, Culham Science Centre, United Kingdom

VIEWPOINT…

Physics as Metaphor in a Novel by Penelope Fitzgerald, Revisited

by Martin Goldstein

Physical scientists who were intrigued by Michael Frayn's use of the uncertainty principle as a metaphor in his award-winning play *Copenhagen* may also be intrigued by the metaphoric use of an episode from the history of physics in a novel published by the late British author Penelope Fitzgerald.

The Gate of Angels, first published in 1990, takes place in and around Cambridge University in 1912. Its main protagonist is a young physicist, Fred Fairly, a Junior Fellow of Angels College (formally called St. Angelicus), an imaginary Cambridge college whose founding in the 15th century, according to the narrator, had been authorized by a real antipope, Benedictus XIII. As the novel opens, Fairly has been doing research and teaching at the Cavendish Laboratory for five years, at a time when J. J. Thomson was in charge of the lab.

Ms. Fitzgerald's prose and close attention to historical detail deftly establishes the atmosphere of the place:

> [T]he labs were overcrowded with research students, all of them left to patch up their own apparatus by trial and error, each of them lucky if they could find a little space, even on a single table. The room at the very top of the building... was cold because of the very narrow bore of the copper heating pipes, which were supposed to avoid magnetic disturbance. Out of this squalor had come indisputable greatness. Not one of the students would have wished to be anywhere else. They were at the Cavendish.

Equally evocative is her description of the medical practices in an early 20th century London hospital. Nonetheless, there are a few minor mistakes with regard to her physics. For example, one of Fairly's colleagues, planning to recreate the Michelson-Morley experiment, refers to "the Fitzgerald-Lorenz contradictions." Fairly, lecturing on Gauss's Theorem, states, "The total normal gravitational flux over any surface enclosing a mass is 4[pi]m." [The word "minus" should precede 4[pi]m.] Another faculty member anachronistically refers to "anti-matter," a term that was not coined until the 1930's.

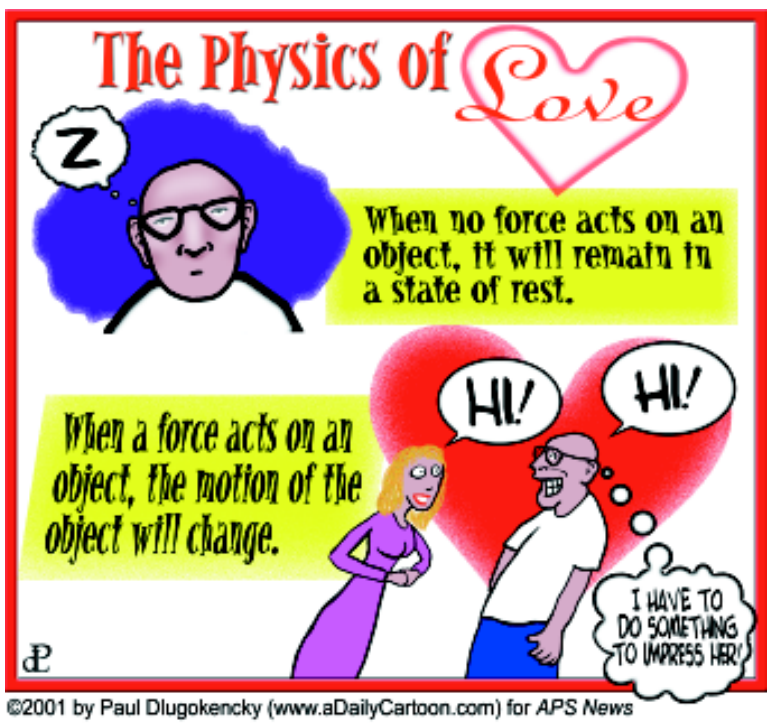
As its title suggests, the novel is concerned, among other things, with forms of faith, religious and otherwise, as "the evidence of things not seen." Indeed, early in the novel Fairly has faced the difficult task of telling his father, a minister in the Anglican Church, that he has lost his Christian faith: "The only evidence we can get [for belief] is from our own senses and from the senses of other people who have gone before us."

The novel is also concerned with issues of faith in science, set during a period when there was a great deal of controversy over Rutherford's "unobservable" atom. Fairly longs to go to Manchester and work with Rutherford, but is actively discouraged by his colleague, Professor Flowerdew — a strong partisan of Ernst Mach, who believed an atom "is not a reality, it is just a provisional idea, so how we can say that it is situated in space?" says Flowerdew.

The novel does not present a naive view of faith, which is also shown to have its aberrations. If one believes in the existence of things not detectable by the senses, one could believe in ghosts as easily as angels, as one character does. Nor is religious belief shown in a flattering light by the amusing history given of the uncompromising antipope Benedictus XIII, who by standing on principle prevented the reconciliation of a schism in his church for a generation. By the novel's end, Flowerdew senses that his cause is lost, but, like Benedictus, cannot admit it. He urges Fairly to attend a lecture by Hans Geiger, Rutherford's assistant, on the difference between the Rutherford and Thomson models of the atom, asking him to take good notes, but is too skeptical about Rutherford's "unobservable" atom to go himself.

One does not need to be a physicist to enjoy this novel, but it helps to have some acquaintance with the history of physics: to know, from the vantage point of the end of the 20th century that Mach's program proved a sterile and unproductive one. The triumphs of 20th century physics came about because at least some physicists had faith in the existence of things not directly observable. Fairly's rejection of religious belief thus stands in ironic contrast to his belief in the reality of atoms.

zero gravity



TIMSS Report Provides International Comparisons in 8th-grade Science & Math

A new report finds that, compared to their peers around the world, US eighth-grade students score above average in science generally but only at the international average in physics, and are less likely than their international peers to have science teachers with a major or degree in physics.

Educators, policymakers, proponents and critics alike of the nation's K-12 education system have relied on information from a series of international comparisons at various grade levels. Four years ago, the Third International Mathematics and Science Study (TIMSS) provided results of a 1995 comparison of fourth-, eighth-, and twelfth-graders around the globe. On December 5, the US Department of Education's National Center for Education Statistics released preliminary results of the TIMSS-Repeat (TIMSS-R) study, conducted in 1999 on eighth-graders.

According to the report, US eighth-graders performed slightly above the international average of 38 nations in both science and math. In the 1995 study, US eighth-graders had tested above the international average in science but below the average in math, compared to students in 41 participating countries. Direct comparisons of international standing cannot be made between the two years because the list of participating countries is not identical. In fact, the data shows no absolute improvement in performance of US eighth-graders between 1995 and 1999, in either science or math.

The TIMSS-R data shows that in science, US eighth-graders outperformed their peers in 18 nations. They performed similarly to their peers in 5 nations, and they scored lower in science than students in 14 nations. In math, the TIMSS-R results show that US eighth-graders performed better than their peers in 17 nations and performed similarly to students in 6 nations. Their scores were surpassed by those of students in 14 nations.

The TIMSS-R data also suggests that US eighth-graders performed worse in science and math in 1999 than US fourth-graders (presumably including many of the same students) did in 1995, when compared to a group of 17 nations that participated in the same two assessments. According to acting commissioner of education statistics Gary Phillips, "This finding validates the results of the previous 1995 study that after the fourth grade, students in the United States fall behind their international peers as they pass through the school system."

While black US eighth-graders improved their math scores over the black eighth-graders of four years ago, they did not improve their science scores. Neither white nor Hispanic US eighth-graders showed improvement in either subject over comparable US eighth-graders in the 1995 study.

The report points out some differences in curriculum, teacher preparation, and teaching practices between the US and other countries, but warns that analysis of the data is still preliminary and cautions against assuming unwarranted correlations. US eighth-graders are less likely to be taught math or science by a teacher with a major or main area of specialty in math or physics, respectively, but are as likely as their international peers to be taught science by a teacher with a major or degree in biology, chemistry, or science education. US students are asked to explain the reasoning behind their science lessons, and to conduct experiments or practical investigations, more often than the international average. The US eighth-graders are more likely to begin doing their math or science homework during class, and to work independently on worksheets or texts in lessons, than the international average. They also spend less time than their international peers doing math or science homework or studying outside of school.

—Audrey T. Leath, AIP Public Information Division

Fall DNP Meeting Features Third Annual Outreach Program for Undergrads

The fall 2000 meeting of the APS Division of Nuclear Physics (DNP), held in Williamsburg, Virginia, featured a program of events designed specifically for undergraduate students. The purpose of this (third annual) "Conference Experience for Undergraduates" (CEU) is to provide a capstone conference experience for undergraduates who have conducted research in nuclear physics, by providing them the opportunity to join the larger professional community, present their research, and participate in the conference activities. The CEU also enables the students to converse with faculty and senior scientists from doctoral institutions about graduate school opportunities.

The CEU was conceived and organized in order to welcome undergraduate students who had some research experience into the larger nuclear physics community to share their work and meet with their peers.

The CEU is sponsored by the NSF and several DOE accelerator laboratories, including the Los Alamos, Lawrence Berkeley, Argonne, Oak Ridge, Jefferson, and Brookhaven Labs. Students qualified to participate in the CEU program include any that have participated in experimental or theoretical nuclear physics research. Interested students submit an application consisting of a research abstract and a brief summary of the student's individual contribution to a larger group effort. The best qualifying students receive travel and lodging awards, while others receive lodging awards and need to raise travel funds from their research groups or home institution departments. Conference registration and banquet costs are covered for all students. Student response has been very strong. Around 60 students attended CEU98 and 99, and 80 participated in CEU 2000. Participation by women students has averaged around 32%, while that of minority students has averaged around 5%.

The CEU2000 events included two student research poster sessions, a welcome breakfast, a CEU nuclear physics seminar, and a graduate school information session, with representatives from over 20 graduate schools and laboratories. Additionally students went on the DNP Jefferson Lab tour and the Friday evening banquet. The CEU homepage is http://physics.westmont.edu/ceu2000 where there is more information about the program, including many photos of the event.

—Warren Rogers

Taking Physics onto the Putting Green

Champion golfer Tiger Woods is a physics lesson in action, and Sandra Harpole wants to prove it. Harpole, a physics professor at Mississippi State University, hopes that someday, just like Woods, one of her students will win a championship of their own — maybe with a little help from physics. Harpole runs a summer program for 6th to 8th graders called "Science on the Green," that teaches kids about golf, as well as physics, math and engineering.

Tiger Woods

Harpole received funding for the program from the United States Golf Association. She says "Science on the Green" gives students, who might otherwise not think of golf as a sport or as a science career, a new perspective. "Many students are totally unaware of the many opportunities in science, mathematics, engineering and technology that exist. They do not picture women and minorities as scientists or engineers or think of science and engineering careers in industries such as golf."

The program runs for two weeks during the summer, with follow-up sessions throughout the school year. "Students spend each morning learning how to play golf, about golf course design and management, and golf etiquette," Harpole says. But these students are teeing up more than golf balls. Each afternoon the students have classes and laboratory experiences that incorporate science and mathematics. For one lab, the students visited Taylor Made Adidas' manufacturing plant to learn how science and engineering are involved in design and testing of golf equipment.

Students determined the coefficient of restitution of the golf balls (which influences how fast the ball will go when hit by a club) and tried hitting balls with and without dimples, showing them the result of good golf ball engineering (dimples on a golf ball create controlled turbulence as the ball flies, reducing the amount of drag on the ball—allowing it to go further). Harpole says, "the students were just amazed at the difference the dimples made."

"They all want to come back next year," says Harpole. Still, she points out that just knowing about the science of the game may not make anyone a better player. "No matter how well you understand the physics," she says, " you still have to practice."

—Inside Science news team

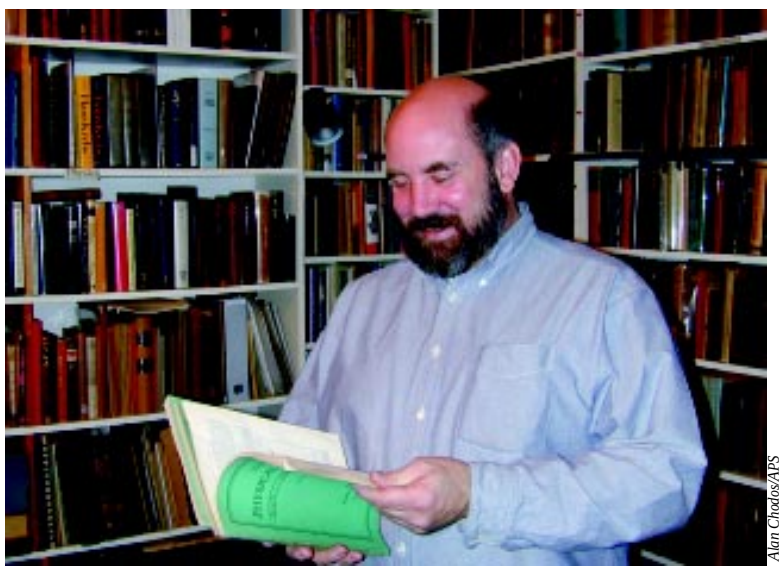
How Much Are Those Old Phys Rev's Worth, Anyway?

The office of many a senior faculty member features shelf after green shelf of ancient volumes of the *Physical Review*, stretching back sometimes into the 1940's and 50's. When said faculty member retires those volumes are often given away or simply thrown out. And yet some of them have a well-established market value, according to John Ptak, proprietor of J. F. Ptak Science Books in the Georgetown section of Washington, DC.

"We are probably the largest sellers of used, out-of-print, scarce, unobtainable and non-existent books in science and mathematics" says Ptak, "not to mention manuscripts, reprints, journals, maps and prints."

A visit to Ptak's establishment at the corner of 33rd and (appropriately enough) Volta Streets in Washington tends to support his claim. The floor-to-ceiling shelves are crammed with volumes both old and fairly recent, jostling each other for space. Books and journals sway precariously in tall piles in the corners, and occasionally come skidding down across the floor. Prints and maps line walls and fill cabinets. Other artifacts, such as an artificial skeleton, a microscope and a set of test tubes, pop up in odd places.

Ptak prefers to buy books, journals, pamphlets and other material in large lots. He then "mines" them for the fraction that has resale value. These are stored both in Georgetown and in a warehouse that Ptak maintains in nearby Maryland. He has "many hundreds, if not over a thousand" older volumes of the *Physical Review* for sale, and the price depends on what's in them. For example, the issue dated April 1, 1948, containing the famous paper by Alpher, Bethe and Gamow, sells at a premium compared to other numbers in the same volume. Other issues on display date back to the early years of the 20th century, some bearing the signature of Clinton Davisson of the Davisson-Germer experiment. In those days the *Physical Review* printed only about a hundred pages a month, and the research articles were sandwiched between ads for books and equipment in the front and back.



Alan Chodos/APS

John Ptak looks through one of the journals of yesteryear.

Ptak is particularly proud of his collection of books and journals on quantum mechanics and quantum electrodynamics. He has hundreds of items for sale, including as one example a first edition of Schiff's book on quantum mechanics, complete with its original dust jacket. Ptak is selling it for $75, whereas the dust jacket reveals that it fetched $5.50 in 1949 when it was new.

Ptak thinks most of his items are real bargains. "Baseball cards or comic books of this vintage and in this condition would sell for ten times as much," he says. "Anyone with a job can afford what I sell."

Those who are interested in Ptak's wares but who are not within striking distance of Georgetown can browse and shop on the web at http://www.thesciencebookstore.com. And he is eager to hear from physicists with books or journals they might want to sell.

INTERNATIONAL DESK

Langer, Lerch Foster Closer Ties with Indian Scientists

Last October, then-APS President James Langer (University of California, Santa Barbara), and APS Director of International Affairs Irving Lerch visited institutes and university physics departments in three major Indian cities: Mumbai (formerly Bombay), Bangalore and New Delhi.

In the aftermath of the Indian and Pakistani nuclear tests in May 1998, there was concern that the punitive impediments enacted by the Congress to prevent the spread of nuclear weapons might undermine long-time scientific collaboration to the detriment of the US and both India and Pakistan. Through the medium of a visit that would be informal, collegial and unofficial, and by participating in private discussions and scientific exchanges, it was hoped that Langer and Lerch could help to assure the Indian physics community that it remains a valued partner in the international enterprise.

Of pressing concern to the Indian scientific community is electronic access to journals, particularly the lack of on-line access. While the most important universities and institutions have such access, most lack broadband Internet connections. India has no national network, and hence major institutions must maintain their own ground stations or land lines. Lerch and Langer stressed that before the APS can discuss possible effective solutions to the problem, the Indian Physics Association (IPA) and other education and research institutes must catalog their needs and capabilities. Lerch believes that the remedial distribution of CD-ROMs will probably be the best alternative in the short run, pending the advent of a wide-band national network in India.

Another issue is the net flow of students and technically trained people from India to the US. "The Indians recognize the importance of this, even though to some extent they are in competition with us," says Lerch, pointing to the fact that the US brings in critical talent which India badly needs at a time when it is trying to build an independent technology base in cities like Bangalore. "Yet they're reluctant to impede these exchanges because they feel the mobility of scientific talent is more important than their immediate needs."

Langer and Lerch were drawn in to casual discussions on issues of safeguards and arms control during their visit to the National Institute of Advanced Studies (NIAS). The Institute Director, Roddam Narasimha, and a number of senior faculty have been engaged in such discussions with the Committee on International Security and Arms Control of the US National Academy of Sciences and there was considerable interest expressed about the attitudes within the US physics community concerning India and Pakistan's entrance into the nuclear club. To date, the Indian physics community has not developed an independent reservoir of nuclear policy expertise capable of affecting government decisions, further hampered by the fact that most Indian physicists are government employees who find it difficult to oppose or even question government policy in this area. "Scientists are essentially wards of the state, as they are in socialist countries," says Lerch, who views this as a major problem.

Both Lerch and Langer believe that they were successful in the central purpose of their mission: to invigorate contacts and explore issues of mutual concern between the two scientific communities. In fact, the APS intends to explore further joint APS/IPA activities, such as junior and senior scientist short-term exchanges, and possibly workshops or similar scientific forums. And the APS plans to continue to work with selected contacts within the Indian physics community to develop and pursue grass-roots discussions on a variety of issues such as obstacles to scholarly exchange and the impact of the technology embargo on Indian-US scientific collaboration.

Ranjit Nair, President of the Centre for the Philosophy and Foundations of Science in New Delhi, introducing James Langer as the Jagadis Chandra Bose Lecturer for 2000.

Langer, who visited India several years ago, confessed to being somewhat distressed at "the sense that some things are getting worse" in the region, most notably air pollution, overpopulation and transportation. However, he was heartened to find that the level of scientific research remains world-class in several institutions, particularly in the area of condensed matter physics, and concluded that "collegial scientific interaction" between the two countries "is as important today as it has ever been."

APS Reps Attend Third World Congress of Physical Societies in Berlin

On December 15 and 16, 90 delegates representing 40 national and regional physical societies assembled in Berlin for the third World Congress of Physical Societies. It was convened by both the European Physical Society and the German Physical Society (DPG), with EPS President Sir Arnold Wolfendale presiding. Wolfendale is the former Astronomer Royal of the United Kingdom and a past-president of the Institute of Physics. The last Congress was held in Tokyo in 1995.

The event was timed to coincide with the conclusion of the centennial of the advent of quantum theory by Max Planck, who published his revolutionary tract in the *Annalen der Physik* on December 14, 1900. To honor this seminal event in the history of 20th century physics, the delegates to the Congress were invited to a Jubilee session in the Schauspielhaus in the center of Berlin and near to the venue of the World Congress. The German Minister for Science and Research, Edelgard Bulmahn, addressed an open meeting attended by scientists, students, and numerous non-scientists. This was followed by scientific addresses by Nobel Laureates Klaus von Klitzing and Claude N. Cohen-Tannoudji.

The delegates convened in the Magnus-Haus, a recently restored 18th century structure in the center of Berlin, which serves as DPG's Berlin headquarters. The meeting focused on three themes: public understanding of physics, raising the profile of physics in the schools, and the strengthening of physical societies. Driving the Congress was a recognition that not all was well with the public face of the physical sciences. While government investment in science in the industrialized nations remains strong, and public confidence in scientists remains high, enrollments in physics—especially in the universities and colleges—is in general decline.

American Institute of Physics Executive Director Marc Brodsky gave a well-received presentation on the new science spots being produced by AIP for television. APS President James Langer chaired the sessions on physics education and gave a talk outlining some of the current APS initiatives. There was consensus that teacher education is an essential element in improving physics education in the secondary schools. An interesting feature of this discussion was the apparent commonality of problems in both the developing and industrial countries. However, the most intractable problem in the developing countries of Africa, Latin America and Asia was government indifference to the role of science in education.

APS Executive Officer Judy Franz presented a talk on the importance of national governments to the health of physics research and education in each country and the role of physical societies in promoting physics to governments and the general public. The role of the International Union of Pure and Applied Physics was discussed by Burton Richter, a former APS president and currently president of IUPAP. He described the role of the commissions and special working groups in planning major new facilities and invigorating international exchange. IUPAP is the only instrument for providing physicists with a structured forum for strategic planning in the international arena. Agreements for the next generation of accelerators and the need for broad based consensus on research priorities makes IUPAP indispensable as international facilities augment national programs in the pursuit of frontier research.

Wolfendale introduced the most controversial topic: brain drain, not only in the third world, but also in Western and East-Central Europe. He saw the continuing drain of scientific talent from East-Central Europe, the Former Soviet Union and other countries as a threat to their future scientific integrity and recovery. He charged that American and — to a lesser extent — European practices bordered on the predatory and suggested that governments importing talented scientists contribute financially to their countries of origin. Richter took strong exception, pointing out that many of the problems in Western Europe were self-inflicted and that it would be damaging to introduce artificial impediments to free exchange. He also pointed out that the mobility of scientists was essential to the economic development of the nations of the Asia-Pacific region and to Europe itself.

In the final session of the conference, a number of resolutions were presented and discussed. These resolutions will undergo editorial review and then be circulated to the conference participants for their approval. APS will make these available on the web when they are finalized.

DOE Reviews, *from page 1*

The full Baker-Hamilton report is available at http://www.fas.org/sgp/library/bakerham.html.

The independent group of scientists was headed by Nobel Laureate Robert C. Richardson of Cornell (no relation to the former Secretary) and contained two members of the Hamre Commission, Richter and William Happer of Princeton, a former director of the DOE Office of Energy Research (since renamed the Office of Science). Richardson's December 14 letter to members of Congress accompanying the group's "discussion paper" pointed out that "the US physics community is deeply concerned about the future of scientific research supported by DOE". The group's first alternative considers a proposal "to elevate the Director of the DOE Office of Science to the rank of Under Secretary for Science and Energy, with additional responsibilities as Science Advisor to the Secretary."

The second alternative is "to create a 'National Institutes of Science and Advanced Technology' (NISAT) within a cabinet-level department in analogy to the National Institutes of Health within the Department of Health and Human Services. NISAT would include the DOE science and energy programs together with other agencies such as the National Institute of Standards and Technology (NIST) and would "form the major part of a new 21st Century Department of Commerce."

Readers interested in the complete discussion paper can view it at http://www.aps.org/apsnews/doescience.pdf.

Others in the group proposing these alternatives were: James S. Langer of the University of California, Santa Barbara, then President of APS; Martin Blume, Editor-in-Chief of APS and former Deputy Director of Brookhaven; Sidney Drell of the Stanford Linear Accelerator Center; John H. Gibbons, former science advisor to President Clinton; Martha Krebs, former Director of the DOE Office of Science; W. Carl Lineberger, University of Colorado, and past chair of DOE Basic Energy Sciences Advisory Committee; Albert Narath, former director of Sandia National Laboratory; and George H. Trilling of Berkeley, then President-elect (and now President) of the APS.

CSIS Study Participants

- Howard Baker, former senator from Tennessee
- Robert Barker, former assistant to the secretary of defense for atomic anergy
- William Bratton, former New York City police commissioner
- D. Allan Bromley, former director of OSTP, Professor of Sciences, Yale University
- Robert Bryant, former FBI deputy director
- James Clapper, former director, Defense Intelligence Agency
- France Cordova, former NASA chief scientist
- Charles Curtis, former deputy secretary of energy
- Jamie Gorelick, former deputy attorney general
- Lee Hamilton, former representative from Indiana
- John Hamre, president of CSIS, former deputy secretary of defense
- William Happer, former director of energy research at DOE
- Miriam John, vice president, Sandia National Laboratories
- Anita Jones, former director of defense research and engineering, DOD
- William Madia, director, Oak Ridge National Laboratory
- Michael May, former director, Lawrence Livermore National Laboratory
- Burton Richter, Nobel Laureate, professor of physical sciences, Stanford University
- James Schlesinger, former secretary of defense, former secretary of energy, former CIA director
- William Webster, former FBI director, former CIA director

ANNOUNCEMENTS

The American Institute of Physics and the US Department of State Announce:

AIP State Department Science Fellowship

Are you a scientist with an interest in foreign policy? This is a new opportunity to utilize your technical expertise to support the work of the US Department of State, and to be actively involved in the foreign policy process. AIP is now accepting applications for candidates to serve a one- to two-year Fellowship term in the State Department, commencing in the fall of 2001.

REQUIREMENTS:

- PhD or equivalent research experience in physics or related field.
- Membership in one or more of AIP's Member Societies.
- Familiarity with, or experience in, scientific or technical aspects of foreign policy.
- US citizenship.
- Fellowship contingent upon receipt of security clearance before starting term.

BENEFITS:

- One- to two-year stipend of $49,000 annually and benefits provided by AIP.
- Other costs associated with assignment paid by host bureau at State Department.

APPLICATION MATERIALS REQUIRED:

- Submit Resume and Letter of Intent to the address below. Please discuss your interest in and suitability for the position.
- Arrange to have three Letters of Reference sent directly to the address below. Letters should address the candidate's scientific competence, and the education, experience and attributes that qualify the candidate for this position.

DEADLINE:

- All application materials MUST BE POSTMARKED BY APRIL 15, 2001 for Fellowship commencing in fall 2001.
- All application materials must be submitted to the address below:

American Institute of Physics
One Physics Ellipse
College Park, MD 20740-3843
ATTN: Audrey T. Leath

For more information, please see our web site at http://www.aip.org/mgr/sdf.html or contact Audrey T. Leath at aleath@aip.org or 301-209-3094.

Y2K APS Fellowship Nomination Deadlines

For submittal information see: http://www.aps.org/fellowships

DIVISIONS		International	
Astrophysics	05/01/01	Physics	04/02/01
Atomic, Molecular, Optical	03/31/01	Industrial and Applied Physics	02/20/01
Biological Physics	04/02/01	Education	04/15/01
Chemical Physics	02/15/01		
Computational Physics	04/14/01	***TOPICAL GROUPS***	
Condensed Matter	PAST	Few Body Systems	04/10/01
Fluid Dynamics	02/15/01	Precision Measurement Fund. Const.	04/02/01
Polymer Physics	04/15/01	Instruments and Measurement	04/02/01
Laser Science	04/02/01	Shock Compression	04/02/01
Materials Physics	02/15/01	Gravitation	04/02/01
Nuclear Physics	04/02/01	Magnetism and Its Applications	04/02/01
Particles & Fields	04/02/01	Plasma Astrophysics	04/02/01
Physics of Beams	03/15/01	Statistical and Nonlinear Physics	04/02/01
Plasma Physics	04/02/01		
FORUMS		***APS GENERAL***	06/01/01
Physics & Society	04/02/01		
History of Physics	04/02/01		

Nomination Deadlines Extended

Submittal information at www.aps.org under the Prize and Awards button.

OTTO LAPORTE AWARD ..... Deadline: 02/15/01

FLUID DYNAMICS PRIZE ..... Deadline: 02/15/01

APS UNDERGRADUATE PHYSICS STUDENT COMPETITION

2001 APKER AWARDS

For Outstanding Undergraduate Student Research in Physics

Endowed by Jean Dickey Apker, in memory of LeRoy Apker

DESCRIPTION

Two awards are normally made each year: One to a student attending an institution offering a Physics PhD and one to a student attending an institution not offering a Physics PhD

- Recipients receive a $5,000 award; finalists $2,000. They also receive an allowance for travel to the Award presentation.
- Recipients' and finalists' home institutions receive $5,000 and $1,000, respectively, to support undergraduate research.
- Recipients, finalists and their home physics departments will be presented with plaques or certificates of achievement. The student's home institution is prominently featured on all awards and news stories of the competition.
- Each nominee will be granted a free APS Student Membership for one year upon receipt of their completed application.

QUALIFICATIONS

- Students who have been enrolled as undergraduates at colleges and universities in the United States at least one quarter/semester during the year preceding the **JUNE 15, 2001** deadline.
- Students who have an excellent academic record and have demonstrated exceptional potential for scientific research through an original contribution to physics.
- Only one candidate may be nominated per department.

APPLICATION PROCEDURE

The complete nomination package is due on or before **June 15, 2001** and should include:

1. A letter of nomination from the head of the student's academic department
2. An official copy of the student's academic transcript
3. A description of the original contribution, written by the student such as a manuscript or reprint of a research publication or senior thesis (unbound)
4. A 1000-word summary, written by the student, describing his or her research
5. Two letters of recommendation from physicists who know the candidate's individual contribution to the work submitted
6. The nominee's address and telephone number during the summer.

FURTHER INFORMATION

See **http://www.aps.org/praw/apker/descrip.html**

DEADLINE

Send name of proposed candidate and supporting information by **JUNE 15, 2001** to: Dr. Alan Chodos, Administrator, Apker Award Selection Committee; The American Physical Society; One Physics Ellipse, College Park, MD 20740-3844; Telephone: (301) 209-3268, Fax: (301) 209-3652, email: chodos@aps.org.

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THE BACK PAGE

Physics, Power and Defense in the 21st Century

by George A. Keyworth, II

In this new digital age we live in, it is no longer the ability to do work that matters but, rather, how fast you do it. And the same logic will shape how we think about defense in this new era.

In just a decade or two, the world has changed: Different dynamics, different rules, and different challenges. It is the reduction of the many barriers to new entrants that so uniquely characterizes the industrial era.

Those barriers stem, largely, from the very factors that define the industrial economy, especially from economies of scale and regulations designed, above all, to ensure capital stability. With those barriers now falling, look at the changes around us, even though the transition from an industrial economy to a digital economy has just begun.

There is no finer example of America's post World War II preeminence than IBM. Yet the speed with which Microsoft, Oracle, and Intel left IBM in the dust offers us a glimpse of just how fast moving and renewing is this new economy. And the Internet, which is but the first step in the conversion of the analog infrastructure of the industrial age to the digital infrastructure needed in the digital age, is increasing the pace. Look at how rapidly Cisco, a communications company but one born digital, surpassed each and every one of the great telephone equipment companies. And look at how tiny Finland, by embracing everything digital, has been reborn as one of the world's more sophisticated and successful economies.

With the barriers of the industrial economy in remission, resulting in revitalized global competition, one can get a glimpse of what Charles Darwin documented in *Origins of the Species*. Perhaps we have simply returned to what is more natural, and the industrial age was less so.

In nature, nothing is more important for survival than a species' ability to adapt. And time and time again, that is what is defining the survivors in the digital economy. Microsoft, Oracle and Intel learned how to adapt and it was a major factor in their success. Each has been threatened, time and again, and each responded in a manner that made the company stronger.

The industrial age saw military forces structured in much the same way as the economy—and similarly resistant to change. That shouldn't be surprising. Inevitably, both a nation's defense and economy are driven by largely the same factors, and by the same technologies. Then what is before us in defense?

It took a decade or more before we accepted the fact that our economy was in a condition of discontinuous, irreversible change. And we now generally accept the fact that it is not simply the post cold-war or the global economy that has caused the change, although those factors do contribute. Instead it is technology—digital technology—that is driving that change.

What might a digital defense look like? First, electronics will play a big part, just as it has in shaping what we mean today when we speak of the modern military. One particular dividend electronics will yield is in precision targeting, that elusive partner to precision delivery. This is possible now, on a full-time, global-coverage scale, using distributed satellites and multi-spectral sensors.

Space-based surveillance systems have comprised the backbone of America's military intelligence for decades. Like mainframe computers, though, their application was limited. Now, with distributed surveillance—highly redundant, mutually supporting sensing platforms—space-based surveillance will inevitably expand to provide tactical support, and the means for better decision-making at all levels of operation.

"With the ability to respond and adapt to a wide variety of threats, with a highly-leveraged technology, one can begin to think realistically of a defense that goes beyond nuclear weapons."

There is enormous technological potential here that can be exploited. In sensors, for example, combining computing with transducers continues to yield performance breakthroughs, like the high-resolution Synthetic Aperture Radar that General Atomics flew recently on its Predator unmanned aircraft. And there is tremendous potential to use the massive computing power of a distributed surveillance network to process complex algorithms for image enhancement, recognition, or data synthesis for decision support, and even simulation.

Another area that will be important is electronic countermeasures (ECM). With radar, stealth technology changed the name of the game, reducing the reflected signal levels to a level where canceling them actively became feasible. Such computing-intensive approaches can be extended beyond radar, even to passive sensing systems such as infrared. And active cancellation is but one example of a rich area of technological opportunity in ECM.

The trend toward increasing precision will continue; the trend toward more and better real-time information will continue; delivery systems will get faster and more complex to detect; and, in missions, rapid strikes will continue to displace fixed engagements.

Just as wireless communication opened up tremendous opportunities for interception in World War II, the new digital infrastructure is opening up new opportunities for exploitation. Nevertheless, information warfare is not a discontinuity.

The last real discontinuity in defense was the nuclear weapon. I suggest to you that the discontinuously-derived digital defense will result from displacing the nuclear weapon. This is not, by any means, to imply that nuclear weapons can, or will, go away. What I do mean is that the overarching role that nuclear weapons played in the cold war is diminishing. That role has been changing for a long time.

One way it began to change was with the introduction of independently guided warheads on a trendline of increasing precision. Together, they led to a fundamental change in nuclear deterrence, and especially in the way we viewed stability. Stability, in nuclear deterrence, is as fundamental as the likelihood of a nuclear attack being initiated. The less the incentive to initiate a first strike, the more stable the deterrence.

At the outset of the cold war, and for three decades thereafter, the condition known as MAD, or mutual assured destruction, resulted in a rather stable form of deterrence, referred to as counter-value deterrence. However, with the introduction of precision-guided, multiple warhead missiles in the mid-1970's, another form of deterrence emerged, known as counter-force deterrence.

In the former, high-value targets such as cities would bear the brunt of a nuclear attack; in the latter version, missiles targeted missiles. Superficially, one might view this as progress. But this newer form of counter-force deterrence was less stable in that there was, conceivably, more rationale for preemption. And by the late 1970's, it became obvious that the Soviet Union was exploiting this potential instability with a nuclear force structure designed for preemption.

Today all this sounds pretty arcane, or perhaps irrelevant, to most of you. But history will reveal that the cold war was a time of enormous hazard, and one that challenged the comprehension of a democratic society. No one has described this dilemma better than Freeman Dyson, one of the truly great mathematical physicists of our time, in his book *Weapons and Hope*. He describes two kinds of citizens, soldiers and civilians, and he describes how differently they will, inevitably, view the conditions for peace. Totalitarian systems are led by soldiers, while democracies are led by civilians.

In 1981, and as result of a massive Soviet buildup of offensive-capable nuclear capability, the US responded with the Reagan administration's strategic modernization program. In parallel, it undertook a dramatic new approach to arms control, one that focused upon reducing the specific kinds of missiles that were most destabilizing, the Soviet SS-18s.

"The use of nuclear weapons is more probable now than at any time since World War II."

In the now-famous speech he delivered on March 23, 1983, President Reagan took a bold step to both challenge the Soviets further, and to launch us on a path to eventually reduce our reliance upon nuclear weapons. He began what became the Strategic Defense Initiative, or SDI—Star Wars by its critics. He called upon the scientific community, who had given us nuclear weapons, to now give us the technical means to make them obsolete.

He viewed our continued reliance upon nuclear weapons, as a long-term basis for our defense, as flawed. He viewed a strategy of deterrence that placed civilians at risk, indistinguishably from soldiers, as morally flawed, founded on principles that were inconsistent with our heritage. He could never take seriously Robert McNamara's often quoted cliché that "deterrence is a condition, not a strategy." What he learned from the many issues that confronted him in strategic modernization, especially the conditions for stability, convinced him that deterrence had become too fragile to endure.

While the SDI was effective in restoring counter-force deterrence to its more stable alternative, counter-value deterrence, the basic problem remains: that morally, nuclear deterrence is a wrong basis for security and, practically, it fails to draw upon the strengths of a democracy.

Paul Nitze has stated recently that the very successful role that nuclear deterrence has played for half a century is simply finished. He argues that he cannot conceive of any circumstance in which the use of nuclear weapons can serve our national interests. And he is right.

Look for a moment at some of the other realities. One is that deterrence is based upon a more than half-century old technology, at the top of its S-curve, where we have made only marginal improvements in the last 30 years. Third-world economies, from Pakistan to India and especially China, are catching up. The adjuncts of deterrence, arms modernization on the right and arms control on the left, can no longer prove effective in preventing the use of nuclear weapons. In fact, in the light of recent nuclear sword-rattling by India and Pakistan, and in spite of non-proliferation efforts, the use of nuclear weapons is more probable now than at any time since World War II.

Moreover, we seem to have a defense policy that assumes that, perhaps 20-50 years from now, China will have a nuclear deterrent that will inevitably challenge our own. Reminiscent of a deer in one's headlights, one can only wonder why steps aren't taken to avoid such a predictable circumstance. Similarly, we seem to assume today that a defeated Soviet Union, no longer even in existence and with the residue of its military machine in collapse and chaos, should serve as the validating basis for arms control treaties that precede modern China, the end of the cold war and even the PC.

George A. Keyworth, II

What could, today, meet the objective Ronald Reagan had in embarking on a path to reduce reliance upon nuclear weapons? What can affect the likelihood that nuclear weapons may be used in Kashmir, or by terrorists against us? What can replace nuclear weapons in the force structure that will ensure our security in the new digital age that we have embarked upon?

I suggest that our next-generation defense will depend upon two primary technologies. One can be extrapolated from current experience and is the kind of continuous, global surveillance that can be achieved with a distributed satellite network. The other, more embryonic, is the technology of short-pulse, high-power lasers that can replace today's speed-of-sound armaments with speed-of-light equivalents. The destructive mechanism here is impulse, rather than thermal, and the effect is both extraordinarily effective and difficult to counteract.

Combined with the precision targeting and overall intelligence capabilities of a distributed surveillance system, a radically new and effective military capability can result. With the ability to respond and adapt to a wide variety of threats, with a highly-leveraged technology, one can begin to think realistically of a defense that goes beyond nuclear weapons.

Nearly 20 years ago, it was these same two technologies that justified a new look at ballistic missile defense. In spite of the passage of time, and with so much progress in other areas, only marginal attention has been paid to these two key areas of defense technology, especially with impulse lasers. But it is time to once again take an inventive approach to how we rebuild our decaying military.

George A. Keyworth is former presidential science advisor to Ronald Reagan, and chairman of the Progress and Freedom Foundation. Adapted from a talk given at the 2000 Industrial Physics Forum in San Diego last November.

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.