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Carl Wieman on
"The Curse of Knowledge"
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Seven Apker Finalists Meet in Washington

Photo by Shelly Johnston

The APS Apker Award is given annually for outstanding research by an undergraduate. Finalists are chosen in two categories: from institutions that award PhD degrees, and from institutions not awarding the PhD. The finalists meet with the selection committee for a day of interviews, which this year took place on September 16 in downtown Washington. The committee then recommends recipients in each of the two categories to the APS Executive Board. Shown in the picture are the seven finalists. Left to right: Stephen Poprocki (the College of Wooster); Scott Bender (Santa Clara University); Matthew Becker (University of Michigan); Silviu Pufu (Princeton University); Jeffrey Thompson (Yale University); Vernon Chaplin (Swarthmore College); and Bryce Gadway (Colgate University). The recipients of the Apker Award will be featured in the December *APS News*.

Physics Fans Get Chance to Win World's Smallest Trophy

A nanoscale football field and helmet, created in silicon and metal by physicists of the Craighead research group at Cornell University in Ithaca, NY, will be awarded as a prize in APS's football video contest.

The contest is an APS public outreach effort to get football fans interested in physics. Participants in the contest will create short YouTube videos demonstrating some aspect of physics in football. The winner will receive the trophy and $1000.

In the nanoscale trophy, the width of the yard lines will be about a thousand times thinner than a strand of human hair. This design will be embedded in a more detailed microscale design, visible using an ordinary optical microscope. Even this version is embedded in an identical design on the scale of millimeters, so it will be visible to the naked eye. The tiny plaque will be mounted on a stand, and the winner will receive micrographs that show the design through an electron microscope as well.

Craighead's lab, also respon-

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2007 Nobel Prize Honors GMR Discovery

Albert Fert (Université Paris-Sud, Orsay, France) and Peter Grünberg (Forschungszentrum Jülich, Germany) have won the 2007 Nobel Prize in physics for the discovery of giant magnetoresistance (GMR), the phenomenon at the heart of read-heads in high density hard drives and other devices that require highly sensitive detection of magnetic fields.

GMR is the dramatic variation in the electrical resistance of multilayered thin film structures that occurs with application of a magnetic field. The applied field changes the relative orientations of magnetic regions in some of the layers. When the fields in adjacent layers are aligned, electrons with spins oriented parallel to the fields (up electrons) pass easily from one layer to another, and antiparallel (down) electrons are strongly scattered, leading to low resistivity for up electrons. If adjacent regions have fields pointing in opposite directions, both spin up and spin down electrons are strongly scattered, and the resistance is high for all electrons. It is the spin-based explanation for GMR that has led to the use of the term "spin valve" for various GMR devices.

Magnetic sensors and the read-heads in high density computer storage media are among the common devices to benefit from GMR, and nonvolatile, low-power, high-density magnetic random access memory (MRAM) may soon replace dynamic random access memory (DRAM) in personal computers. Arguably, the most promising GMR-derived applications are still in their infancy; spin-selective active devices, such as transistors, are only now being perfected, but they have already inspired a new term in the scientific nomenclature: spintronics. Potentially, spin-selective components may even offer a practical avenue to optical and quantum computers.

In fact, the APS anticipated this year's Nobel by recognizing Fert and Grünberg, along with Stuart Parkin of IBM, for their GMR discoveries with the 1994 McGroddy Prize for New Materials.

While the Nobel Laureates made their discoveries independently, both published their fundamental work

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Albert Fert and Peter Grünberg, winners of the 2007 Nobel Prize for the discovery of giant magnetoresistance, both published their work in APS journals. APS has now made their papers describing their work, (*Physical Review* B**39** 4828 (1989) and *Physical Review Letters* **61** 2472 (1988)) "Free to Read," so that they are accessible on the internet without a subscription.

"Free to Read" is an Open Access initiative that allows anyone, including authors, readers, institutions, and funding agencies, to pay a one-time fee to make articles published in APS journals available to all readers at no cost and without a subscription. Any article in *Physical Review A-E*, *Physical Review Letters*, and *Reviews of Modern Physics* is eligible to be made free to read. Readers will have access to the PDF and postscript versions of the Free to Read articles through the APS online journals. Free to Read articles are marked online with a special icon.

Fert's PRL paper was featured as one of PRL's "top ten" in a series that ran in *APS News* in 2002-2003. See www.aps.org/publications/apsnews/200303/prl-6.cfm.

Eight Physicists Honored at November Division Meetings

Five APS prizes and awards will be awarded this month, honoring eight physicists for their work in plasma physics and fluid dynamics. The 2007 James Clerk Maxwell Prize, Dawson Award and Rosenbluth Award will be presented during the annual meeting of the APS Division of Plasma Physics, to be held November 12-16, 2007, in Orlando, Florida. The 2007 Fluid Dynamics Prize and Andreas Acrivos Award will be presented during the annual meeting of the APS Division of Fluid Dynamics, to be held November 18-20 in Salt Lake City, Utah.

2007 James Clerk Maxwell Prize
John Lindl
Lawrence Livermore National Laboratory

Citation: *"For 30 years of continuous plasma physics contributions in high energy density physics and inertial confinement fusion research and scientific management."*

Lindl is currently the Chief Scientist for the NIF Programs Directorate at Lawrence Livermore National Laboratory, where he works with the major participants in the NNSA stewardship program to develop a national plan for ignition on NIF. Lindl received his PhD in astrophysics from Princeton University in 1972. He joined Lawrence Livermore National Laboratory in 1972 as a physicist in A-Division's X-group, concentrating on fluid instabilities and high gain inertial confinement fusion (ICF) targets. Lindl's work in ICF has spanned a wide range of topics including high gain target designs for lasers and particle beams, hydrodynamic instabilities in ICF, implosion symmetry and hohlraum design, high energy electron production and plasma evolution in hohlraums, and the physics of compression and ignition.

2007 John Dawson Award for Excellence in Plasma Physics Research
Andrea M. Garofalo
Columbia University
Gerald A. Navratil
Columbia University
Michio Okabayashi
Princeton Plasma Physics Laboratory
Edward J. Strait
General Atomics

Citation: *"For experiments that demonstrated the stabilization of the resistive wall mode and sustained operation of a tokamak above the conventional free boundary stability limit."*

Garofalo received his Laurea degree in Nuclear Engineering from the

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Monica Plisch, Catherine Mader Join APS Education Team

Two physicists have recently joined the APS education department. Monica Plisch will be the first Assistant Director of Education. She will direct the Physics Teacher Education Coalition (PTEC), a network of universities devoted to improving physics teacher preparation, and lead efforts within PhysTEC, the APS/AAPT-led teacher preparation program.

In addition, a new consultant in the education department, Catherine Mader, will work on projects related to the APS/AAPT initiative to double the number of undergraduate physics majors. Plisch and Mader both started work at APS on September 4.

"As APS works on improving physics education at all levels, Monica and Cathy will enable us to have a far greater impact in many areas," said Ted Hodapp, APS Director of Education.

Plisch earned her PhD in physics from Cornell University in 2001. She then spent a year teaching physics and math at Wells College in upstate New York. In 2002 she accepted a position at Cornell University, where she was the Director of Education Programs at the Center for Nanoscale Systems (CNS).

Photo by Ken Cole

Monica Plisch, Assistant Director of Education

Plisch says she decided to work in science education and outreach because "I wanted to do something where I could make a difference." She believes she can affect a lot of lives through improving science education.

As part of her work at Cornell, Plisch developed a laboratory course in nanotechnology for freshmen. She also organized workshops and a summer institute for physics teachers. The workshops, held at Cornell as well as several satellite locations, provided a chance for teachers to learn about contemporary physics, especially nanoscience, and receive training on new hands-on activities for their classrooms. The activities were developed by teams of scientists and teachers, and equipment for implementing activities was available through the CNS lending library. The workshops also served as an opportunity to build relationships between teachers and

PLISCH continued on page 2

Members in the Media

"It's almost unfair that the universe is teasing us in this way. It gives us this dramatic clue, then shuts us up,"

***Sean Carroll**, Caltech, on dark energy,* Christian Science Monitor*, September 13, 2007*

"We believe that since most of the stuff in the universe may be what we call dark energy, we ought to know what it is."

***Saul Perlmutter**, Lawrence Berkeley Lab, on the reason for the Joint Dark Energy Mission,* San Francisco Chronicle*, September 6, 2007*

"Finally, after all these years, we're reaching fundamental physics limits. Racetrack says we're going to break those scaling rules by going into the third dimension."

***Stuart Parkin**, IBM, on a new type of memory storage,* The New York Times*, September 11, 2007*

"There's no down time for me now. Even though the shadow of the LHC looms, we're relentless in our pursuit."

***Jacobo Konigsberg**, University of Florida, on the search for the Higgs at Fermilab,* Chicago Tribune*, September 5, 2007*

"This Hewlett gift will be transformational. We are moving toward a model that has been developed successfully at private universities."

***Robert Birgeneau**, UC Berkeley Chancellor, on using a private $113 million gift to endow chairs to retain top professors,* Los Angeles Times*, September 10, 2007*

"A 4 percent increase in ball speed, which can reasonably be expected from steroid use, can increase home run production by anywhere from 50 percent to 100 percent."

***Roger Tobin**, Tufts University, on his study of steroid use and home runs,* Reuters*, September 20, 2007*

"It always looks like there is some very difficult problem but as we get closer the focus and the engineering that we bring to bear on it usually remove these barriers and allow us to go by them. There is still a lot of room for creativity–it's not the end of the road."

***Gordon Moore**, explaining that he expects Moore's law to go on for another decade,* BBC News. com*, September 19, 2007*

"Sooner or later, you lose track of what the point is of the lecture. Your mind wanders. For some people, it will happen seven minutes into the lecture; for others, 20 minutes. The problem is that when that happens, you are lost."

***Eric Mazur**, Harvard University,* Washington Post*, September 24, 2007*

PLISCH continued from page 1

scientists.

Now at APS, Plisch is excited to be working with PhysTEC and PTEC because she believes there is a great need for more well-qualified physics teachers, and PhysTEC "is an exciting project that is addressing these issues on a national scale," she said.

Among Plisch's first tasks at APS are organizing the next PTEC conference and a workshop on undergraduate Learning Assistants. In addition, PhysTEC has recently phased in a new cadre of institutions with NSF and APS 21st Century campaign funds. Some of the original PhysTEC-funded institutions are now continuing on their own, sustaining many of the reforms they have put in place. These institutions are serving as models for institutions throughout the country. PhysTEC will be seeking a second round of funding from NSF to continue its mission of working to increasing the number of highly qualified physics teachers by developing strong teacher education programs. They also are working on developing further ways to assess and describe the successes of the project.

Catherine Mader, the new Education Projects Consultant, comes to APS on sabbatical for one year from Hope College in Western Michigan, where she has been on the physics department faculty for 14 years. At APS, Mader will be working on several projects aimed at increasing the number of undergraduate physics majors, including developing a new careers website for undergraduates and planning an undergraduate research session at the April Meeting that high school students would also be invited to attend. In addition, she will develop plans for a late-starter physics major, which would be aimed at accommodating students who need more flexibility, such as those who transfer from a 2-year college, or those who discover their interest in physics after freshman year.

This Month in Physics History

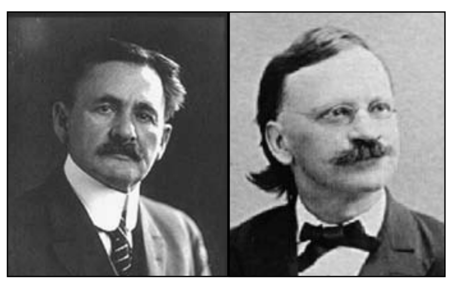
November, 1887: Michelson and Morley report their failure to detect the luminiferous ether

By the late 1800s, physicists generally believed that light was a wave. Therefore, it was thought, it had to travel through some sort of medium, just as sound waves are vibrations in air. Scientists had believed for centuries that a mysterious, ghostly substance, known as the luminiferous ether, must permeate the universe and serve as a medium for the light waves. Various scientists attempted to detect the ether, with no success. Finally, in 1887 Albert Michelson and Edward Morley carried out their famous experiment, which provided strong evidence against the ether. They reported the results in November of that year, but both thought their experiment a failure and continued to cling to their belief in the ether.

Albert Abraham Michelson was born in Strelno, Germany in 1852. When he was two years old his family moved to the US, and he grew up in the rough mining towns of Murphy's Camp, California and Virginia City, Nevada. As a youngster, he showed some aptitude for science, and at age 16 he obtained a special appointment to the U.S. Naval Academy from President U.S. Grant.

As a student at the Naval Academy, he excelled at optics and other sciences, and clearly had an aptitude for precision instruments and measurements. He graduated in 1873, and then became an instructor of physics and chemistry at the Naval Academy. In 1877, while conducting a classroom demonstration of Foucault's measurement of the speed of light, he realized he could make significant improvements on the method. Within the next two years, Michelson managed to measure the speed of light with much greater precision than ever before. The measurement brought him some recognition as a scientist, and settled him on pursuing a career in physics research. He then headed to Europe to study for the next two years.

Working in Berlin, he invented the device known as the Michelson interferometer. He realized he could use the setup to detect the Earth's velocity through the ether. The basic design is simple and elegant. A beam of light is split and sent down two perpendicular paths. Then, after bouncing off mirrors, the two beams are recombined, producing an interference pattern. If the Earth was indeed traveling through the ether, the speed of light would differ depending on its direction with respect to the Earth's motion through the ether, and Michelson's interferometer would pick up a slight shift in the interference fringes. However, these early efforts found no evidence of the Earth's movement with respect to the ether. Michelson was disappointed by the result and considered the experiment a failure. Nonetheless, he continued his effort to detect the ether when he returned to the United States.



Albert Michelson (left) and Edward Morley

In 1882 Michelson took a position at the Case School of Applied Science in Cleveland, Ohio. There he teamed up with chemist Edward Morley, who helped make some improvements in the experiments Michelson had begun in Berlin. The new apparatus was similar in basic design to his previous ones, but much more sensitive. It used extra mirrors to allow the light beams to bounce back and forth, creating a much longer path length. Michelson and Morley conducted the experiments in a basement lab, and to minimize vibrations, the setup rested atop a huge stone block, which floated in a pool of mercury that allowed the entire apparatus to rotate.

Even with this exquisitely sensitive design, Michelson and Morley couldn't detect evidence of motion through the ether. They reported their null result in November 1887 in the American Journal of Science, in a paper titled "On the Relative Motion of the Earth and the Luminiferous Ether." (The paper is online at http://www.aip.org/history/gap/Michelson/Michelson.html)

Though disappointing to Michelson and Morley, the experiment revolutionized physics. Some scientists initially tried to explain the results while keeping the ether concept. For instance, George FitzGerald and Hendrik Lorentz independently proposed that moving objects contract along their direction of motion, making the speed of light appear the same for all observers. Then in 1905 Albert Einstein, with his groundbreaking theory of special relativity, abandoned the ether and explained the Michelson-Morley result, though it is uncertain whether Einstein was actually influenced by their experiment.

Michelson and Morley nonetheless both continued to believe that light must be a vibration in the ether, though Michelson did acknowledge the importance of Einstein's work on relativity.

Although it couldn't detect the non-existent ether, the Michelson interferometer proved useful for other measurements. Michelson used his interferometer to measure the length of the international standard meter in terms of wavelengths of cadmium light, and in 1920 he was the first to measure the angular diameter of a distant star, also using an interferometer. In 1901 Michelson was the second president of the APS, and he became the first American to win the Nobel Prize in 1907, for his precision optical instruments and measurements made with them. In 1889 Michelson moved to Clark University in Worcester, Massachusetts, and then in 1892 to the University of Chicago. He returned to his work refining measurements of the speed of light, and continued making more and more precise measurements right up to his death in 1931.

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Washington Dispatch

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

ISSUE: Science Research Budgets

In July, the House completed passing all twelve appropriations bills for FY 08, which began October 1. But by the start of the new fiscal year, the Senate had completed only four of the 12 appropriations bills. Without a single FY 08 appropriations bill conferenced and signed into law, the federal government is running on a Continuing Resolution that is expected to last until at least November 16. The president has threatened to veto any spending bill that exceeds his requested amount. It is unclear how or when the FY 08 spending bills will be resolved, but the science community must remain vocal about preserving increases approved for basic research.

Since the last Washington Dispatch, the Senate Appropriations Committee and the full House approved funding levels for DOD basic (6.1) and applied (6.2) research, well above the presidential request but below last year's levels. The Senate Appropriations Committee and the full House also approved levels above the president's request for the NASA Science account to cover inflationary costs for research. Congressional funding plans for DOE Science, the NIST Core programs, and NSF are reasonably consistent with the presidential request.

To track the progress of the appropriations bills, visit http://www.aaas.org/spp/rd/approp08.htm or go to http://www.aps.org/policy/issues/research-funding/index.cfm.

In August, the US President signed into law landmark legislation intended to keep the US globally competitive. Public Law 110-69, the America COMPETES Act, calls for sharp increases in federal support for math and science education and for basic research in the physical sciences and engineering. The bipartisan bill, also known as H.R. 2272, authorizes a doubling of funding for the National Science Foundation (NSF), the Department of Energy Office of Science (DOE-SC) and the core programs of the National Institute of Standards and Technology (NIST) over seven years. In addition, the legislation contains initiatives for recruiting and retaining highly qualified educators in the science, technology, engineering and mathematics (STEM) subjects at the K-12 level. It also contains programs to help attract early career researchers to the science and technology fields.

The America COMPETES Act is a positive step for science, but it <u>authorizes</u> increases for only basic research and education. Like the 2002 NSF 5-year doubling bill, budgets will increase only if appropriators fund the authorizations.

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ISSUE: POPA Nuclear Forensics Report

The APS Panel on Public Affairs (POPA) and the AAAS have established a study group on Nuclear Forensics technology and techniques. The chair is Michael May, Emeritus Director of Lawrence Livermore National Lab and Professor Emeritus at Stanford University; other members of the group include Al Carnesale, Phil Coyle, Jay Davis, Bill Dorland, Bill Dunlop, Steve Fetter, Alex Glaser, Ian Hutcheon, Don Kerr, Francis Slakey, & Benn Tannenbaum. The first panel meeting was held in July of 2008, and the report is scheduled to be completed by February 2008.

POPA is an APS standing committee that is charged with advising the Council and officers of the Society in the formulation of APS positions on public policy issues that have a technical dimension of interest to physicists. POPA also investigates the desirability of APS-sponsored expert studies on physics-related topics of importance to society and helps to organize such studies.

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ISSUE: POPA Nuclear Workforce Report

The APS Panel on Public Affairs has established a study group to examine the workforce needs and training infrastructure of the United States Nuclear Workforce. Sekazi Mtingwa, from MIT, is the chair of the study; other members of the group include Ruth Howes, William Magwood, Darlene Hoffman, Andrew Klein, Lynne Fairobent, Allen Sessoms, Marc Ross, & Carol Berrigan. The first panel meeting was held this summer, and a second meeting of the committee is planned in November. A report is slated to be completed in early 2008.

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ISSUE: Campaign Project Update

Eight organizations will be participating in the next phase of a project to educate scientists and engineers in electoral politics. A "Campaign Workshop" is being planned for May 2008. The participating societies are: AAAS, ACS, AIBS, AIP, APS, ASCE, COSSA, and IEEE.

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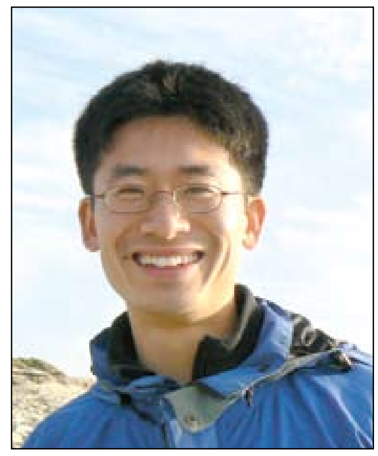
ISSUE: Washington Office Media Update

The San Francisco Chronicle published an op-ed October 8 by Norman Augustine on Sputnik and the competitiveness issue. The fall edition of Capitol Hill Quarterly leads with a story about the APS energy efficiency study being chaired by Nobel Laureate Burton Richter. In other media news, the Task Force on the Future of American Innovation, of which APS is a founding member, is developing plans to announce the winner of its YouTube American Innovation Video Contest. The purpose of the contest was to show how science has changed American life. The winning video will be shown to congressional members to reinforce the need for increased funding for basic research. The Task Force also placed an ad in Congressman Vernon Ehlers' hometown newspaper, the Grand Rapids Press, to thank him for rallying House Republicans to support the America COMPETES bill.

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

Media Fellows Bring Science to the Masses

***Ed. Note:** Each year APS sponsors two mass media fellows as part of a program run by the AAAS. Typically graduate students in physics or a related field, they spend eight weeks working for a mass media outlet, learning how to communicate science to the public. APS mass media fellow Merek Siu spent his summer at The Sacramento Bee, while Erika Gebel spent the summer at the Philadelphia Inquirer. This month Merek Siu tells our readers a bit about his experiences.*



Tickling Bubba's Curiosity

By Merek Siu

Bubba–the Sacramento everyman–has just returned from work, cracked open a beer, and is about to devote fifteen minutes to the paper. He's the guy I need to lure into my article on the direct detection of dark matter. A picture planted in my head by my editor, Bubba anchored me as I struggled to explain why he should care about something that can't even be seen.

Writing science for the public is not a matter of "dumbing it down." Rather, it's about translation–grasping the essence of the science, while not butchering it in the process.

This is the key lesson I took away from my eight weeks at The Sacramento Bee as a AAAS Mass Media Fellow sponsored by the APS. Chances are Bubba's taxes are paying for the research. If I can tell him why people are doing the research they're doing, perhaps he can understand the value of his investment. I might even tickle his curiosity…

The newsroom is a far cry from the bench–it's "real work" with cubicles, telephones, and business cards to boot. Rather than pipetting DNA and aligning lasers, research consisted of following your nose to experts in the field and exploiting the surprisingly effective "I'm a reporter" card. Instead of spending years on the same project, I experienced the taster's delight of sampling the fruits of innumerable graduate-student hours of research in few-day bites. For the science aficionado, it's the ultimate in instant gratification.

And then there's the great challenge of taking a scientific concept, experiment or idea and making it vividly understandable, yet true.

This delicate balance was highlighted by a gem tossed out by a prominent science journalist at the wrap-up meeting following the fellowship: If your stories make the scientists happy, then you're not doing your job.

As a PhD candidate in Biophysics waltzing into the newsroom, I'd like to think that I didn't leave behind a trail of cringing, disenchanted scientists in my wake.

Vanity aside, my fellowship gave me some valuable insight into the tightrope that science writers must walk. How does one balance the rigor demanded by scientists with making the science understandable to the reader? Is the science writer's goal to simply pass on the news or to educate?

I don't have great answers to these questions. But I now have a broader context to frame these questions, and I keep them in the back of my head when I write. So I think I'm off to a good start… My scientific research experience has taught me that asking the right questions is one of the hardest skills to learn.

My short time at The Sacramento Bee was delightful. Despite being in a medium-sized regional newspaper without a science section, I was given the freedom to tackle hard science while minimizing my contribution to science-lite pieces. I learned about a large variety of topics ranging from four million year old extinct viruses, to the world's largest particle accelerator buried 300 feet under the Swiss-French border. Hopefully Bubba learned a little as well.

INTERNATIONAL News

...from the APS Office of International Affairs

X-ray Science in Australia

By Keith Nugent

2007 is an exciting year for Australian science. It has seen the opening of two world-class facilities: the new OPAL research reactor in April 2007 and the Australian Synchrotron in July 2007. It is therefore timely to look at the science that will be done at these facilities and their potential impact on science in the region. Here we look at the state of Australian physical science using x-rays in 2007. We can be sure that the scope of this work will massively expand as the Australian Synchrotron progressively takes its place at the centre of Australian science.

X-ray science in Australia has a long history. Indeed the x-ray work of the elder Bragg began at the University of Adelaide under long-distance mentorship from that other famous antipodean, Ernest Rutherford. Australian physics has had a presence in x-ray physics since that time with a particular strength in x-ray crystallography.

The Australian x-ray science community has long been lobbying for access to synchrotron facilities. The lobbying by the scientific community began to have real effect in 1992 when Australia established a facility at the Photon Factory in Japan known as the Australian National Beamline Facility. This facility was a major success and demand for beamtime rapidly exceeded supply so that, in 1994 negotiations commenced for Australian participation in the Advanced Photon Source project at the Argonne National Laboratory. Funding for this project was approved in 1995 and the Australian Synchrotron Research Program (ASRP) was established. The ASRP provides extensive access to APS and Photon Factory facilities, and after 2002 soft x-ray facilities at the National Synchrotron Radiation Research Centre in Taiwan.

The ASRP sponsored growth led the Australian community to lobby for a local third-generation facility. After a period of debate, discussion and economic analysis, the Victorian government committed in 2001 to devote $A157M to the building of third-generation facility located in Clayton, a suburb of Melbourne, Australia's second largest city. The research community, including universities from all states, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Nuclear Science & Technology Organisation (ANSTO) and the New Zealand government, all provided enthusiastic support as well as an additional $50M for the construction of beamline facilities. It has been claimed that the Australian Synchrotron has attracted more broad-based support from Australia's scientists than any other research project in Australia's history.

The design and construction of the Australian Synchrotron, with a circumference of 216m and a beam energy of 3GeV, commenced in 2003. An initial nine beamlines were planned and funded. Commissioning of the first five of the beamlines commenced in June, 2007. Open user operation will commence in late 2007. In May 2007 the Federal government announced $A50M of operating funding for the facility over the next five years and in June 2007 this sum was matched by the Victorian government. May 2007 also saw Professor Rob Lamb, an expert in surface science from the University of New South Wales, appointed as the inaugural Science Director for the facility. In June a strategic plan for the ongoing development of science with synchrotrons, *Accelerating the Future,* was launched. The pieces were now in place for the Australia Synchrotron to become a pivotal piece of scientific and technological infrastructure for Australia for the foreseeable future.

With the ASRP, Australian science has come to depend on access to a wide range of synchrotron facilities and it is simply not possible for a single facility to meet all of its needs. The Australian Synchrotron is designed to meet as much of the demand as possible and also particularly serve the protein crystallography community. As such, it is anticipated

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zero gravity

The Lighter Side of Science

The Joy of Teaching...But First...

By W. R. Marshall

Editor's Note: *Wolfgang Ketterle did not actually engage in any of the conversations described below. They are fiction. But, according to the author of the article, everything else is based on real conversations with the folks involved in the "business" of education.*

Wolfgang Ketterle, 2001 Nobel Laureate and John D. MacArthur Professor of Physics at MIT, has read about the record shortages of math and science teachers in American schools and decides to lend a hand. He leaves MIT and comes to Springfield to teach high school. He calls to offer his services:

"Hello," says Professor Ketterle. "To whom would I speak about teaching at your school?"

"That would be Principal Skinner."

"Not Seymour Skinner? We attended the Max Planck Institute together."

"Yes, that's our Principal Skinner. I'll give you his office."

"Thank you," Professor K says.

"Principal Skinner's office," says a woman pleasantly.

"Yes, hello, my name is Wolfgang Ketterle; I'd like to speak to Principal Skinner."

The woman gasps, "The Wolfgang Ketterle? The Wolfgang Ketterle, who along with Eric Cornell and Carl Wieman, won the Nobel Prize in Physics for discovering the Bose-Einstein condensate?"

"I am that guy," Prof K confesses.

The pleasant voiced woman gushes, "Big fan, Dr. Ketterle, big fan, been following you since you worked with Pritchard back in the '90's."

"I'm flattered, thank you."

"Now what can I do for you, Dr. Ketterle?"

"I'd like to teach at your school."

"Wonderful. Wonderful. Just send me your Letter of Clearance from the County and I'll set up the interview."

"My what?"

"Your Letter of Clearance."

"I'm afraid you have me at a disadvantage," Prof K says. "Just tell Principal Skinner it's Wolfie."

"Dr. Ketterle," the woman replies. "He can't interview you unless you have a Letter of Clearance from the County."

"He can't even speak to me?"

"Not if you're looking for a job."

"I see. And how do I get such a letter?"

"You have to call the County School District. Here's the number...and I think you're much better looking than Cornell or Wieman."

Prof K calls the county.

"Hello, Teacher Recruitment," says another pleasant voice. "How can I help you?"

"I'd like to get a Letter of Clearance so I can teach high school."

"Are you state certified?"

"Well, I've been teaching Physics at MIT for a while."

"I see. Do you have a teaching certificate from Massachusetts?"

"I have a PhD."

"Yes, but no certificate."

"I won the Nobel Prize in Physics in 2001."

"Yes, well, that's very nice. You'll need to be certified before you can teach high school. You can find the County paperwork online, but I wouldn't bother filling that out until you've done the State paperwork, we can't process the county papers until you've completed the state paperwork. Here's their number."

Yet another person with a pleasant voice answers the phone and after getting the details says, "Dr. Ketterle, you're a perfect candidate for our Alternative Teacher Program. It's where we bring nontraditional people into the classroom; lawyers or business people or college professors, you know, people who haven't taught."

"But I taught physics at MIT."

"Yes, but you didn't teach high school. It's very simple really. You send us $75 along with the paperwork you'll find on our website. Make sure you include your work history, letters of recommendation, transcripts, etc; and don't forget your fingerprints. Then you'll have to take the praxis exam in your subject; we have to know that you know your subject. The test only costs $100 per subject."

"But I won the Nobel Prize in Physics; I can get you a letter saying I know the subject."

"Yes, well, we have to protect our children...where was I...oh, yes. There's a four week course you'll have to take before you can start, they'll teach you things like classroom management, curriculum, teaching methodologies and so on, but the beauty of our program is you can get your certification while you're teaching, and the money you'll be earning will help defray the cost of the classes you have to take. We've really worked it out so everyone wins."

Prof K takes a deep breath, "I see, and how long will this take?"

"Depending on how quickly you can get your paperwork together, as little as two months, but it might take as long as three."

"And then I can teach?"

"No. Then you can go back to the County and after you do their paperwork, they'll issue you a Letter of Clearance–then you can start to interview."

"But I discovered the Bose-Einstein condensate."

"Look, Dr. Ketterle, I hear that a hundred times a day. We don't want to waste our principals' time interviewing people who aren't good candidates. It's for the children you know."

Mark Twain said it best: "God made the Idiot for practice, and then He made the School Board."

W. R. Marshall is a novelist and syndicated columnist.

Lidar, Laser Sperm Traps Highlight Annual OSA/DLS Meeting

From September 16-20, scientists converged on San Jose, California, for a week of cutting-edge presentations on the latest advances in lasers and optics in San Jose, California at the 2007 Frontiers in Optics conference. This is the annual meeting of the Optical Society of America, as well as the annual meeting of the APS Division of Laser Science (DLS). As such, the conference provides an important forum for the latest work on laser applications and development, spanning a broad range of topics in physics, biology and chemistry.

Near-Infrared Lidar Helps Pilots. Airline pilots will have more advance warning of potentially hazardous atmospheric conditions–such as icing–using a new near-infrared LIght Detection And Ranging (LIDAR) system developed by scientists at RL Associates in Chester, Pennsylvania. The system will also provide better images in foggy, rainy, or extremely hazy conditions, making it easier for pilots to take off and land in those conditions, thereby reducing flight delays. Lidar exploits the same basic principle as radar, using light waves instead of radio waves. It is frequently used in atmospheric physics to measure the densities of various particles in the middle and upper atmospheres

According to Mary Ludwig, the RL Associates system uses a polarized laser light beam as the source pulse. When the beam encounters aerosol particles in the atmosphere, for example, the light is scattered in all directions. The system then analyzes the backscatter for changes in polarization to determine the nature of the object(s). Other Lidar systems have used similar polarization techniques in the visible spectrum, but the RL Associates system is the first to use near-infrared, which can be operated on runways without damaging pilots' eyesight.

The system also employs a "range-gated detector" that is only turned on for very short periods of time when the return signal is expected. The camera detector is off when the initial laser pulse is emitted and therefore doesn't pick up a lot of excess near-field backscatter, usually a large source of noise. So there is a vastly improved signal-to-noise ration, resulting in better images, particularly in obscuring conditions such as fog or haze.

Restoring Sight, One Pixel at a Time. Researchers at the University of Southern California's Engineering Research Center (ERC) for Biomimetic MicroElectronic Systems (BMES) have developed a tiny camera for retinal prosthetic systems that can be implanted directly into the human eye. It is an important milestone in the ultimate goal of providing limited vision to those rendered blind by certain diseases, via a fully implantable retinal prosthetic device. Current retinal prostheses are designed to be used with an external (extraocular) camera mounted in a pair of glasses.

In order to optimize the design constraints, Tanguay's group performed a series of psychophysical studies to determine the minimum requirements for the most important characteristics of human visual perception: object recognition, face recognition, navigation, and mobility. They found that very few pixels were required to achieve good results for many of those tasks: 625 pixels in total, compared to more than a million for a typical computer display. They also found that pre-and post-pixellation blurring of images resulted in significantly improved object recognition and tracking– even better for moving objects as with static ones.

Those findings have made it possible to substantially reduce the components of the intraocular camera, thereby reducing the prototype intraocular camera's size and weight down to about one-third the size of a Tic-Tac. According to USC/BMES team leader Armand Tanguay, Jr., the next generation prototype will be close to fully implantable. One early prototype was successfully implanted into a dog's eye in July 2004, although human FDA trials are still at least two years in the future.

High-Throughput Sperm Sorting. Researchers at the Irvine and San Diego campuses of the University of California have developed a new high-throughput sorting technique for sperm using a laser trap to separate stronger, faster sperm from slower sperm. Faster sperm are more likely to successfully fertilize an egg, so the technique could improve the chances of conception via in vitro fertilization by ensuring that only the fastest, strongest sperm are used. The technique could find wide application in animal husbandry and human fertility treatments.

UCI scientist Bing Shao and his colleagues used special conic-shaped lenses called "axicons", which, when combined with a standard lens and a laser, forms a ring-shaped focus (a laser trap). Changing the diameter of the ring makes the trap suitable for imaging cells of various sizes–everything from sperm to algae and microbes. The trap acts as a "speed bump" for swimming sperm, depending on the power of the laser used: slower, weaker sperm below the threshold of the laser power being used will be slowed down, redirected, or stopped altogether in the trap, while faster, stronger sperm are hardly affected at all because their energies are above the critical threshold.

Shao's new technique could also be used to separate male from female sperm to assist with gender selection. "X sperm generally are heavier and swim slower, while Y sperm are lighter and swim faster," he explains. "It is certainly possible that this technique can be used for X/Y separation since they swim at different velocities, and might also swim with different forces. As long as the difference is sufficient, we should be able to tell."

Detecting Malaria with Light. It is possible to analyze large tissue samples for signs of malaria with much greater detail and accuracy, using a macroscope to determine telltale changes in the polarization of light reflecting off the sample, according to the latest research by a team of scientists at the University of Waterloo in Ontario, Canada, and Spain's University of Murcia. Accurate identification and measurement of population densities of malaria parasites present in a given sample are critical for determining results of clinical trials, according to Melanie Campbell, a researcher at the University of Waterloo and currently president of the Canadian Association of Physicists.

Prior research has demonstrated that the malaria parasite is sensitive to light polarization, and this has been exploited to diagnose blood samples using polarimetry. Campbell and her colleagues have extended this approach to analyzing tissue samples. They used both infected and normal tissue in their experiments, and used a confocal laser scanning macroscope to measure changes in polarization to determine the levels of malaria parasites in the tissue samples.

Using the macroscope means that much larger tissue samples can be imaged at higher resolutions, making it easier to analyze them for signs of the malaria parasite. They also found that they achieved strong contrast of the malaria parasites within the tissue samples (which included retinal vessels), with incident linearly polarized light.

Better Virtual Navigation. Researchers at the University of Cali-

LIDAR continued on page 6

Letter

Unethical and Elitist Conduct Found Shocking

Arnold Bloom reported in the Letters (*APS News* August/September) that around 1960 Varian Associates of Palo Alto took an Army contract to study ways of canceling or shielding the force of gravity; Varian knew the idea was nonsense but took the contract with the intent of redirecting it. It was exceedingly unethical for Varian to take money and promise to do work they had no intention of doing. It was also very elitist of them to assume they should redirect Army funding into "fields more meaningful to the Army" as Mr. Bloom put it, as though they naturally understood better what research the Army needed than did the Army personnel charged with that responsibility. I suspect their motives weren't even that pure: had they convinced the Army to redirect the research before taking the contract (Did they actually bid for it?) they may have lost the competitive bid and thus the revenue and fee. I don't know whether I was more shocked by such unethical and elitist conduct on the part of Varian or the cavalier reporting of it by Mr. Bloom, who apparently thought he and Varian behaved properly and the story just reflected badly on the "ha, ha, stupid" Army. I do know this: If the readers of *APS News* are not revolted by the story, we are indeed the technically competent but amoral, elitist profession so many laymen think we are.

Paul Dickson
Aiken, SC

From Researching the Universe to Running the University: The Physicist as President

By Alaina G. Levine and Ernie Tretkoff

Editor's Note: *The interviews for this article were conducted earlier this year, when all those interviewed were serving as university presidents. Since that time, Frank Franz has retired as president of the University of Alabama, Huntsville, and Robert Dynes has announced his intention to step down as President of the University of California system.*

Rare are the physicists who will swap their passion for solving the most fundamental of scientific problems for any other occupation, let alone one in higher education administration. But there exist a few physicists who heard the call of leadership and not only answered, but excelled in doing so.

Recently, we had the opportunity to chat with five university presidents whose backgrounds are in physics. We had conversations with Robert Dynes of the University of California, Frank Franz of the University of Alabama, Huntsville, Shirley Ann Jackson of Rensselaer Polytechnic Institute, Allen Lee Sessoms of Delaware State University and Robert N. Shelton of the University of Arizona.

What would compel someone to wean themselves off of a habitual regimen of research, writing, and regular attendance at APS meetings? Our subjects provided unique insight into their choices and why and how physics paved the way for their successes.

A president has to solve complicated, detail-oriented problems every single day. He or she must be able to tackle each situation from a holistic

Robert Dynes

point of view and work with diverse teams of people. Just as most physicists enjoy interaction with their colleagues, so too do the presidents we interviewed.

"I love meeting with the students, hearing their aspirations and worries," said Shelton. He also appreciates "the stimulation you get from having serious conversations with faculty."

Sessoms agreed. He derives "satisfaction in watching the students grow into adults, and watching faculty who can thrive through the bureaucracy with the help you give them."

In his tenure as President, Dynes realized that "I can have more impact as President than as a professor."

"The ability to effect change" was the most rewarding aspect of the job for Franz. "It's very satisfying to be able to look back and see that you have contributed to helping the university move many steps forward," he said.

Each of these physicists took a different path to their presidency. Franz began his career as a faculty member at Indiana University. His first experience with administration came during a time of student unrest in the late 1960s, when he was asked to serve as a mediator between students and faculty and administration. After that, he served as an associate dean, then as dean of the faculty, while continuing his physics research part-time. Franz then went on to become provost at

Allen Lee Sessoms

West Virginia University, and from there assumed the presidency of the University of Alabama, Huntsville.

Jackson, a theoretical physicist, held high level positions in government, including Chairman of the U.S. Nuclear Regulatory Commission, and in industry at the former AT&T Bell Laboratories. She also was a professor at Rutgers University.

Dynes worked for 22 years at Bell Labs before becoming a professor of physics at the University of California, San Diego in 1990. At UC San Diego, he served in various administration positions, including chancellor of the UC San Diego campus. In 2003, Dynes became President of the University of California. Dynes is also a professor of physics at UC Berkeley.

Shelton's career involved stints as department chair and Vice Chancellor for Research at the University of California, Davis, Vice Provost for Research at the University of California President's Office, and Executive Vice Chancellor and Provost at the University of North Carolina-Chapel Hill.

Sessoms went from a faculty position at Harvard to serving as the director of the Department of State's Office of Nuclear Technology and Safeguards, where he oversaw nuclear nonproliferation and arms control negotiations, to positions in the US Embassies in France and Mexico. While serving as the deputy ambassador to Mexico, where he helped negotiate NAFTA, he was invited to assist in the construction of a strong state system of higher education in Massachusetts. This ultimately led to his first presidency at Queens College.

However diverse their career trajectories, it is clear that these professionals were well-suited to succeed in their presidencies because of the

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Università degli Studi di Palermo, Italy, in 1990. He received his PhD from Columbia University in 1997, with a thesis based on experimental work on the High Beta Tokamak, Extended Pulse (HBT-EP) experiment Since completing his graduate work, Garofalo has been a research scientist for Columbia University, carrying out MHD stability research on the DIII-D Tokamak National Fusion Facility at General Atomics, in San Diego. His research on DIII-D, research on stabilization of the resistive wall mode led to the first-time demonstration of stable confinement of plasma pressure at nearly double the conventional free-boundary stability limit in a tokamak. Since then, he has been pursuing the application of this discovery toward the realization of high-beta, steady-state "advanced tokamak" plasmas.

Navratil received his PhD in plasma physics from the University of Wisconsin-Madison in 1976. In 1977 he joined the faculty of Columbia University and in 1978 was a founding member of the Department of Applied Physics and Applied Mathematics, serving as department chair from 1988 to 1994 and from 1997 to 2000. His research work focuses on MHD equilibrium and stability of magnetically confined plasmas. He directs research on the HBT-EP tokamak facility in the Columbia Plasma Physics Laboratory as well as off-campus collaborations at the DIII-D National Tokamak Facility in San Diego and the NSTX Experiment at the Princeton Plasma Physics Laboratory. In 2005 he was appointed the Thomas Alva Edison Professor of Applied Physics and now serves as Interim Dean of the School of Engineering and Applied Science at Columbia University.

Okabayashi received his PhD degree in 1968 from the University of Tokyo. He then took a position at the Princeton Plasma Physics Laboratory, where he has been conducting research in the area of MHD macro stability. His primary interest has been plasma stability and device performance improvement. He was a key contributor to the design of the Princeton Divertor Experiment (PDX), the Princeton Beta eXperiment (PBX), and the Princeton Beta eXperiment-Modified, PBX-M. On PBX-M, he discovered the resistive wall mode, an external kink modified by the resistive wall. Since then, his primary research focus has been the active stabilization of the resistive wall mode. He is currently working on active stabilization of the resistive wall mode on the D-IIID device in collaboration with the Columbia and General Atomics groups.

Strait earned his PhD at the University of Wisconsin-Madison in 1979. He joined General Atomics in 1982, where he worked first on the Doublet III tokamak and then its successor, DIII-D. He developed DIII-D's magnetic diagnostic system, which is used for feedback control of the discharge, equilibrium reconstruction, and stability analysis. His research has focused on the MHD stability of tokamak plasmas, including the stability limits of high beta plasmas, instabilities associated with transport barriers, and the stability of toroidicity-induced Alfven eigenmodes. He is currently working on wall stabilization of high beta plasmas and active control of resistive wall mode instabilities. Strait is manager of the ITER Physics research group in the DIII-D Experimental Science Division.

2007 Marshall N. Rosenbluth Outstanding Doctoral Thesis Award
Erik J. Spence
ETH Xurich, Institute of Geophysics

Citation: *"For a dynamo experiment that provided a laboratory demonstration of dipole magnetic field, generated by turbulence, in an MHD flow."*

Spence received his bachelor's degree in physics from McGill University (Montréal, Canada) in 1998. He did his PhD studies on the Madison Dynamo Experiment, a one-meter-diameter sphere of flowing liquid sodium, in the physics department of the University of Wisconsin, Madison. He was involved with most aspects of commissioning the experiment, including its design, fabrication, construction, operation and data analysis. His dissertation work, done with Professor Cary Forest, demonstrated the presence of a turbulent electromotive force in the experiment. Spence is presently employed by the Institut für Geophysik at ETH Zürich, where he is studying the application of liquid metal experiments to planetary cores.

2007 Fluid Dynamics Prize
Guenter Ahlers
University of California, Santa Barbara

Citation: *"For pioneering experimental work on fluid instabilities, low-dimensional chaos, pattern formation, and turbulent Rayleigh-Bénard convection."*

Ahlers received his PhD in physical chemistry from the University of California at Berkeley and became a member of the technical staff at Bell Laboratories. Then he worked on critical phenomena and on superfluid hydrodynamics. In 1970 he began research on Rayleigh-Bénard convection in liquid helium that led to the experimental observation of chaos in a fluid-mechanical system. In 1979 Ahlers became a Professor of Physics at UCSB where he has studied pattern formation in convection and Taylor-vortex flow, and turbulent Rayleigh-Bénard convection. He and his co-workers have published over 260 papers in the *Journal of Fluid Mechanics*, *Physics of Fluids*, *Physical Review A*, *B*, and *E*, *Physical Review Letters*, and elsewhere.

2007 Andreas Acrivos Dissertation Award in Fluid Dynamics
David Saintillan
Courant Institute, New York University

Thesis Title: *"Collective dynamics in dispersions of anisotropic and deformable particles."*

Saintillan received his BS from École Polytechnique, Palaiseau, France, and he performed his PhD research at Stanford University under the joint supervision of Professors Eric Shaqfeh and Eric Darve. He is now an Associate Research Scientist at the Courant Institute of Mathematical Sciences at NYU.

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in papers submitted to the *Physical Review* journals in 1988. The work of Fert and colleagues first appeared in *Physical Review Letters (PRL)* November 21, 1988, and is one of the top ten most frequently cited PRL papers in the journal's history. Grünberg and colleagues' paper in *Physical Review B* was published March 1, 1989, although they had submitted their work to the journal nine months earlier.

"Few discoveries in physics have equaled GMR in so rapidly revolutionizing the technologies that we rely on in our daily lives," says APS Editor-in-Chief Gene Sprouse. "We're proud that the fundamental work of Fert and Grünberg first appeared in journals of the American Physical Society."

"The work of Fert and Grünberg generated great excitement in the condensed matter physics community when it first appeared in the APS journals almost twenty years ago," says Joe Serene, APS Treasurer and Publisher, "but none of us realized how important giant magnetoresistance would become in our daily lives. It's already revolutionized data storage in personal computers, and may soon revolutionize the processors themselves. This is a marvelous example of the way that whole new technologies, like the GMR-based field of spintronics, can grow out of fundamental research in basic physics of the sort that we publish in the journals of the American Physical Society, and of the need for our nation to continue to invest in basic research."

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sible for the world's smallest guitar in 1997, is known for their nanoscale fabrication. To create the trophy, they will use atom and photo lithography, engraving the tiny pattern by exposing the material to beams of atoms or light, respectively. For the larger image, they will use ordinary etching methods.

To win the trophy and cash, contestants must submit a video around two minutes in length that demonstrates some aspect of physics in football. Contestants can break down the forces in some footage of their favorite high school, college, or NFL team. Or they can get together with friends or family to film an experiment relevant to the game and its equipment. Videos could talk about air pressure inside the ball, the rotation of a spiral, the impact of a tackle, or acceleration in a breakaway touchdown run. Other creative approaches are welcome.

To submit a video, contestants should upload it to YouTube with the tag "nanobowl" and send an email to physicscentral@aps.org. The film deadline is January 15th, 2008. The winner will be announced on Super Bowl Sunday, February 3, 2008. For more details and contest rules, see www.physicscentral.com/nanobowl.

National Summit Urges Commitment to Competitiveness

Congress should maintain a long-term investment in basic research, innovation and education to keep the nation competitive in the face of increased global competition, said high-ranking public and private officials who participated in the recent National Summit on American Competitiveness in Washington, D.C.

"We have fallen behind (our international counterparts) in math, science and basic research and development," said Craig Barrett, chairman of Intel Corporation's board of directors, whose comments generated thunderous applause from the near-capacity crowd at the Reagan Center Amphitheater.

The purpose of the summit, which took place in September, was to explore how to support and develop the human talent and creativity that have made America the envy of the world.

Barrett added that the recently passed America COMPETES bill, which authorizes the expenditure of $33.6 billion over seven years, including the doubling of funding for scientific agencies, must be fully funded to help the country regain its hard-fought global economic leadership."Just do it," he said, adding, "we've been talking about this for years."

The COMPETES legislation will go a long way in preparing students to meet the demands of a rapidly changing world economy requiring highly skilled workers, said the summit's participants.

"Every nation gets the connection between education and the next-generation economy," said G. Wayne Clough, president of Georgia Tech University. Clough pointed out that Georgia Tech has a cooperative study abroad program that enables students to learn and work overseas to prepare for jobs in an international economy.

Haley Barbour, governor of Mississippi, said his state is funding training for workers for highly skilled jobs such as energy construction projects. "We are investing in people," he said.

Students must understand what is required of them in the high-tech workforce, said Gary Jacobs, chairman of High Tech High, a charter school in San Diego.

"All juniors have to participate in an internship as part of our curriculum," said Jacobs, who noted that 100 percent of the school's students attend college and pursue technical degrees.

Time to Celebrate and to Look Ahead

Photo by Marvin T. Jones & Associates

On September 20, members of Congress, Congressional staffers, and science advocates gathered on Capitol Hill to celebrate passage of the America COMPETES Act, which President Bush had signed into law the previous month. The bill authorizes improved funding for science education, innovation and basic scientific research. Here APS Director of Public Affairs Michael Lubell (left), who lobbied tirelessly for this legislation over many years, chats with Vernon Ehlers (R-MI), one of two PhD physicists in Congress, who was one of the chief sponsors of the bill. As Lubell pointed out, the effort by science societies to focus congressional attention on the competitiveness issue began in 1997, with the impetus of the late D. Allan Bromley, who had previously served as science adviser to President George H.W. Bush and later as APS president. Ehlers emphasized that with the authorization bill passed, Congress now has to focus on implementing its provisions by appropriating the necessary funds.

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fornia, San Diego, have developed a new optical tracking device for improved navigation in a panoramic 3D virtual reality system. Immersive virtual environments are already widely used for surgical and flight training, military training, scientific visualization, and for helping patients with brain injuries recover neuro-motor skills, especially patients recovering from strokes, who are undergoing rehabilitative therapy to regain motor function.

The UCSD system uses five networked computers linked to five large-scale plasma display screens arranged in a pentagon, mounted on a supporting framework. The scene rendered on each display is refreshed in response to the tracking device, which is wireless, so there is no confusing mix of connecting wires when multiple users are involved. Up to five different users can interact with the virtual environment simultaneously with natural motion, just like tasks in the real world.

The main challenge the researchers faced was how to get all five displays and the optical tracking device synchronized, so that a user could perceive the visual and audio feedback on the displays immediately. They overcame this just by using a sixth computer devoted just to the tracking via the 3D input device. The sixth computer sends tracking results to all five of the other PCs via a high-speed wireless connection.

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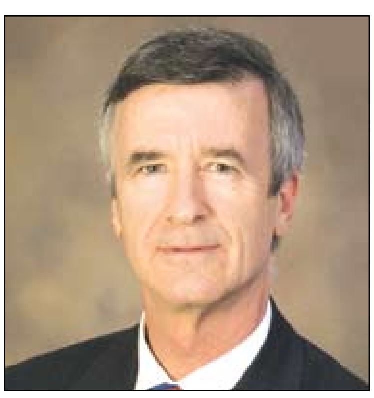

Robert N. Shelton

foundations that physics gave them.

"The key thing you learn as a physicist is to approach problems from a comprehensive perspective," said Sessoms, "Take a look at all the issues you are trying to solve and understand the whole picture."

Franz also maintained that he approached many problems in administration the way he would approach a physics problem, by getting to the fundamentals and figuring out how things work. "It really is creating a model. In physics we're always creating models of how things work," he said.

Jackson added that "as a physicist, one naturally develops the ability to analyze complex questions in situations [and] to synthesize information from multiple sources to come up with what the core of an issue may be."

Dynes agreed: "It certainly allows you to look at multi-dimensional problems… and [determine] which are the critical variables and focus on those critical variables," he said.

Other physics-derived skills which allow these presidents to lead effectively include an understanding of causality and a quantitative outlook, which is "not normal from many peoples' perspectives, but totally normal for a physicist," said Sessoms.

Problem-solving ability and facility with numbers came in handy for Franz when he was faced with a budget problem at the University of Alabama. His creative solution to the puzzle ended up becoming an accounting textbook example. "I sometimes tell people, that the one thing if you're a physicist that people can't accuse you of is being unfamiliar with numbers," he said.

Shelton, an experimentalist, draws strength from his experience managing his research laboratories. His list of valuable skills he learned includes "organizing large, diverse groups of people…in order to set priorities for the group," he said. In addition, "you get a lot of experience in the people side, the human side, and how to get the best out of folks when you have a larger, global target goal that you're seeking."

Both Jackson and Shelton see

Shirley Ann Jackson

physics as a means to learn how to operate in a multi-cultural environment, and Sessoms thinks physics is especially perfect for university administration because "physics forces you to confront reality no matter how brutal that reality is to your psyche," he said. "Mother Nature will make a fool out of you no matter how smart you are. There is no physicist who has not been made a fool of. This is very humbling…it forces transparency on the president."

The challenge to balance a career in research and administration is real and is confronted by these leaders regularly. The presidential post "is full time and then some," said Shelton. "This job is all consuming. That's the great joy of it."

But then again, so is the career of a physicist. As Sessoms described it, "physics is a discipline where you can't dabble…Being a physicist is a game for people with very few outside pursuits."

Each president has brokered a virtual deal with themselves that allows them to reach some sort of balance between their scientific and leadership engagements.

They all keep abreast of their respective fields as much as possible. Dynes, who still has a lab, relies on postdoctoral associates and literature reviews to keep him aware of research activities, and spends about 10-15 hours a week thinking about physics problems, meeting with students, and reading papers.

Jackson feels that it is important to keep up in some way in science, especially in a Research 1 university. She stays connected by attending professional meetings, reading, and speaking with faculty. Although she admits it is "hard to do the level of focus one might wish," she said.

In some university administration positions, it is possible to balance both research and administrative duties, said Franz, and he thinks it is "best to have people in administrative roles who maintain a connection to their disciplines." But once one has reached the level of university president, it's extremely difficult to keep running a research lab. "It's an exceptional person who is truly able to carry on both responsibilities," he said.

It is clear in speaking with these commanders-in-chief that the university president is a multi-dimensional position that requires high energy and tenacity. A university president is the CEO of a multi-million dollar (often billion dollar) business, a lobbyist and a politician, a fundraiser, a public relations pro, a community leader, and often even an international emissary as well. When asked how our subjects view themselves, there were several surprising answers.

Frank Franz

"All of the above," said Jackson, as well as "the chief motivator for those in the university."

"As the primary visible representation of the university," said Shelton.

"As a choir leader," said Dynes. "You can't do all these things without an enormous amount of help from a lot of people…Everyone has to sing from the same song sheet and that's your song sheet."

"As the mayor of a small town," said Sessoms. "You have got to be everything to everybody and no matter what happens you are blamed for it, whether you were directly involved or not."

He also joked that the president is the "local beggar, and local profiteer, taking advantage of the faculty who are doing amazing things" as well as the peacemaker within the institution and bridge-builder between the university and community, he said.

Our panel expressed an excitement for leading their institutions and making a positive impact on their constituents. Several recommended physics for a career in university administration.

However, for those physicists out there ready to launch a career in higher education leadership, there were some very specific and strategic quarks of advice offered.

"I would certainly encourage it," said Franz. He suggests starting out as he did, in a temporary or part-time position in administration that allows one to keep up some research activity.

Yet, stresses Shelton, "in the early stage of your career, please, please focus on being a world class scholar." As a student in physics, "this is not the time to be thinking about becoming a university president. You should be thinking about moving the frontiers of science in your own personal way and to be the best scholar you can be." He added that by concentrating on your scientific craft early on in your career, you will ultimately gain valuable "insight into what a university's about" which will benefit a person when they do elect to pursue the presidency.

When (and if) these administrators retire, will they go back to the lab? The answer for many is an unknown variable. Franz said he isn't sure exactly what he'll do next, but "I absolutely want to maintain a connection with physics and with the University."

Just as physics helped them be better presidents, so too has the presidency aided them in becoming better physicists.

As President, Jackson has learned the importance of intellectual agility, she said, and "to see connections between and among disciplines and subdisciplines. This ability is needed when one is doing pure research."

Dynes discovered how to be a better communicator, to be open and transparent, and perhaps most importantly, to know how to say "I don't know".

"The successful presidency requires an ability to sleuth out connections between seemingly unrelated information and then use these connections to create new opportunities," said Shelton. "The successful physicist operates similarly as he/she strives to discover underlying principles from seemingly unrelated research outcomes."

ANNOUNCEMENTS

2008 Prize and Award Recipients

Editor's Note: The prizes and awards listed below were approved by the APS Executive Board at its September meeting. Most of them will be presented at either the March or April meeting next spring. The citations accompanying these awards are posted on the APS web site (click on the individual prize or award). Biographical information for the recipients, and their pictures, will be posted as the information is received. In addition, the recipients will be featured in the special prizes and awards insert to the March 2008 APS News.

Abraham Pais Prize for History of Physics
Gerald Holton

Andrei Sakharov Prize
Liangying Xu

Aneesur Rahman Prize for Computational Physics
Gary S. Grest

Arthur L. Schawlow Prize in Laser Science
James Bergquist

Dannie Heineman Prize for Mathematical Physics
Mitchell Feigenbaum

David Adler Lectureship Award in the Field of Materials Physics
Karin Rabe

Davisson-Germer Prize in Atomic or Surface Physics
Horst Schmidt-Böcking

Earle K. Plyler Prize for Molecular Spectroscopy
Steven G. Boxer

Edward A. Bouchet Award
Ronald E. Mickens

Excellence in Physics Education Award
University of Washington Physics Education Group

Frank Isakson Prize for Optical Effects in Solids
Joseph Orenstein
Zeev Valentine Vardeny

George E. Pake Prize
Julia M. Phillips

Hans A. Bethe Prize
Friedrich K. Thielemann

J. J. Sakurai Prize for Theoretical Particle Physics
Stanislav Mikheyev
Alexei Smirnov

James C. McGroddy Prize for New Materials
Jun Akimitsu
Robert C. Haddon
Arthur F. Hebard

John H. Dillon Medal
Kari Dalnoki-Veress

Joseph A. Burton Forum Award
Pierre Goldschmidt

Joseph F. Keithley Award For Advances in Measurement Science
Bjorn Wannberg

Julius Edgar Lilienfeld Prize
H. Eugene Stanley

Lars Onsager Prize
Tin-Lun Ho
Gordon Baym
Christopher Pethick

Leo Szilard Lectureship Award
Anatoli Diakov
Pavel Podvig

Maria Goeppert Mayer Award
Vassiliki Kalogera

Max Delbruck Prize in Biological Physics
Steven M. Block

Oliver E. Buckley Condensed Matter Prize
Mildred Dresselhaus

Polymer Physics Prize
Kenneth S. Schweizer

Prize for a Faculty Member for Research in an Undergraduate Institution
Michael R. Brown

Robert R. Wilson Prize for Achievement in the Physics of Particle Accelerators
Lyndon R. Evans

Tom W. Bonner Prize in Nuclear Physics
Arthur M. Poskanzer

W.K.H. Panofsky Prize in Experimental Particle Physics
George Cassiday
Pierre Sokolsky

Will Allis Prize for the Study of Ionized Gases
Kenneth Kulander

Nicholson Medal for Human Outreach
David P. Landau

APS CONGRESSIONAL SCIENCE FELLOWSHIP 2008-2009

THE AMERICAN PHYSICAL SOCIETY is currently accepting applications for the Congressional Science Fellowship Program. Fellows serve one year on the staff of a senator, representative or congressional committee. They are afforded an opportunity to learn the legislative process and explore science policy issues from the lawmakers' perspective. In turn, Fellows have the opportunity to lend scientific and technical expertise to public policy issues.

QUALIFICATIONS include a PhD or equivalent in physics or a closely related field, a strong interest in science and technology policy and, ideally, some experience in applying scientific knowledge toward the solution of societal problems. Fellows are required to be U.S. citizens and members of the APS.

TERM OF APPOINTMENT is one year, beginning in September of 2008 with participation in a two week orientation sponsored by AAAS. Fellows have considerable choice in congressional assignments.

A STIPEND is offered in addition to an allowances for relocation, in-service travel, and health insurance premiums.

APPLICATION should consist of a letter of intent of no more than two pages, a two-page resume: with one additional page for publications, and three letters of reference. Please see the APS website (http://www.aps.org/policy/fellowships/congressional.cfm) for detailed information on materials required for applying and other information on the program.

ALL APPLICATION MATERIALS MUST BE SUBMITTED ONLINE BY JANUARY 15, 2008.

Now Appearing in RMP: Recently Posted Reviews and Colloquia

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

Fermi-liquid instabilities at magnetic quantum phase transitions

Hilbert v. Löhneysen, Achim Rosch, Matthias Vojta, and Peter Wölfle

Fermi-liquid theory, which describes in particular the state of electrons at low temperatures, is one of the central pillars of modern condensed matter physics. Instabilities of the Fermi-liquid state are therefore of fundamental interest, in addition to leading to very remarkable observable properties. In this article the authors discuss one way for the Fermi-liquid state to break down, namely, the system undergoing a quantum phase transition, and difficulties in understanding the latter within the framework of simple theories.

APS Designates Rad Lab as Historic Site

Photo by Justin Knight

As part of the APS historic sites initiative, on October 5 APS President-elect Arthur Bienenstock (left) presented a plaque to MIT to commemorate the MIT Radiation Laboratory that played a key role in the development of radar during World War II. Receiving the plaque on behalf of MIT is Dean of Science Marc Kastner (center), while incoming physics department head Edmund Bertschinger looks on. The citation on the plaque reads "At this location, the MIT Radiation Laboratory was established in the fall of 1940 to develop microwave radar systems. Radar quickly took its place in all arenas of World War II and played a decisive role in the Allied victory. The laboratory closed on December 31, 1945."

X-RAY continued from page 3

that the Australian Synchrotron will meet in excess of 90% of the Australian demand for synchrotron time, with the remainder being met by an ongoing access to selected overseas facilities including fourth-generation sources.

Australia has particular strengths in the development of imaging methods and in materials science. A significant amount of experimental and theoretical work on the fundamentals of propagation-based phase-contrast imaging and on the method of diffraction-enhanced phase-contrast imaging has been done by groups at CSIRO, led by Steve Wilkins, and at the University of Melbourne led by Keith Nugent and in collaboration with scientists at the Advanced Photon Source. Rob Lewis and collaborators at Monash University and at SPring-8 have been applying these methods to, among other things, the study of the aeration of the lungs of new-born wallabies. Andrei Nikulin, also of Monash University, has another very active collaboration with scientists at SPring-8 where he is developing diffraction and phase-recovery techniques for the examination of multilayer superstructures

The development of coherence based methods has been extended to the field of coherent diffractive imaging via funding from the Australian Research Council to establish Centre of Excellence for Coherent X-ray Science, directed by Keith Nugent. This centre includes physicists, chemists and biologists from four universities and CSIRO and will explore the application of coherent x-ray methods to problems in the biosciences. The project includes the development and application of high-harmonic-generation laser based soft x-ray sources and the development of a theoretical understanding of the interaction of intense coherent fields with molecules. The work of the centre will impact the goal of the international x-ray free-electron laser community of imaging a single biomolecule at atomic resolution using an ultrashort coherent x-ray pulse.

The role of materials physics and chemistry is particularly important given the almost simultaneous opening of the OPAL research reactor based at ANSTO in Sydney. Ian Gentle of the University of Queensland uses both x-ray and neutron reflectivity to probe the properties of interfaces. John White of the Australian National University works on the fabrication of molecular thin films and uses x-rays and neutrons for the subsequent material characterization and development of applications. Mark Ridgway of the Australian National University is exploring the processing and characterisation of semiconductor materials using x-ray and neutron small angle scattering and reflectivity experiments. Rob Lamb, now at the Australian Synchrotron and the University of Melbourne, studies the surfaces of thin films and materials using a range of surface sensitive analytical techniques including x-ray photoelectron spectroscopy, secondary ion mass spectroscopy, small angle scattering, synchrotron x-ray absorption spectroscopy and wettability. David Jamieson of the University of Melbourne and Chris Ryan of CSIRO are bringing their long experience in proton microprobe work to bear on the construction of a microprobe beamline at the Australian Synchrotron, and Chris Chantler of the University of Melbourne is developing extremely high precision measurement methods for the characterisation of the interaction of x-rays with matter. Andrea Gerson of the University of South Australia looks at interfacial and solid state structure and reaction mechanisms in relation to crystallization phenomena within the petrochemical, Bayer and pigment industries. Andrea is currently the Lead Australian Scientist for the Australian-Canadian synchrotron collaboration that focuses on the development of industrially useful synchrotron end-stations at both the Canadian Light Source and the Australian synchrotron. Pete Hammond of the University of Western Australia has been using UV radiation from Sincrotrone Trieste to explore atomic physics, and Robert Leckey, John Riley and colleagues at La Trobe University are continuing their exploration of Fermi surfaces through their long standing collaboration with BESSY in Germany, a collaboration that moved to BESSYII in 2003.

Australian x-ray science is at a dynamic stage, and there is a great deal of excitement surrounding the new facility. Australia's national strengths will be reflected in the development of the Australian Synchrotron in the coming years, while we continue to nurture our extensive international collaborations and linkages.

The Back Page

The “Curse of Knowledge” or Why Intuition About Teaching Often Fails

By Carl Wieman

In the pages of *APS News* and elsewhere there has been much discussion about the deficiencies of our science education system. Everyone from leaders of government, industry, and academia to concerned parents is pointing to the evidence and lamenting how these deficiencies hinder economic growth and the attainment of a scientifically literate citizenry capable of making wise informed decisions on important societal issues. Usually, such laments are accompanied with an opinion as to the source of the problem and how to solve it. One common claim is that higher education is failing because the faculty members in science care only about research and have little interest or concern with teaching. (Physics is often held out as a subject of particular criticism in this respect.)

I reject this claim. I have spoken with many physics faculty members throughout the world about teaching, and I can probably list on one hand the number who did not have a clear and sincere desire to have their students learn physics and appreciate its usefulness and inherent intellectual beauty. So how can one reconcile this observation with the compelling accumulation of physics education data showing most college students are not attaining these goals? (And if such education studies do not convince you, just ask a few non-physicists how they feel about their college physics classes!)

Here I would like to offer an explanation for this disparity between good intentions and bad results and, on this basis, suggest how to improve teaching and learning. The explanation arises from what has sometimes been called the “curse of knowledge” by educational psychologists. It is the idea that when you *know* something, it is extremely difficult to think about it from the perspective of someone who does *not* know it. There is a classic easily replicated demonstration of this provided by psychologist Elizabeth Newton. She had subjects tap out the melodies of very familiar songs with their finger and predict what fraction of those songs will be recognized by a listener. “Tappers” typically overestimated the fraction recognized by a factor of 20! In a recent science education example of the same idea, we saw students express disbelief that anyone could hold a certain misconception, yet we had seen those same students actually express this very misconception themselves, just a few months earlier! I would argue that well intentioned physicists are achieving poor educational results because the “curse of knowledge” makes it very difficult for them to understand how physics is best learned by a novice student, or to accurately evaluate that learning.

Recent advances in brain imaging show us that this gap in understanding has quite basic origins. The brains of novices in a subject are activated quite differently from experts when confronted with a problem. And as mastery is achieved, the brain literally changes; different links are formed and there are different activation patterns during problem solving.

This fundamental difference between the novice and expert brain explains many of the findings reported by those who study student learning of physics. Students can think about a topic in ways quite unimagined by the instructor, and so a lesson that is very carefully thought out and is beautifully clear and logical to experts may be interpreted totally differently (and incorrectly) by the student. Another example is that the standard lecture demonstration has been shown to have negligible impact on learning. Many teachers find this hard to believe because the demonstration attracts students’ attention and usually demonstrates an important idea in a compelling fashion. However, the lack of learning makes sense when one realizes that research also shows that students often perceive both the intention of the lecture demonstration and what it shows very differently from the instructor. My group routinely sees similar perceptual differences in our testing of educational interactive simulations. When we have students try an untested simulation, they often literally see different things happening on the computer screen than do experts. As a result, the student can interpret what is shown very differently from what was intended, and learn incorrect ideas. Finally, studies reveal that the instructors’ interpretations of the students’ thinking based on their exam answer are frequently very different from the actual thinking. In much of science instruction, it is almost as if the instructor and the student are speaking different languages but neither realizes it.

This mismatch between student and instructor perceptions can lead to even more disturbing results at another level–namely that of general beliefs about the nature of physics, how it is learned and used, and how physics knowledge is established. The University of Maryland physics education group and now my own group have studied such beliefs in students and how they are shaped by physics courses. We have consistently measured that such student beliefs, on average, become less like those of a scientist after completing typical introductory college physics courses. Put in the starkest terms–our physics courses are actually teaching many students that physics knowledge is just the claim of an arbitrary authority, that physics does not apply to anything outside the classroom, and that physics problem solving is just about memorizing answers to irrelevant problems. Even more disturbing, we find that those students who are planning to become elementary school teachers have the most extreme of these novice-like beliefs. If one looks at the “anti-science” movement, one can see such beliefs inherent in much of what it represents. Of course, no teachers would intentionally be teaching such beliefs to their students, but the sobering fact is that the data indicate that this is what is actually happening in nearly all introductory physics courses.

“...our physics courses are actually teaching many students that physics knowledge is just the claim of an arbitrary authority...”

This “curse of knowledge” means is that it is dangerous, and often profoundly incorrect to think about student learning based on what appears best to faculty members, as opposed to what has been verified with students. However, the former approach tends to dominate discussions on how to improve physics education. There are great debates in faculty meetings as to what order to present material, or different approaches for introducing quantum mechanics or other topics, all based on how the faculty now think about the subject. Evaluations of teaching are often based upon how a senior faculty member perceives the organization, complexity, and pace of a junior faculty member’s lecture. In the pages of *APS News*, this same expert-centered approach to assessing educational experiences has played out recently in the debate over the use of interactive simulations vs. hands-on labs.

It is even dangerous to decide on how one learns based upon one’s memory of learning physics many years ago. I was reminded of this recently while participating in a TA training workshop and reflecting on the differences between what the beginning graduate students (not yet physics experts but sophisticated current learners) felt was important for effective learning compared to what I often hear from senior faculty members. The beginning graduate students were asked to discuss and tabulate their “best and worst learning experiences.” In their examples of best experiences, there was no mention of particular topics or how topics were organized or presented, except in the context of how the presentation was explicitly shaped to make the material interesting and accessible from their student perspective. While aspects of enthusiasm and interest of the instructor were mentioned, the students particularly focused on the instructor’s interest in the students’ learning, as evidenced by making efforts to find out what was being learned and providing individualized feedback and encouragement to support the student’s learning. Other characteristics of instructors that are so often part of faculty discussions of teaching (such as personality or how easy or hard they made assignments or exams) were never mentioned. In fact, the most valuable learning experience for many of these grad students did not involve an instructor at all! A widely shared most valuable learning experience was “working with a motivated group” [of fellow students]. Finally, in many faculty discussions of good teaching one often hears it described as “an art form” that might be amenable to slight improvement by training and experience, but is largely an innate ability. In contrast, the characteristics of valuable learning experiences listed by these grad students’ were all straightforward things that any instructor could do, but many often do not.

Any reader who has gotten this far ought to be getting quite depressed. The data says our best intentions to teach well are failing, and many of one’s ideas as to how to improve are suspect, because our brains are different from our students and so our intuition is flawed.

However, the situation is not nearly as dire as it might appear. The clever physics community has already found an approach for how make progress in areas where one’s initial intuition is obviously flawed, e.g. figuring out the structure of atoms. That approach is to rely on careful objective experimental measurements and to use that data to develop new improved understanding and intuition. For teaching physics, this means looking at data on how people learn and how students do and don’t learn the various topics in physics. Of course outstanding instructors gather their own data by carefully and systematically probing the thinking of their students, but this is difficult and time consuming to do accurately. Relative to many other sciences, physics instructors are fortunate to have the benefit of a substantial body of education research on discipline specific topics, as discussed on the Back Page previously by Noah Finkelstein [*APS News*, Jan. 2006]. Guided by this literature, an instructor can bridge the perceptual gap and understand how students are thinking, what are the common difficulties and misconceptions, and find rigorously tested effective ways to improve student learning and motivation. The literature also describes assessment methods to substantially help in efficiently gathering data on one’s own students. This physics-like approach to the teaching and learning of physics has led to new insights and dramatic progress, such as the discovery of teaching methods that double or more the learning of concepts. By the way, the findings of this body of research on learning match well with the recollections of the TAs mentioned above as to the most important characteristics for effective learning.

In much the same way that physicists had to go through the wrenching process of replacing their classical-physics-based intuition with a new, more useful intuition about the quantum world, we need to make a similar step with regard to physics education. We must abandon the implicit assumption that all brains are the same and so passing along what is clear to us will be clear to the novice student, and if it fails, it is an indication that the students are simply incapable. We must instead come to recognize that mastery of a subject is much more a process of restructuring the brain than simply of transferring knowledge, and knowing a subject is profoundly different from knowing how that subject is best learned. The result will be greatly improved learning of physics. Knowledge becomes a curse only if one fails to recognize its limitations.

(References to the many studies mentioned here are not compatible with the Back Page format, but are posted at www.cwsei.ubc.ca/resources .)

Carl Wieman is Director of science education initiatives at both the University of British Columbia and the University of Colorado and chairs the Board on Science Education of the National Academy of Sciences. He does research in physics education and has done extensive research in atomic physics. He shared the 2001 Nobel Prize in physics with Eric Cornell and Wolfgang Ketterle for the achievement of Bose-Einstein condensation in dilute gases of alkali atoms.