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APS Mourns Loss of President-Elect John Bahcall

John N. Bahcall, president-elect of APS, passed away on August 17, 2005 at age 70. He was the Richard Black Professor of Astrophysics at the Institute for Advanced Study in Princeton.

In a message to all APS members, APS President Marvin Cohen said "John was one of the great masters of theoretical astrophysics, and we were very fortunate that he decided to devote time to serve in the presidential line of the APS. Last spring, due to declining health, he announced his intention to step down as president-elect, but his death only a few months later comes as a great shock. His loss will be keenly felt, both as a physicist of outstanding achievements and ability, and as a leader in the scientific community. On behalf of all the members of the APS, I want to express my deep sympathy to his wife, Neta, and his family."

Because he had announced his intention to step down, a special election was held this summer to insure the proper succession in the APS presidential line. The new president-elect

John Bahcall

is now John Hopfield (succeeding Bahcall).

Bahcall's most widely recognized achievement in astrophysics was his calculation of the predicted neutrino flux from the sun. This was the theoretical impetus for the experiment conducted by Raymond Davis to detect solar neutrinos, which led ultimately to the discovery that neutrinos have mass and that the flavor of the neutrinos oscillates as they propagate from the sun to Earth. This

APS Mourns Loss continued on page 3

APS Members Elect Kadanoff, Bienenstock To Presidential Line

Leo P. Kadanoff and Arthur Bienenstock

APS members elected Leo Kadanoff, professor emeritus, at the University of Chicago as president-elect, and Arthur Bienenstock of Stanford University as APS vice-president in the 2005 general election. The two men will assume these offices on January 1, 2006. Because of the death of former APS president-elect John Bahcall in August (see related story), Kadanoff immediately becomes APS vice-president, while vice-president John Hopfield of Princeton moves up to become president-elect. Hopfield will become APS president in 2006, succeeding current President Marvin Cohen, to be followed by Kadanoff in 2007 and Bienenstock in 2008.

In other election results, Margaret Murnane of the University of Colorado/JILA was elected chair-elect of the APS Nominating Committee, which is responsible for proposing a slate of candidates each year for the Society's general election. Christina Back (General Atomics) and the University of Maryland's Wendell Hill were elected as general councilors, while Albrecht Wagner of DESY and the Univesity of Hamburg (Germany) will be the Society's new international councilor.

Kadanoff received his PhD from Harvard in physics, and followed up with a postdoc in Copenhagen. He taught at the University of Illinois (1962-1969), Brown University (1969-1978), and then moved to the University of Chicago. He has served as vice-president of the Urbana Chapter of the NAACP, as a member of both the Board of Governors of Argonne National Laboratory and the Board of Physics and Astronomy of the National Research Council (US), and twice as Director of the University of Chicago Materials Lab. Kadanoff has won the APS Buckley and Onsager Prizes, the National Medal of Science (US), and la Grande Médaille d'Or of the French Academy of Sciences. His theoretical work has focused on condensed matter and statistical physics, and he helped establish the scaling and universality basis of phase transition theory.

Bienenstock received his PhD in applied physics from Harvard in 1962. After an NSF Postdoctoral Fellowship, he joined Harvard's Division of Engineering and Applied Physics in 1963. He joined Stanford University's Materials Science and Applied Physics Departments in 1967. In 1978, he took on the Stanford Synchrotron Radiation Laboratory directorship. In November, 1997 he was confirmed as the Associate Director for Science of the White House Office of Science and Technology Policy (OSTP) and remained in that position until 2001. Bienenstock served as an APS general councilor, on the APS Committee on Applications of Physics, on the Audit Committee, on the Panel on Public Affairs, and as chair of the Ethics Committee.

Murnane is a Fellow of JILA and is a member of the faculty in the Department of Physics at the University of Colorado. She received her PhD degree in physics from the University of California at Berkeley in 1989. She remained at Berkeley for one year as a postdoctoral fellow, before joining the faculty at Washington State University in 1990. In 1996, Murnane moved to the University of Michigan, and in

Election Results continued on page 7

Twenty Troupes Pack 'em In to See Physics on the Road

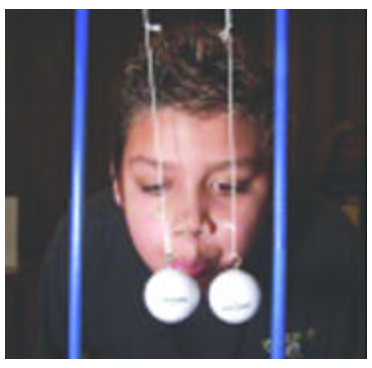
By Ernie Tretkoff

Twenty traveling physics demonstration troupes have been on the road all across the country this year, using grants from the APS Physics on the Road program, part of the celebration of the World Year of Physics. These shows are reaching schools and community groups in many areas, including poor, inner city, and rural areas where children would not otherwise have had the opportunity to see such a show.

Students of all ages watched these exciting and sometimes explosive shows. They touched liquid nitrogen clouds, made their hair stand up on end with a Van de Graaff generator, and marveled at bed of nails demonstrations, spinning bicycle wheel gyroscopes, and many other demonstrations, all while learning about physics.

As reported in *APS News* in February, the 20 Physics on the Road grant recipients were chosen from among forty applicants. Each group received $10,000 for supplies, vehicle maintenance, room and board for participants, and other costs associated with performing physics demonstrations. Funding was provided by the National Science Foundation, the Department of Energy's Office of Science, and the National Institute of Standards and Technology.

"The shows are great because they really show kids the fun and exciting side of physics," said Jessica Clark, APS Public Outreach Coordinator. "It



Bernoulli's principle in action at the Purdue Physics on the Road show.

has also been rewarding for us at *APS* to be able to help these programs." The Physics on the Road grants also give some visibility to these groups, which reach thousands of young people but often receive little recognition.

Some teams have used the grants to travel farther or do more shows, some have expanded their shows and created more demonstrations, and some have worked to make demos that incorporate topics recommended or required by state or national science standards.

The University of Texas at Brownsville and Texas Southmost College Physics Circus traveled around the Rio Grande area, reaching thousands of middle school students with their show, called Si! Tu Puedes ser un Cientfico! (Yes! You can be a scientist!) They report having surveyed students before and after the presentations. Before the show, when students were asked "what is physics?" most answered "I don't know." After the show, the students had an understanding of physics as a branch of science that relates to motion, or at least replied that "I don't know, but it looks cool and fun to me." Other Physics on the Road groups report similar increases in student's interest in physics after students attended a demonstration.

The Carolina Physics on the Road group (whose motto is "CPR gets your heart pumping") from the University of North Carolina, Chapel Hill, has used the grant to expand and formalize its program, especially developing collaborations with other outreach

Physics on the Road continued on page 6

DOE Report Highlights Promising Areas of Solar Energy Research

By Ernie Tretkoff

Sunlight has great potential to supply the world with abundant clean energy, but more research needs to be done to make solar power competitive with fossil fuels, according to a recent Department of Energy (DOE) report. The report, *Basic Research Needs for Solar Energy Utilization*, lists promising priority research directions for solar energy.

The report is the result of a workshop held in April by the DOE Office of Basic Energy Sciences. Over 200 scientists representing academia, national laboratories, and industry in the United States and abroad attended the workshop. The report is similar in scope to a report released two years ago on research needed for the hydrogen economy.

Sunlight is by far the largest carbon-neutral energy source, the report notes. More energy reaches Earth from the sun in an hour than is used on the planet in an entire year. Yet solar electricity currently provides only approximately one millionth of the total electricity supply. World demand for energy is expected to more than double by 2050. "Finding sufficient supplies of clean energy for the future is one of society's most daunting challenges," the report states.

To meet this challenge, more research is needed. "We spend

Doe Report continued on page 6

Cohen Sends Message to Gulf Coast Physicists

In a message to APS members in the Gulf Coast region affected by Hurricane Katrina, APS President Marvin Cohen said, in part, " On behalf of APS, I'm writing to express my sincere hope that all of you and your families are safe, and to offer the help of the Society over the coming weeks and months as you seek to rebuild your departments, laboratories and workplaces. If we can assist you in any way in your efforts to recover from this devastating tragedy, please contact our Director of Membership, Trish Lettieri, at lettieri@aps.org or 301-209-3272. Our thoughts are with you." The full message is on the APS web site.

Those who can offer assistance to affected members of the physics community are also urged to contact Lettieri, to bring those in need together with those who can help. Anyone in the affected area with a pending APS membership renewal will have their membership fee waived for the coming year.

Members in the Media

"It's great to see everything. Obviously, there are some mixed feelings, but I just love the enthusiasm that brought these people together again."

—Roy Schwitters, University of Texas at Austin, on a reunion of people who worked on the SSC, Dallas Morning News, July 23, 2005

"In some sense this is the first real measurement of this quantity, so it's a very big deal."

—Giorgio Gratta, Stanford University, on measuring neutrinos from the earth's core, The New York Times July 28, 2005

"Physics wasn't ready. We didn't have the tools."

—Jessica Clark, APS, on why Einstein failed in his quest for a unified field theory, Chicago Sun-Times, July 3, 2005

"This magnet is a world record because it has a very high magnetic field over a very large volume, so we'll be able to study the kinds of materials that can't be studied in any other magnet around the world."

—Greg Boebinger, National High Magnetic Field Laboratory, on a new large magnet at the lab, Associated Press, July 28, 2005

"We've done very well for the last 20 years without any experimental input."

—Michael Douglas, Rutgers University, on string theory, The New York Times, August 2, 2005

"Anything that's not oil can reduce our consumption of oil."

—Mark P. Mills, on tax credits for solar panels on homes, Newsday, August 2, 2005

"Learning physics is not a spectator sport. You have to be part of it."

—Gary Gladding, UIUC, on the newly revised introductory physics courses at his university, The News-Gazette (Urbana-Champaign, IL) August 8, 2005

"If you look through the shelves of science books, you'll find row after row of books written by men. This can be terribly off-putting for women."

—Lisa Randall, Harvard University, on one of the reasons she decided to write a book, The Guardian, June 21, 2005

"When you can hear your motion, that turns out to be a very useful thing. It can help people make real changes in their golf swing, just by changing what they hear instead of telling them physically to do this or that or the other thing with their hands mechanically."

—Robert Grober, Yale University, on a golf club he designed that lets people hear their swing, Bay news 9.com (Tampa, Florida) August 14, 2005

"The experience of being a scientist makes religion seem fairly irrelevant. Most scientists I know simply don't think about it very much. They don't think about religion enough to qualify as practicing atheists."

—Steven Weinberg, University of Texas, Austin, on science and religion, The New York Times, August 23, 2005

"It was quite exciting. You can even see Einstein's fingerprints in some places."

—Carlo Beenakker, Leiden University, on a recently discovered Einstein manuscript, bbcnews.com, August 21, 2005

"I'm fortunate that I can talk to people about the black hole, the Big Bang and Mars, and everyone is wide-eyed. That can't be said for a lot of other sciences—I can't see a physicist holding court like this."

—Neil deGrasse Tyson, on a program he gives at the Hayden Planetarium for the public, The New York Times, August 23, 2005

"I didn't realize that President Bush's faith-based initiatives have reached so far as Air Force research projects. None of the three forms of teleportation of large objects discussed in this report are anywhere near being practical in the foreseeable future and (are) probably ultimately impractical, as a trained physicist can see by just plugging in a few numbers."

—Victor J. Stenger, University of Hawaii (emeritus), on an Air Force study of teleportation, San Francisco Chronicle, August 29, 2005

This Month in Physics History

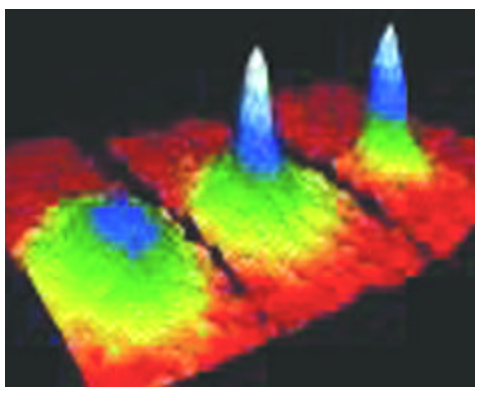
Einstein Lays Theoretical Foundation for BECs

Einstein had achieved worldwide fame with his theory of general relativity, although his personal life was far from idyllic. His wife, Mileva, complained that he had no time for her in the midst of his fame, adding, "I am very starved for love." For his part, Einstein felt increasingly suffocated in his marriage and embarked on a love affair with his cousin, Elsa Löwenthal. Mileva and Albert separated in 1914, after bitter arguments, and divorced in 1919. That same year he married Elsa, and settled in with her and her two grown daughters by a previous marriage.

Scientifically, however, he was still going strong. Einstein's 1917 paper detailing a quantum theory of radiation sowed the seeds for quantum electrodynamics and quantum optics, cavity quantum electrodynamics, and the processes of spontaneous and stimulated emission – the last of which led, later on, to the invention of masers and lasers by other physicists. And it also provided the underpinnings for a theoretical new state of matter.

Einstein's theory of radiation provided a complete characterization of the light quantum's specific particle properties. However, he didn't immediately work out the statistical mechanics of those particles–an omission that has surprised several science historians, since he based his 1905 paper on the energy quantization of radiation on a study of the entropy of thermal radiation.

That omission was remedied in 1924, when he received a paper



A Bose-Einstein Condensate

from a colleague, Satyendra Nath Bose, that successfully derived Planck's law by treating photons as indistinguishable particles, rather than individual quanta. Einstein promptly forwarded the paper for publication, and applied the same reasoning as Bose used to a gas of indistinguishable atoms. The result was the creation of Bose-Einstein statistics. Many physicists regard this work as Einstein's last major contribution to physics.

Satyendra Bose

Einstein and Bose used their new method to predict the possibility of a new form of matter, dubbed a Bose-Einstein condensate (BEC). They surmised that the wave-like nature of atoms might allow them to spread out and even overlap, if they are packed closely enough together. Lowering the temperature reduces the atoms' speed. If the temperature gets low enough (billionths of a degree above absolute zero) and the atoms are densely packed enough, the different matter waves will be able to "sense" one another and coordinate themselves as if they were one big "monoatom."

Einstein published a paper on the topic, entitled "Quantum Theory of the Monatomic Ideal Gas," in the proceedings of the Prussian Academy of Sciences in Berlin, Germany, in January 1925. In August of this year (see Members in the Media), a student at Leiden University's Lorentz Institute for Theoretical Physics uncovered Einstein's manuscript for the paper, while reviewing documents in the archive for his thesis on Paul Ehrenfest.

But the technology didn't yet exist to create such a new state of matter in the laboratory. In the mid-1980s, Stanford University physicist Steven Chu demonstrated laser cooling by weaving a "web" out of infrared laser beams. He called it "optical molasses." The beams bombard target atoms with a steady stream of photons, whose wavelengths are carefully selected so that they will only be absorbed if they collide head-on with atoms. As the atoms slow down, they cool down to about 10 millionths of a degree above absolute zero.

Carl Wieman, a physicist at JILA/University of Colorado, and his JILA colleague, Eric Cornell, embarked on a five-year quest to produce the first BEC, using a combination of laser and magnetic cooling equipment that Wieman designed himself. While other groups were pouring research dollars into cutting-edge $150,000 lasers, he pioneered the use of simple $200 diode lasers. Using a laser trap, they cooled about 10 million rubidium gas atoms; the cooled atoms were then held in place by a magnetic field. But the atoms still weren't cold enough to form a BEC, so the two men added a second step, evaporative cooling, in which magnetic fields in a web conspire to kick out the hottest atoms so that the cooler atoms can move more closely together. Evaporative cooling was an old technique; the JILA scientists simply tinkered with it until they got the low temperatures they needed.

Wieman and Cornell made physics history at 10:54 a.m. on June 5, 1995, producing a BEC of about 2000 rubidium atoms that lasted 15-20 seconds. Shortly thereafter, MIT physicist Wolfgang Ketterle achieved a BEC in his laboratory. By September 2001, over three dozen teams had replicated the experiment. Wieman, Cornell and Ketterle shared the 2001 Nobel Prize in Physics for their achievement.

The discovery launched an entirely new branch of physics. BECs enable scientists to study the strange, small world of quantum physics as if they were looking at it through a magnifying glass; a BEC "amplifies" atoms in the same way that lasers amplify photons. Among other things, scientists have used BECs to build an atom laser that releases individual atoms; it could one day be useful to etch tiny patterns on computer microchips. Others hope to build atomic computer circuits that rely on the motion of atoms instead of electrons to store and process information. And in February 1999, researchers at Harvard University found they could slow down light – which normally travels at 669,600,000 MPH—to just 38 MPH by shining a laser beam through a BEC. Two years later they briefly brought light to a complete stop.

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An Historic Occasion

This year APS is inaugurating a program to designate historic physics sites in the US (see APS News, May 2005). On July 13, APS presented the first plaque to the Franklin Institute in Philadelphia, in recognition of the scientific achievements of Benjamin Franklin. Shown here are John Rigden of Washington University, the Chair of the Historic Sites selection committee, Philip W. Hammer, Vice President of the Franklin Institute, and Alan Chodos, Associate Executive Officer of the APS.

APS Selects Mohta as New Congressional Fellow

A mathematical physicist from Cambridge, Massachusetts, is the new APS Congressional Fellow for 2005-2006. Vivek Mohta, who recently completed his graduate study at Harvard University, will spend the next year broadening his congressional experience through direct involvement with the legislative and political process.

The APS Congressional Fellowship program is intended to provide a public service by making individuals with scientific knowledge and skills available to members of Congress. In turn, the program enables the scientists selected to gain experience in the political process.

Mohta received BS degrees in both mathematics and physics from MIT in 1999, and recently earned a PhD in mathematics from Harvard University with a thesis on applications of chiral perturbation theory, with a particular emphasis on pentaquark masses.

Quarks normally exist in groups of two (mesons) or three (baryons), but the theory of quantum chromodynamics holds that groupings of four quarks and one anti-quark should be possible. In 2003, a research group in Japan announced the first experimental evidence for a pentaquark, a finding that was quickly confirmed by other groups who reported sightings of the elusive particle. But other studies produced null results, stirring up a controversy over the existence of the five-quark states. The most recent experimental results from CEBAF at the Thomas Jefferson National Accelerator Facility also found no evidence for the pentaquark, as reported at the 2005 APS April meeting in Tampa, Florida (see *APS News*, June 2005).

The brisk debate surrounding the conflicting results is one reason Mohta chose to apply chiral perturbation to the pentaquark. "It's one of those great examples of how science actually works, all that controversy and excite-

Vivek Mohta

ment," he says, an experience that is so different from "the sterile picture that's often presented in textbooks."

Mohta has a long-standing interest in public service, having been active as an undergraduate at MIT in delivering food to homeless shelters in the Cambridge, MA area, as well as

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APS President Says Intelligent Design Should Not be Taught as Science

APS President Marvin Cohen, University Professor of Physics at the University of California, Berkeley, issued a statement in August saying that only scientifically validated theories, such as evolution, should be taught in the nation's science classes. His statement was in response to remarks by President George Bush regarding intelligent design, a form of creationism.

In comments to journalists in Texas, President Bush had said that intelligent design should be taught side-by-side with scientific theories of evolution in the classroom. Those remarks were later clarified by Presidential Science Advisor John Marburger.

"We are happy that the President's recent comments on the theory of intelligent design have been clarified," said Cohen. "As [Marburger] has explained, President Bush does not regard intelligent design as science. If such things are to be taught in the public schools, we believe they belong in a course on comparative religion, which is a particularly appropriate subject for our children given the present state of the world."

The APS Council has long opposed the inclusion of religious concepts such as intelligent design and related forms of creationism in science classes, passing two public statements on the issue in 1981 and 1999. The full text of those statements can be found at:

http://www.aps.org/statements/81_1.cfm

http://www.aps.org/statements/99_5.cfm

CORRECTION

In the "International News" column in the August/September *APS News*, the institutional affiliation of Anne Harrington was stated incorrectly. The affiliation should have read

"Anne M. Harrington served for over 15 years at the Department of State, including as Deputy Director of the Office of Proliferation Threat Reduction, and is now the Director at CISAC."

APS News regrets the error.

INSIDE THE BELTWAY: WASHINGTON ANALYSIS AND OPINION

The Avoidable Tragedy of New Orleans

By Michael S. Lubell, APS Director of Public Affairs

Each day when the sun finally sets over the Potomac, what Washington accomplished is a matter of priorities and politics. And it hinges on what two groups want: voters in general and campaign contributors in particular. Science is not even in the mix.

What happened in New Orleans last month in the aftermath of Hurricane Katrina is an archetypal example. It was no accident. It reflected more than two decades of federal Crescent City policies that had sacrificed science on the altar of political expediency.

A month ago, three days after the Bayou dikes gave way and the punch bowl that is New Orleans filled up with water from Lake Pontchartrain, President Bush did a one-on-one interview with Diane Sawyer of ABC's Good Morning America. The President, in what will long be regarded as one of the rhetorical low points for an Administration that is guided by a tightly controlled public relations shop, said, "I don't think anyone anticipated the breach of the levees." He might as well have said that the earth is flat, Thomas Friedman's bestseller notwithstanding.

There is ample bipartisan blame to go around, but unfortunately the Bush White House must accept most of it. It's a rule of politics: When the worst natural disaster in the history of the nation occurs on your watch, even if prior administrations ignored the warning signs, in the public's view 90% of the

Inside the Beltway continued on page 6

US Physics Team Wins Five Medals in 2005 International Physics Olympiad

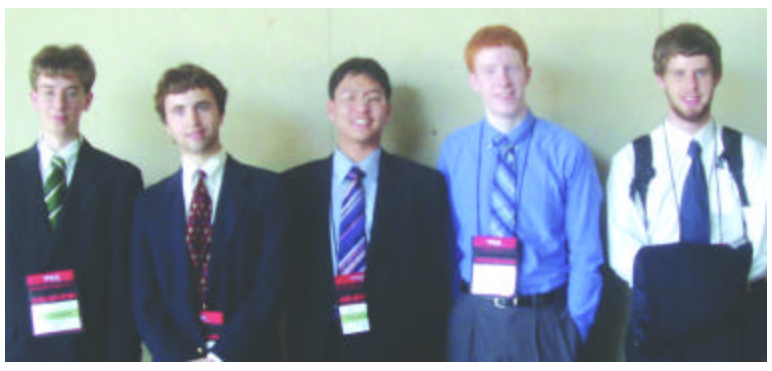


Photo Credit: Mary Mogge

Left to right: Nickolas Fortino, Daniel Whalen, Men Young Lee, Timothy Credo, and Eric Mecklenburg.

Representatives of the 2005 US Physics Team won five medals at the 36th International Physics Olympiad held July 3-12 in Salamanca, Spain. Eric Mecklenburg of Gates Mills, Ohio, and Men Young Lee of Alexandria, Virginia, were awarded gold medals. Timothy Credo of Aurora, Illinois, and Nickolas Fortino of Andover, Massachusetts both received silver medals, and Daniel Whalen, also of Andover, won the bronze medal.

The Olympiad is an international competition among pre-university students from more than 70 nations. The goals of the Olympiad are to encourage excellence in physics education and to reward outstanding physics students. Competitors are asked to solve challenging theoretical and experimental physics problems. The 24 members of the US Physics Team are selected through two competitive examinations.

The members of the team met at the University of Maryland for an intensive one-week training camp May 14-23. At the end of the training camp, five members were selected to represent the US Physics Team: Credo, Fortino, Lee, Mecklenberg, and Whalen.

From 1986 to 2005, the United States Teams have brought home 26 gold medals, 20 silver medals, 26 bronze medals, and 11 honorable mentions.

Estate Planning Information Available to APS Members

Following a very successful session on estate planning offered last spring at the March meeting in Los Angeles, APS members can obtain, free of charge, brochures on the following topics:

- Better Estate Planning
- Personal Financial Affairs Record
- How to Make a Will That Works
- A Guide to Giving in 2005
- Giving Through Your Will
- Giving Through Retirement Plans

A handout prepared by the speaker at the meeting, Reynolds T. Cafferata of Rodriguez, Horii & Choi LLP, is also available.

The session at the meeting was entitled "The Danger of Tax Laws and Opportunities for Creative Arrangements." Highlights included an overview of estate planning tools to minimize estate taxation, as well as how best to structure charitable gifts that feature tax savings and other financial benefits.

Also, as a reminder, APS announced the formation of a Bequest Society in Nov. 2004, and is most grateful to individuals who choose to include APS in their estate plans.

Members who would like copies of the brochures and handout and/or would like to discuss opportunities to include APS in their will can contact Darlene Logan, Director of Development, at (301) 209-3224 or logan@aps.org.

APS MOURNS LOSS CONTINUED FROM PAGE 1

achievement was recognized when Davis and Masatoshi Koshiba, leader of the Kamiokande neutrino experiment, each received part of the 2004 Nobel Prize in physics.

Bahcall was also a leader in planning and advocating for the Hubble Space Telescope in the 1970s. More recently, he led efforts to extend the life of the Hubble Telescope through the current decade.

He was the recipient of many honors and awards, including the APS Bethe Prize in 1998, and the National Medal of Science in the same year. He shared the Benjamin Franklin Medal in Physics with Davis and Koshiba in 2003.

Bahcall was born in Shreveport, LA in 1934, and received his AB from UC Berkeley in 1956, his MS from the University of Chicago in 1957, and his PhD from Harvard in 1961. He is survived by his wife, Neta Bahcall, who is a professor of astrophysics at Princeton University, and three children.

Photo Credit: James Riordon

John Bahcall with winners of the APS PhysicsQuest competition at the Institute.

The family has asked that contributions in his memory be made to the John N. Bahcall Fund for Science Education in Israel and the United States, c/o the Institute for Advanced Study in Princeton, NJ.

Letters

Back Page Rehashes Same Old Arguments

This letter is specifically a comment on the Back Page article by Norman Augustine in the July issue of *APS News*, and more generally a comment on many such discussions that have appeared over the past decade.

This article makes the point that, for a variety of reasons, the funding from the US government for "hard science," particularly in the universities, should be increased. The primary reason stated is that much of the job formation in this country can be attributed ultimately to advances in basic research. Among the challenges quoted in this article are: i) the infighting between physics and chemistry, particle physics and astrophysics, experimental physics and theoretical physics, etc.; ii) making a direct connection between advances in basic research and applications, creation of jobs, etc.; iii) publicizing those connections to the general public.

This article also makes the point that basic research in industry is much smaller than several decades ago, and arguably nonexistent at this point.

We have all seen these same points made numerous times in *Physics Today*, *APS News*, in talks at conferences and at our own institutions, etc. The basic question I would like to ask is: After 10 or 15 years of these same arguments being made over and over, why have they not succeeded?

I don't know the answer, but rather than continuing to make the same arguments to ourselves, we should either figure out a better way to make this case, or to (gulp) accept the fact that US government-funded physics research will continue to shrink, and figure out what to do differently after we accept that.

Neil Zimmerman
Gaithersburg, MD

Innovation May Not Pay Off

I read with general agreement Norm Augustine's editorial, "Making the Case for University Research." However, one of his premises, "Only one acceptable choice remains: to be among the world's foremost innovators," is unfortunately open to question. It is a well-known fact that venture capitalists, at least in Silicon Valley, are increasingly sending their venture money and the associated jobs overseas. This is one of many pieces of evidence that suggest that innovation may not pay off for our economy today.

Looking back at the history of the United States of America, innovation has usually been greeted with praise and interest, but rarely rewarded. It's been natural for our country, with its great natural resources, to focus on resource exploitation, and the present day seems to be no exception. For those of us who innovate by choice, we will likely continue, whether or not there is any real reward.

Richard Holmes
Cannon Park, CA

APS Should Survey Members on Intelligent Design

It is disturbing but hardly surprising that President Bush has gone on record as supporting the teaching of intelligent design along with evolution in the nation's public schools (*NY Times*, Aug 3rd). Even more disturbing, though, is the statement attributed in the same article to Dr. Richard Land, President of the Ethics and Religious Liberties Commission of the Southern Baptist Convention that "evolution is too often taught as fact....if you're going to teach the Darwinian theory as evolution, teach it as theory. And then teach another theory that has the most support among scientists."

One has to wonder from whom Dr. Land gets his information (presumably not from the APS), and I would like to propose that the APS undertakes a very simple statistical survey of its members to see which side they support, and whether evolution and intelligent design should be taught side-by-side in science classes. I hope the results would be communicated to the White House by the President's Science Advisor.

David Cox
Bellport, NY

Republicans in Physics: Are they Underrepresented? Do We Care?

In a July Viewpoint, Gary White commented on Andrew Warden's letter in the April issue, which in turn referred to the January "Inside The Beltway" article by Michael S. Lubell. Andrew Warden claims that Republicans are underrepresented and that this is an "obvious fact." Before considering why this might be, or what we should do about it, we should first establish whether it is real. It's relatively easy to collect information by gender, and we have data on the underrepresentation of women in physics. It's harder to even define what "Republican" might mean with respect to science and scientists. (As Lubell quoted the late Representative George Brown, science itself should not be a partisan enterprise.) Has anyone collected any hard data on the politics of physics students, APS members, or APS officers? Would APS members answer such a survey? Although there is room for all political persuasions in APS, and we should try to ameliorate real inequities within our community, we don't yet know whether Warden's assumed political asymmetry is real. In addition, I believe that we should not dedicate any of the time and treasure of this Society toward specifically recruiting political ideologues of any stripe.

Randall Brynsvold
San Jose, CA

Viewpoint...

Funding Cuts in Physical Sciences Reach the Danger Level

By Keith R. Dienes and Gordon Kane

For research physicists, learning to live with funding cuts is often considered par for the course. For many years now, both theoretical and experimental physicists have been challenged to maintain high-quality research programs with decreasing financial support and resources. Sometimes, they have even been able to do so.

However, we believe that the effects of this trend are now reaching a dangerous stage. From large groups at prominent universities to individual researchers at liberal arts colleges and undergraduate institutions, recent funding cuts are beginning to cause considerable damage to the health and vitality of our field. The funding level for newly hired faculty is woefully insufficient for the establishment of vibrant research programs, thereby threatening promising careers at their inception. Likewise, the depth of recent cuts required of larger, more prominent groups has been so great that we fear for their continued excellence. Indeed, funding agencies are now being forced into cannibalistic choices, sacrificing funding for one active researcher in order to minimally support another. Or, as may be happening in nuclear physics and other areas, choosing between major facilities. Even if funding continues at current levels, we believe that the physics research program in the United States will suffer significant and possibly permanent harm.

As theorists, we are particularly aware of the shortages of funding for theoretical research, yet the intellectual merits of a strong theoretical program are very clear. Strong university programs combine the best of both theory and experiment, and help attract the best young minds to the sciences. A healthy theoretical infrastracture is also absolutely necessary for the planning and guidance of future experiments, as well as for the interpretation of data from upcoming experiments in all branches of physics, whether high-energy physics, astrophysics, cosmology, condensed-matter physics, or even biophysics. Indeed, in some fields, there are large experiments for which significant funds have already been spent; without appropriate theoretical input, the full impact of measurements may not be realized. While theory is relatively inexpensive compared with experiment, it plays a critical role in the scientific ecosystem, and adequate funding is necessary in order to sustain it.

But there are also broader issues at play across all of the physical sciences. According to a recent report issued by the Task Force on the Future of American Innovation (available at http://www.future-ofinnovation.org), the effects of funding cuts for the physical sciences are already being felt at both the national and international levels. During just the past several years, the United States has been passed by Western Europe in the total numbers of published science and engineering articles, with a 7% lead turning into a 5% deficit in just the past 13 years. Asia is also rapidly closing in on the US, with our 27% lead already cut in half. Moreover, the US share of worldwide citations is shrinking significantly, falling by 8% in a single decade. While such statistics are for scientific research in general, the situation in the theoretical physical sciences is as bad or worse.

The larger implications of this funding crisis are dramatic. For the first time, the United States is under threat of losing its dominant position in US patent applications, and the world's fastest-growing economies are rapidly gaining on the US in terms of total research & development investments. The US is rapidly losing its world share of high-tech industrial exports, and in just the past four years has gone from being a net exporter to a net importer of advanced-technology products. This includes sectors as diverse as energy, aerospace, biotechnology, information technology, and nanotechnology. Even our graduate programs are threatened: as foreign university research funding levels begin to exceed those in the US, it is only natural that increasing numbers of foreign graduate students—a major asset of our PhD programs—will choose to remain in their home countries, denying the US an important inflow of talent and intellectual strength. It is worth noting that the Task Force on the Future of American Innovation, which issued this alarming report, comprises not only academic and scientific institutions such as the American Physical, Chemical, and Mathematical Societies, but also leading private technology corporations such as Microsoft, Hewlett-Packard, IBM, Intel, and Texas Instruments.

The causes of this worsening situation are clear. As a percentage of the US Gross Domestic Product, federal investment in the Physical Sciences has fallen by nearly 50% over the past thirty years. While funding for the biological sciences has kept pace with inflation and even seen increases, funding for the physical sciences has fallen far short — worse than average for all research. The effects on the future of the American workforce are also clear. While the number of Bachelors degrees in the biological and life sciences has climbed by 71% in the past twenty years, the numbers of Bachelors degrees awarded in the physical sciences, in engineering, in mathematics, and in computer/information sciences have fallen by 11%, 21%, 28% and 36% respectively. Students will clearly not invest their futures in fields in which the federal government is unwilling to invest its financial resources. Taken together, this state of affairs not only damages the American educational system and the state of American science, but also has threatening, far-reaching effects on the American economy and national security.

Viewpoint continued on page 7

Invention of the Maser and the Laser Clarified

In "This Month in Physics History" in the August/September *APS News*, you give Charles Townes and Arthur Schawlow credit for inventing the laser, in particular crediting Schawlow for the idea of trapping the photons in a mirrored tube.

In fact, Townes invented the maser, not the laser. The laser was invented by Gordon Gould, and in particular he conceived the idea of the mirror-ended tube which he patented. After a long court battle, Gordon's patent claim was recognized, and he became a very wealthy man since he derived royalties from every supermarket scanner, CD player, etc.

On another note, your description of stimulated emission asserts that the original photon and the stimulated photon "will travel in the same direction." I wonder how you concluded this. The two photons are coherent (i.e. their amplitudes are additive) because, even in principle, there is no way to distinguish between them. But coherent particles need not travel in the same direction. Think of two-slit (or neutron) diffraction or, for that matter, scattering of alpha particles by helium.

Paul Zweifel
Radford, VA

Lamb Understates Nuclear Risk

Frederick Lamb's Viewpoint article on US security in the August/September *APS News* is certainly to the point, and certainly unsettling in its description of the catastrophic effects of a nuclear bomb. But the catastrophic effects of a nuclear bomb detonated in a US city hardly stop there. Consider how the Second World War ended, a mere 60 years ago, with the systematic destruction of city after city first with firebombing and then with nuclear weapons. Does anyone really think that we have come far since then? If a nuclear bomb is detonated in the US and hundreds of thousand die, there will be a ferocious "it's us or them" reaction. There are plenty of Curtis LeMay types around and the all-too-likely result will be that those countries suspected of having anything to do with the perpetrators of the bombing –countries suspected of being sources of nuclear material or sources of terrorist fanatics –will be wiped from the earth. Tens of millions of innocent people will follow their American cousins to the grave.

Jon Orloff
College Park, MD

PHYSICS AND TECHNOLOGY FOREFRONTS

Time-Resolved Emission Microscopy of Silicon Integrated Circuits

By Stanislav Polonsky

Background

When asked about the light emission in semiconductors we tend to think about devices such as light emitting diodes or semiconductor lasers. It is less known that the silicon metal-oxide-semiconductor field-effect transistor (MOSFET), a workhorse of modern integrated circuits (IC) technology, can also emit light. The emission takes place when a MOSFET is in saturation (see Fig. 1). In saturation, the current through the device practically does not depend on drain voltage since the conducting channel is pinched off. The voltage drop across this pinched-off region gives rise to high electric field (>10^5 V/cm). The Light Emission in Saturation (L_{SAT}) arises from the relaxation of hot electrons created by this field. Its broad spectrum covers visible and near infrared regions. For the majority of people the idea of using a MOSFET as a light source may seem strange and useless. Still, it finds important applications in the area of semiconductor IC testing and debug, known as photon emission microscopy (PEM) of IC.

In the dominant Complementary Metal-Oxide-Semiconductor (CMOS) technology, the voltage drop across a conducting transistor is close to zero, so a MOSFET can never be permanently in saturation, provided that a circuit works properly and it is in a well defined logic state. In a circuit with a fault such as a shorted or open wire, the MOSFET can stay in saturation, and the light emission from it can assist in localizing the fault. This fact

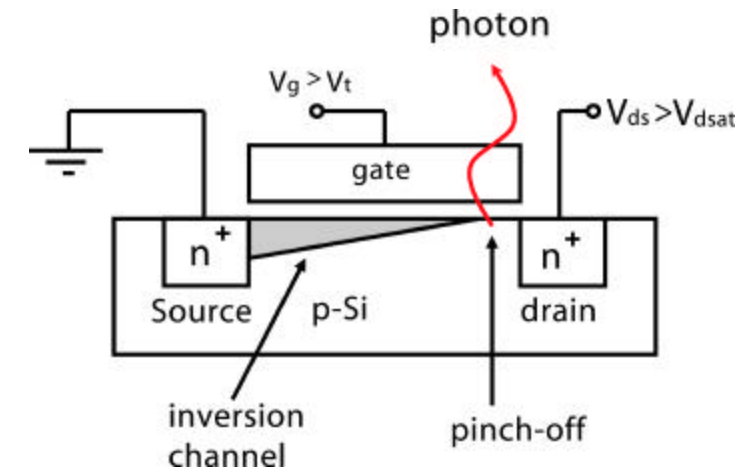


Fig.1. Light emission from saturated n-type MOSFET (V_g– gate voltage, V_t–threshold voltage, V_{ds}–drain-to-source voltage, $V_{dsat} \approx V_{ds}-V_t$)

explains the power of PEM in IC defect localization. For completeness, it is worth mentioning that PEM also uses another light emission mechanism–radiative electron-hole recombination. In bulk CMOS technologies it can occur when two parasitic bipolar transistors latch up.

When a properly working CMOS circuit switches, some of its MOSFETs can be driven into saturation for a short period of time. The resulting L_{SAT} is very weak–it produces less than a photon per transistor per switch; detecting L_{SAT} requires single photon detectors. The transient emission from a CMOS circuit was first detected by two IBM researchers, Jeffrey Kash and James Tsang, in 1996. Using a thermoelectrically cooled microchannel plate (MCP) photomultiplier with a position sensitive resistive anode, they detected short (*<270 ps*) pulses from a fully functional ring oscillator fabricated in 0.6 mm CMOS technology running at voltage $V_{DD}=3.5V$. Analysis of arrival times of such pulses and correlating them with particular transistors allows one to reconstruct the switching dynamics of a circuit and provides invaluable information about its internal operation. The invented technique became known as PICA–Picosecond Imaging Circuit Analysis.

Applications

PICA enjoyed a lucky history–immediate industrial applications followed soon.

In late 1997 an IBM team measured the clock tree skew in 0.25 µm 64-bit 2.5V CMOS microprocessor running at 100 MHz. The measurements were performed from a thinned and polished back side of the chip.

PICA was first licensed by the Schlumberger Probe System Group. At present, an Emiscope® product line, capable of performing time-resolved emission microscopy, is available from Credence Systems corporation. As a result of increased availability of commercial tools, PICA has become a standard technique in failure analysis labs of many semiconductor corporations.

Challenges of CMOS scaling

CMOS scaling is presenting a number of challenges to maintaining the usefulness of PICA: low voltage operation, high power chips, and shorter channel lengths of transistors.

Lowering power supply voltage V_{DD} is a necessary consequence of CMOS scaling. Since the invention of PICA, it dropped from *3.5 V* down to *1V*. This has drastically influenced the choice of single photon time-resolved detectors for PICA. Decreasing power supply voltage shifts emission spectra into longer wavelengths and exponentially decreases its intensity. The MCP imaging detectors with S-25 photocathod are sensitive in 400-900 nm range. For backside measurements, which is the only viable option for modern flip-chip packaged microprocessors, most of the emission in this spectral range is blocked by silicon. MCP continued to be useful as technology approached $V_{DD}=1.8$ *V* (180 nm technology node). For 180 nm chips running at nominal voltage typical acquisition time could easily be as long as tens of hours. For next generations, a new type of the detector was needed, developed by the group of physicists from Moscow State Pedagogical University (MSPU), led by Professor Gregory Goltsman, and in collaboration with Rochester University. Named Superconduct-ing Single Photon Detector (SSPD), the detector operates by producing short voltage pulses when a single photon is absorbed in a sub-critically current-biased superconducting nanowire. It had quantum detection efficiency *QE=5%* at wavelength 1.3 µ and timing jitter (i.e. photon detection time error) about 40 ps. The detector operates at temperature T=2÷3 K. SSPD-based tools are thousands times faster than those based on MCT, and they demonstrate short measurement times (minutes) when debugging modern 90 nm microprocessors running at $V_{DD} \approx 1V$. Our experience shows they will also be adequate for coming 65 nm microprocessors. The price paid for achieving such performance was abandoning imaging capabilities of the original technique and using single pixel detectors.

An alternative approach was chosen by researchers from Credence Systems Corporation. They used a thermoelectrically cooled InGaAs avalanche photodiode with custom quenching electronics as a single photon detector. At expense of higher dark count, it achieves impressive *QE>10%*.

Increasing power dissipation, which could be more than 100 W in modern microprocessor, is also a growing concern. Indeed, backside PICA measurements require removal of a heat sink, without which the chip just does not work properly. Blowing dry nitrogen on a chip can sometimes alleviate the problem, especially for relatively simple application-specific integrated circuits (ASICs). The permanent solution is diamond heat spreaders, or even water cooling.

Shorter transistor channel length L_{ch} is also a consequence of CMOS scaling. Denser placement of transistors makes it difficult to resolve them optically. Resolution of Si subsurface imaging is limited to 0.5 µm. Solid immersion lenses (SIL) can improve diffraction-limited resolution and light collection efficiency by an order of magnitude. They are becoming a standard feature of PEM tool manufactures.

Another consequence of decreasing L_{ch} is increasing off-state drain-to-source leakage current and electric field in the channel. Taken together, these two factors give rise to hot electron populations sufficient to emit a measurable amount of light even when the device is in off-state. Such off-state light emission (L_{OFF})

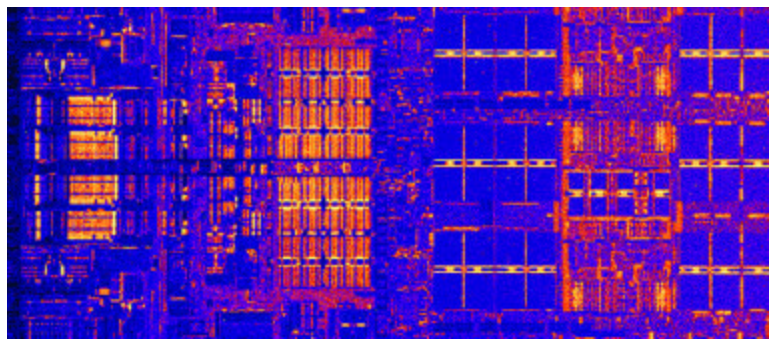


Fig. 2. Off-state emission from a quiescent 130 nm microprocessor. Brighter colors correspond to more intense emission.

becomes noticeable in devices from 180 nm technology generation and dramatically increases for subsequent generations (see Fig. 2). While being a consequence of a highly undesirable effect, leakage currents in MOSFETs, L_{OFF} can be put to use in IC emission microscopy. Fig. 3 illustrates the concept of off-state light emission from a CMOS inverter. N-type MOSFET emits off-state light L_N only when the inverter is in logic state 1 while p-type MOSFET emits light L_P only when the inverter is in logic state 0. The leakage emission from both types of devices is persistent–the devices emit the light as long as the inverter is in a definite state. For practical purposes, it is possible to say that L_{OFF} tracks leakage current with one important advantage–it can be easily measured using standard tools of photon emission microscopy. Off-state leakage current and, consequently, L_{OFF} depend on a number of parameters that are difficult to measure on a chip: internal voltages, device temperature, channel length, threshold voltage, etc. The ability to non-invasively measure these parameters is important for IC design and fabrication. For example, knowing the on-chip voltage variations caused by wire crosstalk noise, inductive interconnect response, and power grid noise caused by circuit switching activity are crucial for signal integrity characterization of modern high speed digital IC.

Time-resolved measurements of off-state emission allowed our group to extract optically the dynamics of gate and drain voltages across a *single* MOSFET with accuracy few *mV*. We were also able measure the dynamics of Silicon-on-Oxide MOSFET self-heating, using the dependence of off-state emission on device temperature. The dependence of off-state emission on the logic state of a circuit can be used to localize a resistive fault in a microprocessor. One of the most recent developments is optical characterization of across chip device performance variations which become more and more important as transistor size shrinks and it becomes more difficult to control its parameters. Smaller L_{ch} and V_t make MOSFET to switch faster, and, simultaneously, increase L_{OFF}. We used this fact to optically map device performance variations within a single chip.

Opportunities

Measurements of transistor switching times will probably continue to be the major application of PICA. Our experience with next generation technologies, which are presently being under development, indicates that the light emission from the future MOSFETs is strong enough to be measured by existing single photon detectors. The major opportunities lie in the PICA tools area. Making the analysis easy to use, integrating it with other failure analysis techniques (e.g. thermal imaging) will determine further adoption of PICA by the industry.

There are opportunities in adding value to PICA by utilizing new sources of light emission such as off-state current, or using time-resolved spectroscopic data. Also, in recent technologies the light emission from ever increasing gate oxide leakage current has become strong enough to be reliably detected with available tools. Static imaging of this type of emission has already been used for device reliability studies. The question if time-resolved measurements can add value to the technique is still open.

In almost ten years since the invention, PICA has become a mature IC diagnostics technique. Most probably, it will find ever wider applications as IC technology produces increasingly more complex chips. It offers research opportunities for interested physicists together with a promise of immediate commercial applications.

Stanislav Polonsky is a research staff member in the Optical Communications and High Speed Test Group of the IBM T.J. Watson Research Center in Yorktown Heights, NY.

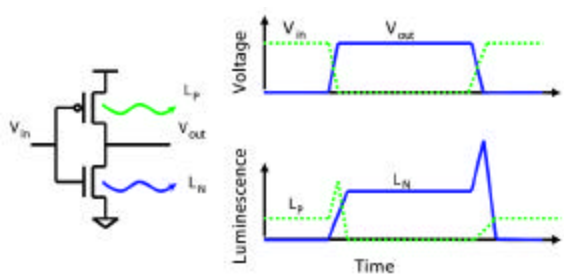


Fig. 3. Light emission from n-type MOSFET (L_N) and p-type MOSFET (LP) in a CMOS inverter is a combination of L_{SAT} and L_{OFF}: L_{OFF} (horizontal region) "tracks" the logic state of a transistor; L_{SAT} (peaks) corresponds to the emission from switching transistors. Light emission from n-type devices is much stronger than that from p-type devices.

PHYSICS ON THE ROAD CONTINUED FROM PAGE 1

groups on campus, including a traveling lab from the biology department, and the UNC's Morehead Planetarium, where the Physics on the Road team plans to do as many as a dozen shows a week this fall. While it's not truly "on the road," these shows have a big impact because so many student groups visit the planetarium, said Duane Deardorff, who is in charge of the UNC Physics on the Road program. Some of the CPR group's demos are quite unusual. With younger children, Deardorff likes to do a simple demonstration of density that always amazes people–it turns out that a 10 pound bowling ball will float, but a 14 pound one will sink. He also likes to have students play with "roomerangs," small boomerangs that can be thrown in a room like a school cafeteria. "It's a really fun toy, but there's also lots of fun physics that can be demonstrated," he says. Deardorff is also trying to make portable versions of some of his demonstrations, including a water drop and strobe light setup that makes falling water drops appear suspended in air. "We're using Physics on the Road grant funds to make this into something we can take on the road," he said.

Brian Jones of Colorado State U. and friend at the southern Navajo reservation.

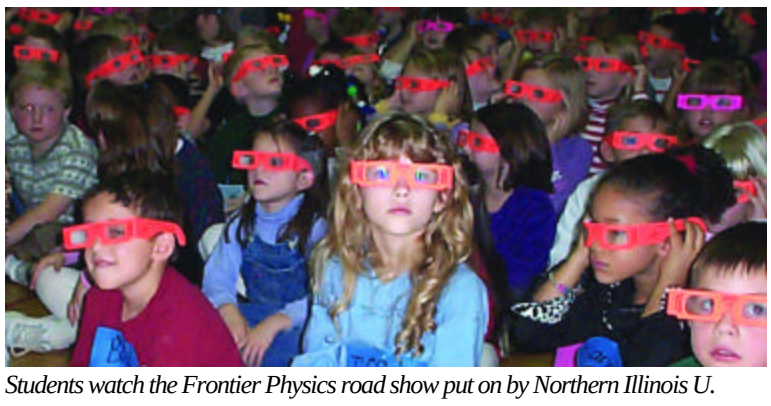
The University of Oregon has incorporated a professional circus performer into its show, using juggling and other circus arts to demonstrate concepts such as gravity and rotational motion. As a side effect, the Physics on the Road grant has made the World Year of Physics more visible to their own department, the Oregon group reports.

The University of Wisconsin, Madison group is taking the "on the road" part quite seriously–they're well on their way to meeting their goal of visiting every one of the 42 counties in the state with their show, which includes favorites such as a liquid nitrogen cloud, exploding balloon, bowling ball pendulum and many others.

WYP Cookies baked by Grace Johns at Illinois State University.

The University of Iowa group has also expanded its reach, traveling as far as 110 miles from Iowa City. They have already visited three times as many locations as last year. During the summer they reached many minority and disadvantaged students who were participating in science camps. The group also expects to use the Physics on the Road grant as a springboard to get other grants.

Perhaps the largest area served has been by the Idaho State University physics demo road show, which has traveled to Utah, northern Nevada, eastern Oregon, and southern Idaho, and plans to visit schools and community groups in Montana, Wyoming, and northern Idaho later this year.



Students watch the Frontier Physics road show put on by Northern Illinois U.

Students at Jonas C. Salk elementary school do hands-on physics at the Purdue demo show.

DOE REPORT CONTINUED FROM PAGE 1

more money in ten minutes buying gas at the pump than we spend on solar energy R&D in a year," said Nathan Lewis, a chemist at Caltech who was one of the workshop chairs.

The workshop attendees identified 13 priority research directions that could advance solar energy conversion to electricity, fuels, and thermal end uses. Many of the suggested research directions build on recent advances in nanotechnology and biotechnology. Better ways of exploiting a larger part of the solar energy spectrum, making cheap materials function as well as expensive ones, and developing new materials that absorb sunlight more efficiently are among the research goals.

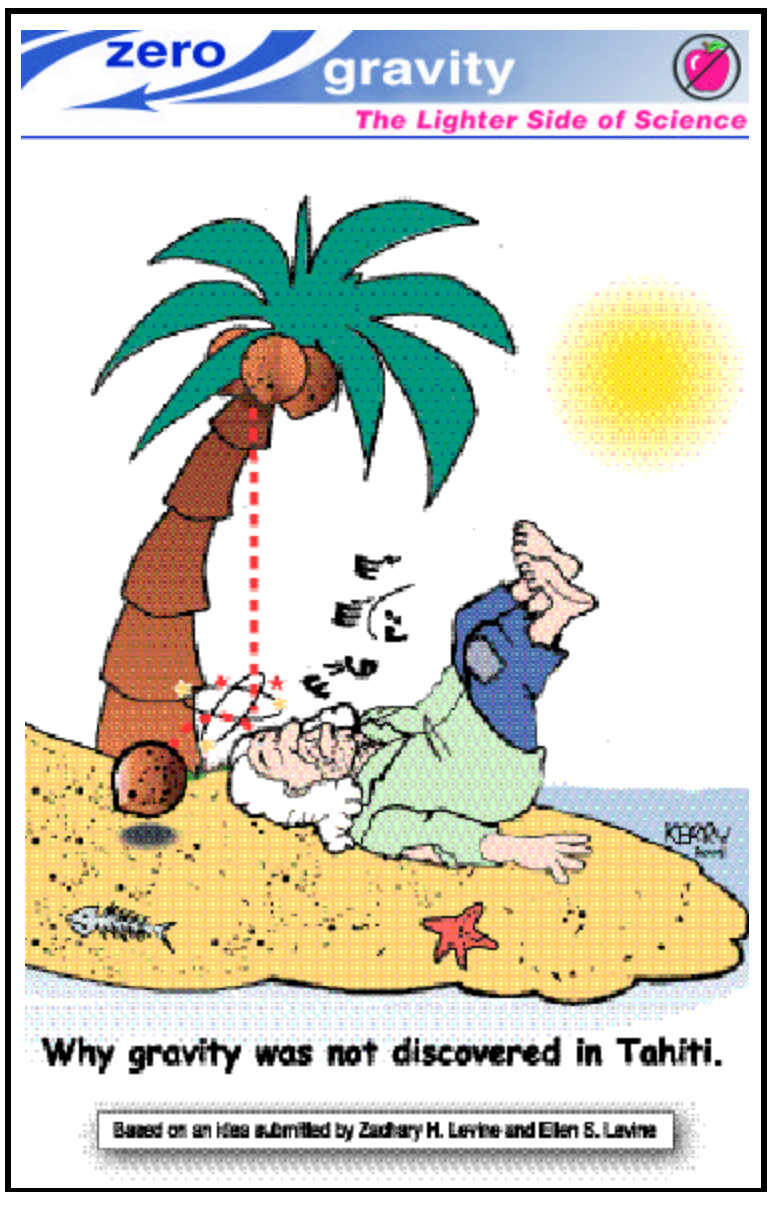
According to the report, the proposed research could also lead to a number of advances, including artificial "molecular machines" that turn sunlight into chemical fuel, "smart materials" based on nature's ability to transfer captured solar energy with no energy loss, cheap plastic solar cells, new photovoltaic designs, solar concentrators, new materials for thermal storage, and ways to use sunlight to split water molecules into oxygen and hydrogen that can be used for fuel.

These are all promising research directions, said Lewis. He says he is optimistic that efficient ways to use solar energy can be developed because the basic principles of solar energy conversion are understood. "We're good at applying fundamental principles to develop technologies that help change our lives. Once we have the principles, we can figure out how to do it. There are no laws of physics that we don't know here."

"This report demonstrates the important contribution the entire scientific community can make to the development of new sustainable energy resources," Ray Orbach, Director of DOE's Office of Science, said in a press release. "Science and basic research can and must play a key role in addressing the energy security needs of our nation."

It has not yet been determined how much funding will be available for solar energy research. "This is a really important problem. The question is whether the country is serious about doing something. We all are going to hang on to see if the country is serious about exploiting this renewable resource," said Lewis.

The full report is available at http://www.sc.doe.gov/bes/reports/abstracts.html#SEU



INSIDE THE BELTWAY CONTINUED FROM PAGE 3

fault is yours–particularly if you didn't assemble the right team.

Michael Chertoff, the Secretary of Homeland Security, the Department charged with overseeing such domestic disasters, has scant credentials qualifying him for the position. Prior to taking over DHS, he had served as a United States Court of Appeals judge, a law partner in Latham and Watkins, special counsel for the Senate Whitewater Committee and Assistant Attorney General for the Criminal Division of the Justice Department.

And Michael Brown, the new Director of the Federal Emergency Management Agency, who had direct line management responsibility for the Katrina catastrophe, has an even thinner résumé. Before he was appointed Deputy Director of FEMA in 2001, he had been a commissioner of the International Arabian Horse Association. He might have been a fine equestrian judge, but as Matt Stearns and Seth Borenstein of the Knight Ridder Newspapers observed, "there was little in Michael D. Brown's background to prepare him for the fury of Hurricane Katrina."

Still, these personnel failings pale in comparison to the wanton neglect of the detailed scientific reports of the last few years that had predicted just the sort of outcome southern Louisiana would suffer if it were hit by a category four hurricane like Katrina. In "Drowning New Orleans," Mark Fischetti wrote in *Scientific American* in October 2001, "The boxes are stacked eight feet high and line the walls of the large, windowless room. Inside them are new body bags, 10,000 in all. If a big, slow-moving hurricane crossed the Gulf of Mexico on the right track, it would drive a sea surge that would drown New Orleans under 20 feet of water... Extensive evacuation would be impossible because the surging water would cut off the few escape routes. Scientists at Louisiana State University, who have modeled hundreds of possible storm tracks on advanced computers, predict that more than 100,000 people could die."

On June 8, 2004 a New Orleans newspaper, *The Times-Picayune*, also published a lengthy article describing the devastating effects on the region that a major storm would cause. The article noted additionally that the Office of Management and Budget had repeatedly slashed funding for critically needed remedial work on the system of levees that protected the city.

No one in the White House and no one in a leadership position on Capitol Hill was paying much heed to the scientific studies and computer modeling that forecast the cataclysmic results of a category four hurricane. Instead, when Mike Parker, who directed the Army Corps of Engineers, spoke out in 2002 about the need for increased funding for the Corps' work, the Bush Administration summarily dismissed him.

Perhaps scientists and engineers are too arrogant. Perhaps they do a bad job of communicating with public officials. Perhaps science is too complicated for policy makers to understand. Perhaps they don't trust the analyses experts produce. Whatever the case, the tragedy of New Orleans points up the need for major changes in the way the United States manages its science and technology policy.

As a first step, the White House should take a cue from Energy Secretary Samuel Bodman. Earlier this year, Bodman successfully lobbied Congress to create a new position of Under Secretary for Science within DOE in order to provide the Department with high-level management of its research portfolio. President Bush should follow Bodman's lead and restore the office of science advisor to the Cabinet rank that it held during his father's administration. He should act now. The nation can ill afford to wait.

Announcements

AMERICAN INSTITUTE OF PHYSICS STATE DEPARTMENT SCIENCE FELLOWSHIP

This Fellowship represents an opportunity for scientists to make a unique contribution to US foreign policy. At least one Fellow annually will be chosen to spend a year working in a bureau of the State Department, providing scientific and technical expertise to the Department while becoming directly involved in the foreign policy process. Fellows are required to be US citizens and members of at least one of the 10 AIP Member Societies at the time of application. Qualifications include a PhD in physics or closely related field or, in outstanding cases, equivalent research experience. Applicants should possess interest or experience in scientific or technical aspects of foreign policy. Applications for the 2006-7 Fellowship (starting in fall 2006) should consist of a letter of intent, a two-page resume, and three letters of reference. Please visit http://www.aip.org/gov/sdf.html for details. All application materials must be postmarked by November 1, 2005 and sent to: AIP State Department Science Fellowship, American Institute of Physics, Attn: Audrey Leath, One Physics Ellipse, College Park, MD 20740-3843.

A History of the Canadian Association of Physicists

2005 marks the 60th anniversary of the Canadian Association of Physicists. In celebration of this occasion, the Executive and Council of the CAP are pleased to announce that "60 Years A-Growing: A History of the Canadian Association of Physicists" by Jasper McKee, PPhys, will be available effective 2005 September 21. This book provides readers with a brief history of the CAP, based on a combination of historical records and personal recollections submitted to the author.

Order forms are available online at www.cap.ca. Price: $15 Cdn/ $12.50 US +shipping

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

Todd M. Squires and Stephen R. Quake Microfluidics: Fluid Physics at the Nanoliter Scale

With the advent of new technologies which allow the fabrication of micron-size channels, networks, and reaction systems, the field of microfluidics is emerging as a meeting ground for fluid dynamics, colloidal physics, biotechnology, and biological physics. This review summarizes the current state of the field, with emphasis on the characteristic dimensionless parameters that quantify the competition between various physical processes.

2006 APS Journal Policy Change

Starting in 2006, *Physical Review A-E* will no longer be available to members in a print version. Online only subscriptions will be available for these five titles. There are exceptions to the new policy, and current subscribers will be contacted with more information.

Subscription options for *Physical Review Letters, Reviews of Modern Physics, Physical Review Online Archive* (PROLA), and/or *Physical Review Index* will remain unchanged for 2006.

If you have any questions, please contact a membership representative at membership@aps.org or 301-209-3280.

Rebecca Forrest Receives First Blewett Scholarship

By Ernie Tretkoff

Rebecca Forrest is the first recipient of the APS Hildred Blewett Scholarship for Women in Physics. Forrest is a Research Assistant Professor at the University of Houston, where she plans to use the scholarship funds to establish her research program in condensed matter physics.

The scholarship was endowed by a bequest from M. Hildred Blewett, a particle accelerator physicist who died in 2004. Hildred Blewett loved physics and wanted to help women overcome obstacles to their careers. A remembrance of Blewett was the subject of the *APS News* Back Page in February of this year (see http://www.aps.org/apsnews/0205/020506.cfm).

The purpose of the scholarship is to enable early-career women to return to physics research after having had to interrupt their careers for family reasons. The scholarship consists of a one-year award of up to $45,000, which can be used for dependent care, salary, travel, equipment, and tuition and fees.

Forrest earned her PhD in condensed matter physics from the University of Houston in 1998. She was a postdoctoral researcher in the Materials Science and Engineering department at UCLA from 1998 to 2000. Forrest then moved back to Houston in 2000 when her husband began a new job at NASA's Johnson Space Center.

Forrest says she has been limited in her search for a tenure track position by her husband's career. "In order to be part of the space program, he's geographically limited. I have to find the best position available in the city we live in." She also has two boys, ages 4 and 7, whom she cares for, and therefore cannot put in the very long hours needed to do both full-time teaching and research.

In 2000 Forrest took a position as a postdoctoral researcher and adjunct instructor at the University of Houston. In 2002, she accepted a position as a full-time lecturer at the University of Houston–Downtown. The workload at the Downtown campus is primarily teaching, she says, so she had almost no time for research.

Rebecca Forrest

In 2004, she obtained a position as a Research Assistant Professor at the University of Houston main campus. While her primary duty is still teaching, she has a slightly lower teaching load and thus more time for research. In addition, she says, "I'm closer to colleagues and research labs. Now that I have the Blewett scholarship, I can devote more time to research."

She plans to use the scholarship to establish an active research program. Forrest expects to study lateral composition modulation, a type of spontaneous periodic modulation in alloy composition which has been observed in many semiconductor alloys and is known to affect electrical and optical properties. Forrest plans to investigate whether lateral composition modulation affects the lasing performance of antimonide-based diode lasers. These lasers are being developed by researchers at the Naval Research Laboratory for military and medical applications.

Forrest says she will use the Blewett scholarship for lab equipment and childcare costs. She hopes to have some initial results within a year, and plans build on those results to apply for grants for more research funding. "I hope that by getting my research back underway I will be an attractive candidate for a tenure track position," she says.

NEW FELLOW, CONTINUED FROM PAGE 3

raising funds for education projects in underserved communities in India. "I was always interested in service, but I thought of it as a separate thing," says Mohta; like his peers, he had his day job, and performed community service on evenings and weekends.

The terrorist attacks of September 11, 2001 caused a shift in his thinking towards a more outward focus. "I had to stop and think about what I was doing and why I was doing it, and reflect on what effect my work would have on the world," he says. He found himself volunteering more of his time, first to organizing panel discussions on foreign affairs, and later to the political arena. He was a volunteer for the gubernational campaign of Robert Reich, as well as for a local city council campaign.

Mohta soon found himself branching out into the political arena. In 2004, he was an organizer for South Asian Americans for Kerry. That same year, he also worked with an interdisciplinary non-proliferation study group as part of MIT's Security Studies Program.

After completing his doctoral thesis, Mohta began looking at various opportunities for applying science to societal problems, and moving into science policy. That's when he decided to apply for the APS fellowship. This summer, he is working at the National Academy of Science's Committee on International Security and Arms Control. "It's a nice transition between academia and policy," he says. "It's an academic setting in which policy work is done."

Following an intensive orientation process organized by the American Association for the Advancement of Science, Mohta will choose where to spend his fellowship year: either working in a Congressional office, or with one of the many associated committees. His policy interests include nuclear proliferation, and he would like to continue his work in that arena. However, "I also want to explore security-related issues beyond nuclear proliferation to see how it fits into the broader context," he says.

For more information about the APS Congressional Fellowship program, see http://www.aps.org/public_affair/fellow/index.cfm.

ELECTION RESULTS CONTINUED FROM PAGE 1

1999 she moved to the University of Colorado. She served as Chair of the APS Committee on the Status of Women in Physics in 2004, and currently coordinates the CSWP Site Visit program. She has served on the APS Council and Executive Committees, as well as on the Executive Committees of the APS Divisions of Laser Science and Atomic, Molecular and Optical Physics.

Back is an experimental physicist with expertise in the study of radiation in high energy density plasmas. She earned her PhD in plasma physics from the University of Florida in 1989. Following her PhD she worked in France at the Ecole Polytechnique for two years. In 1992 she joined Lawrence Livermore National Laboratory. This year, she became the Center Head of High Energy Density Physics Targets and Research at General Atomics. Back currently serves on the APS Division of Plasma Physics Executive Committee.

Hill holds the rank of Professor at the University of Maryland, College Park, with appointments in the Institute for Physical Science and Technology and the Department of Physics. He received a PhD in physics from Stanford University in 1980. He is a guest worker at NIST, where he was a postdoc before joining the faculty of the University of Maryland in 1982. His current investigations center on ultrafast dynamics, coherent control, strong-field laser-matter interaction, atom optics and quantum information. He leads the first group to combine ultrashort pulses and coincidence imaging with position-sensitive detectors to extract correlated ejection details previously not possible. Most recently, his group has demonstrated an all-optical atom switch to transfer atoms between two different guides. Hill was a member of the Executive Committee of the APS Division of Laser Science, the APS Committee on Minorities, and chaired the Nomination Committee for the APS Division of Atomic, Molecular and Optical Physics.

Wagner received his doctoral degree in physics in 1971 from Heidelberg University with work done on an experiment at CERN. He worked from 1973 to 1974 at the Lawrence Berkeley National Laboratory. He did research from 1975 until 1986 at DESY, and from 1986 until 1999 at CERN. In 1984 he became full professor at the University of Heidelberg. In 1991 he was offered a professorship at the University of Hamburg and at the same time was appointed Director of Research at DESY. He is chair of the board of the TESLA Collaboration, which works on superconducting accelerator development.

VIEWPOINT CONTINUED FROM PAGE 4

Where can we go from here? Clearly, maintaining preeminence in the sciences, and specifically theoretical physics, will require sustained funding at a significantly higher level than is presently available. We believe that at least a 20% increase in available funds is necessary to maintain the minimal health of the field. Major roadblocks are now occurring in four critical areas: support for graduate students in PhD programs; numbers of postdocs supported for high-quality scientific training; funding for new faculty; and funding for top researchers who require adequate resources to be maximally productive. All of these areas desperately require significant increases soon. Securing adequate resources must be a primary goal for all of us, and for the organizations that represent us. Undoubtedly, this will require efforts and arguments that go beyond business as usual. It's time to start.

Keith R. Dienes is Associate Professor of Physics and Mathematics at the University of Arizona. Gordon Kane is the Victor Weisskopf Collegiate Professor of Physics at the University of Michigan.

The Back Page

Intelligent Design: The New Creationism Threatens All of Science and Society

By Marshall Berman

For most of my life, I thought everyone knew that "Creation Science" was "dark ages" stuff, until a physicist began to argue with me that evolution was a bunch of "just-so" stories, with no supporting evidence. Since then, I've seen, read, and heard hundreds of other creationists and "Intelligent Design" advocates argue that there is no fossil evidence to support evolution, that evolution has endured for almost a century and a half only because modern scientists are part of a conspiracy to cover up the truth, that there are major questions concerning the reliability of radioactivity dating methods, and that many scientists "worship at the altar of Darwinism." Indeed, I learned that creationists, like biological species, come in many varieties: young earth, old earth, and a reincarnated species, intelligent design creationists.

Gallup polls taken during the past 20 years consistently show a plurality (45% in February 2001) of Americans agreeing with the statement: "God created human beings pretty much in their present form at one time within the last 10,000 years or so."

There is a stark difference between the views of scientists and those of the general public. 5% of scientists hold creationist views, compared to 44% of the public. 95% of scientists hold naturalistic or theistic views that evolution is valid.

Some 700 scientists (out of a total of 480,000 US earth and life scientists) give credence to creation-science. That would put the support for creation science among those branches of science that deal with Earth and its life forms at about 0.14%.

Our nation is paying a heavy price for having failed to teach students critical thinking skills, reasoning, and good science for several generations. The consequences are an appalling science illiteracy among most Americans. In a 2000 NSF survey, about half the respondents did not know:

•The earliest humans did not live at the same time as dinosaurs.

•It takes Earth one year to go around the Sun.

•Electrons are smaller than atoms.

•Antibiotics do not kill viruses.

American adults in general do not understand what molecules are. Fewer than a third can identify DNA as a key to heredity. Only about 10% know what radiation is. One adult American in five thinks the Sun revolves around Earth. The US is falling rapidly behind in science and math education compared with other industrial countries, especially in East Asia. US competitiveness is destined to be second-class, unless we can turn this around.

In the 1980s, federal courts and the Supreme Court ruled that the First Amendment prohibited the teaching of creationism and so-called "Creation Science." Shortly thereafter, an "evolved" version of creationism appeared called "Intelligent Design" (ID). ID actually re-invents a discredited 200-year-old argument that goes back to William Paley. He claimed that complex living things required direct, divine intervention by a creator.

Although the current version of ID professes to be scientific, it is religious. Its center is the Discovery Institute (DI) in Seattle, Washington, which includes the Center for Science and Culture (CSC). Financial support comes from 22 foundations, at least two-thirds of them with explicitly religious missions.

ID refuses to "publicly" describe the "designer," say anything about methods or timing of the conversion of design into creation, demonstrate any scientific predictability, show any empirical support, or even conceive of how the "notion" could be tested or falsified. [Leading ID supporter, Michael Behe, has said: "*…Possible candidates for the role of designer include: the God of Christianity; an angel—fallen or not; Plato's demi-urge; some mystical new age force; space aliens from Alpha Centauri; time travelers; or some utterly unknown intelligent being" (http://www.ideacenter.org/contentmgr/showdetails.php/id/1341)]*. ID cloaks itself in scientific vocabulary and pseudo-scientific concepts such as "irreducible complexity." It attacks a few details about the evolutionary process, all of which have been extensively and fairly analyzed by the science community and found wanting, false or just typical ongoing research questions. DI hired a well-known public relations firm, and has influenced many local, state and federal politicians, including US Congressmen, Senators, and even the President. DI does everything a political advocacy group would do, but it does not perform any scientific research or produce any new scientific knowledge.

Nevertheless, they claim to be a growing movement, and that it is "only fair" to "teach the (non-existent scientific) controversy." Their immediate goal is to insert their unscientific ideas into public school science classrooms; they care little about gaining acceptance in the science community. Unfortunately, many conscientious religious people, including politicians and school board members, have come to believe that there really is a scientific controversy.

Many readers of *APS News* may not know the goals of the DI which developed a plan, called the "Wedge." Evolution is only the initial target of the Wedge's edge, to be followed by an attack on all of science, and ultimately by profound changes in our society, culture, and government. Here are their own words, excerpted from their plan and goals:

"*Discovery Institute's Center for the Renewal of Science and Culture seeks nothing less than the overthrow of materialism and its cultural legacies. …The Center explores how new developments in biology, physics and cognitive science raise serious doubts about scientific materialism and have re-opened the case for a broadly theistic understanding of nature.*

Five Year Strategic Plan

"*The social consequences of materialism have been devastating…. However, we are convinced that in order to defeat materialism, we must cut it off at its source. That source is scientific materialism…. If we view the predominant materialistic science as a giant tree, our strategy is intended to function as a "wedge" that, while relatively small, can split the trunk when applied at its weakest points…. Design theory promises to reverse the stifling dominance of the materialist worldview, and to replace it with a science consonant with Christian and theistic convictions.*

Governing Goals

• To defeat scientific materialism and its destructive moral, cultural and political legacies.

• To replace materialistic explanations with the theistic understanding that nature and human beings are created by God.

Twenty Year Goals

• To see intelligent design theory as the dominant perspective in science.

• To see design theory application in specific fields, including molecular biology, biochemistry, paleontology, physics and cosmology in the natural sciences, psychology, ethics, politics, theology and philosophy in the humanities; to see its influence in the fine arts.

• To see design theory permeate our religious, cultural, moral and political life."

The above quotes demonstrate that ID's claim to be non-religious is false. And the ID movement has aims far beyond attacking evolution in its attempt to return society to the "idyllic" and "moral" culture that prevailed in Europe prior to the Enlightenment. The writings of the leading CSC senior fellows make this nostalgia for the Dark Ages frighteningly clear:

"*From the sixth century up to the Enlightenment it is safe to say that the West was thoroughly imbued with Christian ideals and that Western intellectual elites were overwhelmingly Christian. False ideas that undermined the very foundations of the Christian faith (e.g., denying the resurrection or the Trinity) were swiftly challenged and uprooted. Since the enlightenment, however, we have not so much lacked the means to combat false ideas as the will and clarity."* (Dembski, W. A. and Richards, J.W., *Unapologetic Apologetics, 2001, p. 20*).

John Mark Reynolds is a CSC fellow on the faculty at Biola University, an ID-leaning college. He writes, "*Torrey Honors Institute (at Biola) is at war with the modern culture. Torrey does not want to 'get along' with materialism, secularism, naturalism, post-modernism, radical feminism, or spiritualism. We want to win over every facet of the culture, from the arts to the sciences, for the Kingdom of Christ.*" (http://web.archive.org/web/20000124070727/http://www.biola.edu/academics/torrey/origin.cfm).

Marshall Berman

The target is all of science and society; evolution is just the beginning, the edge of the "Wedge."

Scientists and Politics

Scientists often avoid the realm of politics for good reasons: long hours of research, dedication, raising research funds, teaching, and family needs, among other demands. Individual scientists and even science organizations can be politically powerless. Unfortunately, politicians often regard scientists as a small voting bloc [although the number of employed US scientists and engineers is about eleven million.] Scientists and their advice often get little respect from politicians.

In 1996, the NM State Board of Education removed all references to evolution and the age of Earth from the state science content standards. The majority of Board members had little knowledge of science and were misled by a physicist member who was a creationist. He complimented himself on reviewing the National Science Education Standards, finding faults; and accusing the developers of the standards of being "completely clueless as to the canonical characteristics of good standards, whether they hail from the National Academy of Sciences or not." (Lenard, R., 1996. "*Standard Fosters Scientific Rigor,*" Albuquerque Journal, Sep. 21, 1996). The opinions of a few scientists are often given equal weight against an overwhelming majority of mainstream scientists. The media frequently promote this disproportionate representation by attempting to be "fair" to both sides.

Many New Mexicans organized to oppose this attack on the science standards. But all our efforts failed. We were outsiders. Ultimately, we decided that we had to become insiders to effect change, and I ran for the State Board position in the next election.

The campaign actually became a valuable lesson in democracy. Many people volunteered. We made signs. We searched the voter rolls for groups who voted often. We had teams go door-to-door to talk to voters, most of whom were receptive and very interested in education. We actually raised more money (entirely from small contributions) than any other candidate had in this kind of election. We built a website. We distributed flyers. And we ultimately defeated a 20-year incumbent.

I eventually gained the confidence of most of the other fourteen Board members. They relied on me for issues related to gathering and analyzing data, statistics, and other education issues, especially related to science and math. And we were able to return evolution and the age of Earth to the science standards in 1999 and again in 2003. Ultimately, New Mexico approved some of the best science and math standards in the US. But the political controversy continues. Only now the IDers are targeting local school districts.

Conclusions

The ID movement poses a threat to all of science and perhaps to secular democracy itself. The movement is highly political, very astute, extremely well-marketed, disingenuous, and grossly misunderstood by most Americans. The so-called "controversy" has been couched in slogans that focus on "fairness," "Darwinism is a religion," "what are scientists afraid of," "evolution equals atheism," and other loaded phrases that mask their real initial target: open up public school science classrooms to address supernatural phenomena. ID movement has influenced many politicians with little or no scientific backgrounds. We must therefore fight in the political arena as well as the science community. Scientists must become more politically involved if this assault is to be stopped.

Ed. Note: A more detailed and fully referenced article can be found online on the http://www.aps.org/apsnews/1005/100518.cfm

Marshall Berman has been a manager at Sandia National Laboratories, vice president of the New Mexico State Board of Education, and Executive Director for Education of the Council on Competitiveness in Washington D.C.

APS News welcomes and encourages letters and submissions from its members responding to these and other issues. Responses may be sent to: letters@aps.org.