APS NEWS

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APS physics

Highlights

What Exactly Is Michael Crichton's "Scientific Method"?
By James Hansen
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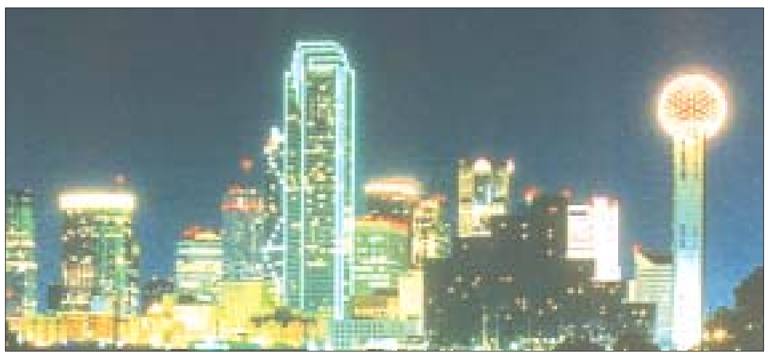
"Big D" Hosts APS April Meeting

Over 1000 physicists will head to Dallas this month for the April APS meeting, to be held April 22-25, in conjunction with the annual Sherwood Fusion Theory Conference.

The meeting will include three plenary sessions, approximately 75 invited sessions, and more than 100 contributed sessions and poster sessions, covering the latest astrophysics, nuclear physics, particle physics, and plasma physics. There will also be a number of sessions on physics education, physics history, and physics and society. Some potential highlights follow. The complete program is on the web at http://www.aps.org/meet/APR06/.



Dallas Skyline

Plenary Talks. Three slates of plenary presentations will cover a cosmic range of topics: At Session A1, Voyager 1 and 2 at the edge of the solar system; the study of quark-gluon plasma; and results from the MiniBoone neutrino experiment. At Session O1: the cosmological role of neutrinos; learning about astrophysical plasmas through experiments on Earth; and the physics, engineering, and social implications of cochlear implants. At Session V1: carbon nanotubes; the search for gravity waves with LIGO; and physics and engineering issues for the prospective International Linear Collider.

On Monday as well, there will be a special lunchtime talk at 12:45 by Norman Augustine, former Chairman and CEO of Lockheed Martin Corporation, and Chair of the National Academy of Sciences committee that provided the report "Rising above the gathering storm".

High-Energy Machines. Discerning the subtle logic of submicroscopic matter requires beams of high potency. Session J1 centers on the 10th anniversary of the top quark discovery and the latest results from Fermilab's Tevatron machine. Session C14 looks at a novel accelerator scheme where beams of muons would collide. Colliding beams of electrons with beams of heavy ions (Session J2) is still another way to probe matter, especially for looking at the quark content of protons and the nucleus in general. Speakers in several sessions will look at the new physics on the horizon at the Large Hadron Collider (LHC), presently under construction at CERN, where high energy protons will collide head on, and the proposed International Linear Collider (ILC), where electrons would

April Meeting continued on page 7

Special Events

Friday, April 21
High School Physics Teachers' Day
8:00 a.m. – 2:45 p.m.

Student Reception
8:00 p.m. – 9:00 p.m.

Saturday, April 22
Welcome Reception
5:30 p.m. – 7:00 p.m.

Scientific Professionalism and the Physicist: The Skills You Need to Succeed in Physics-based Careers
7:00 p.m. – 9:00 p.m.

New Reports from Major National Studies
7:15 p.m. – 8:45 p.m.

Sunday, April 23
Meet the Editors
3:00 p.m. - 5:00 p.m.

Awards Program, Presidential Address & Lilienfeld Prize Talk
5:15 p.m. – 6:45 p.m.

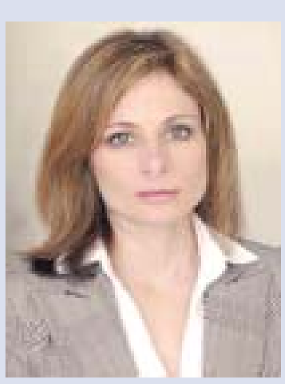
Monday, April 24
CSWP/DPF Luncheon for Women in Physics
12:00 p.m. – 1:30 p.m.

Students Lunch with the Experts
12:30 p.m. – 2:00 p.m.

Special Invited Talk: "Rising above the gathering storm", Norman R. Augustine
12:45 p.m.

COM/CSWP Reception
5:30 p.m. – 7:00 p.m.

Public Event Features Lisa Randall



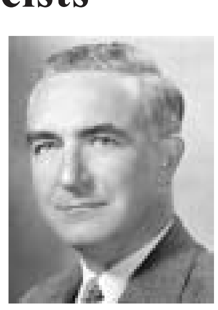
Lisa Randall

Those attending the April meeting in Dallas can join interested members of the public for "An Evening of Cosmology and String Theory" with Lisa Randall, at 6:30 pm on Monday, April 24. The event takes place in the Landmark A Ballroom in the Hyatt Regency.

Randall, a Harvard University physics professor, is the author of ***Warped Passages: Unraveling the Mysteries of the Universe****. She is best known for co-authoring two seminal 1999 papers in* ***Physical Review Letters*** *with Raman Sundrum: "Large mass hierarchy from a small extra dimension," and "An alternative to compactification." Each has been cited more than 2500 times.*

Randall's research has been covered by ***The New York Times****, the* ***Economist****, the* ***Los Angeles Times****, and* ***The Dallas Daily News****, as well as* ***Science****,* ***Nature*** *and* ***New Scientist****.* ***Warped Passages*** *is her first book for a general audience.*

Largest APS Prize Targets Young Physicists



George E. Valley, Jr.

The George E. Valley, Jr. Prize is given biennially by the APS to recognize the achievements and the potential of a physicist within five years of his or her PhD. Named in honor of a generous bequest from the estate of George E. Valley, Jr., the prize carries with it a cash award of $20,000, making it the largest single prize that the Society gives.

The prize will be given for the third time this year. Nominations are currently being sought for outstanding candidates in any field of physics, with a nomination deadline of July 1, 2006. This year's recipient will be announced in the fall after the selection committee's recommendation is approved by the APS Executive Board.

Largest APS Prize continued on page 5

Coast to Coast

Photo credit: Ken Cole

Retiring APS President Marvin Cohen of Berkeley (left) passed the coveted presidential gavel, symbol of the awesome power of the APS presidency, to his successor, John Hopfield of Princeton, at the Executive Board meeting in College Park in early February.

Does the "Impact Factor" Impact Decisions on Where to Publish?

The impact factor, a numerical score that claims to rank the importance of scientific journals, may be resulting in unnecessary pressure on researchers to publish in journals with high values for that score.

With some qualifications, the impact factor is a measure of the average number of citations for papers published in a particular journal. It is calculated by counting the total number of citations papers in the journal receive, and dividing by the number of papers published in the journal. These statistics are compiled by the Institute for Scientific Information (ISI).

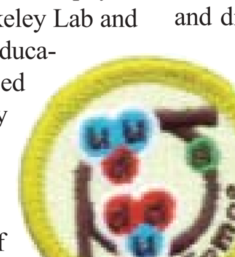
Does the impact factor provide an accurate measure of a journal's importance? In counting citations, only papers published in the past two years are considered, though many research papers may be influential for much longer than two years. Also, items such as news articles and editorials that some journals publish are not counted in the denominator of the

Impact Factor continued on page 5

APS Helps Boy Scouts Explore Nuclear Science

With the help of the APS Division of Nuclear Physics Education Committee, the Boy Scouts of America has revised its Atomic Energy merit badge program. The new merit badge, now called "Nuclear Science," updates the program and increases the emphasis on science.

Howard Matis, a nuclear physicist at Lawrence Berkeley Lab and member of the DNP education committee, noticed that the Atomic Energy merit badge program needed updating when a local scout troop visited his lab. Some of the requirements for the old merit badge were confusing, and the handbook's information was outdated and in some cases wrong, said Matis.



Matis has been involved with the Boy Scouts for a long time. He is an Eagle Scout (though he never earned the Atomic Energy merit badge), and now has a son who is a Boy Scout.

He and the DNP Education Committee wrote to the Boy Scouts of America, offering to help revise the handbook. It turned out that BSA was already in the process of updating the badge. Matis was able to serve as an advisor.

The old Atomic Energy badge program focused on engineering, and did not emphasize the science enough, said Matis. "We wanted to put science back into the requirements."

He worked with a writer to help make sure the science in the new booklet was correct and included the most modern model of the nucleus. He also added some information, including a description of a career as a nuclear scientist.

The new Nuclear Science handbook is an 88-page booklet that covers nuclear science at a level accessible to 14-year olds with little prior knowledge. It includes topics such as

Boy Scouts continued on page 5

Members in the Media

"European and Asian students definitely get it. I've yet to run into one in Germany who thinks science is intrinsically bad or awful."

–Robert Rosner, Argonne National Laboratory, contrasting European and Asian attitudes towards science with American attitudes, USA Today, February 8, 2006

"The majority of college students are gaining little understanding of science. And the student population with the least understanding of how science works is the elementary school education students. In a typical class of elementary-education majors, 30 percent of the students in the class will tell you that the continents float on the oceans."

–Carl Wieman, University of Colorado, on math and science education, Rocky Mountain News, February 11, 2006

"We have a different kind of war, an economic war. The importance of investing in long-term research for winning that war hasn't been understood."

–Robert Birgeneau, University of California, Berkeley, on the US losing its lead in science and technology, Time Magazine, Feb. 13, 2006

"Ten years ago in China, it was virtually all derivative stuff. Students would sit and listen and try to capture every word. Now they're asking lots of questions."

–Steven Chu, Lawrence Berkeley National Lab, on China's catching up to the US in science, Time Magazine, Feb. 13, 2006

"The bottom line: science at NASA is disappearing – fast."

–Donald Lamb, University of Chicago, on scientific missions being cut back by NASA's budget, The New York Times, March 1, 2006

"I wanted to find a place where I could express my love of chemistry, but I didn't want to be involved with this black goo."

–Donald Sadoway, MIT, on why he went into metallurgy rather that study oil, the Boston Globe, February 20, 2006

"I take a nice drinking glass, rotate it clockwise, and slide it down a counter. Everyone thinks that it will go to the right. That's the natural reaction from curling. But it goes to the left, and the initial reaction [from curlers] is that I'm performing some kind of magic trick."

–Mark Shegelski, University of Northern British Columbia, explaining some of the physics of curling, National Geographic News, February 23, 2006

"I'm trying to bring out the beauty of the wood and make a shape that is attractive to people, while keeping the original beam to preserve its history. My goal is to create something that people want to touch, so they connect with the wood which has a heritage and was once part of a living tree."

–Gary Carver, NIST (retired), on his hobby, carving wooden replicas of birds, the Frederick News-Post, February 21, 2006

"I'm lucky. I don't think I'll ever stop work. It's too much fun."

–Giacinto Scoles, Princeton University, on why he didn't make time to watch the Olympics, Newark Star-Ledger, March 2, 2006

"On average, our computers are bigger than their computers."

–Eugene Stanley, Boston University, on the advantage physicists have over economists in analyzing lots of data, Chicago Tribune, March 3, 2006

"I'm not giving away the family secrets or the crown jewels. What I've learned is through open sources."

–Charles Ferguson, Center for Nonproliferation Studies, on a class he gave at Georgetown University called "How to build a Nuclear Bomb," The Washington Post, March 2, 2006

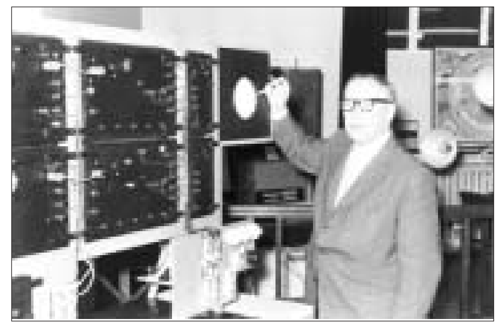
"There are a lot of problems that you can represent in terms of this language. We're providing the technique. Whatever people use it for, it's great for us."

–Veit Elser, Cornell University, on an algorithm he developed that both processes x-ray diffraction data and solves sudoku puzzles, United Press International, March 6, 2006

This Month in Physics History

April, 1935: British Patent for Radar System for Air Defense Granted to Robert Watson-Watt

Many scientists and engineers contributed to the development of radar systems, which played a vital role in the Allied victory in WWII. Radar (the acronym stands for RAdio Detection And Ranging), detects distant objects such as airplanes or ships by sending pulses of radio waves and measuring the reflected signal. One of the greatest radar pioneers was Sir Robert Watson-Watt, who developed the first practical radar system that helped defend the British in WWII.



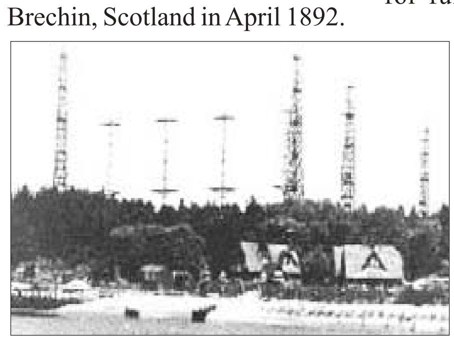
Sir Robert Watson-Watt

The basic principles needed for radar systems were established in the 1880s, when German physicist Heinrich Hertz first produced and transmitted radio waves across his laboratory. He discovered that the invisible waves were a form of electromagnetic radiation, and noticed that some materials transmit radio waves while others reflect them.

Radio waves were quickly put to use. In 1901, Italian physicist Guglielmo Marconi sent the first wireless radio communication across the Atlantic Ocean. In 1904 German engineer Christian Huelsmeyer invented a crude system that used radio waves to prevent boats and trains from colliding on foggy days. US navy researchers also discovered that they could detect ships using radio wave echoes, but their invention was largely ignored.

Some work on early radar detection systems continued during the 1920's and 1930's in the United States and elsewhere. But the value of the technology was most obvious in Great Britain, which was especially vulnerable to German air attack.

Sir Robert Watson-Watt, a descendant of steam engine pioneer James Watt, was born in Brechin, Scotland in April 1892.



Chain home radar station

He graduated from University College, Dundee, in 1912 and then worked as an assistant for Professor William Peddie, who encouraged his fascination with radio waves.

In 1915, Watson-Watt hoped to go to work for the War Office, but no suitable position in communications was available there, so he joined the Meteorological Office. He was put to work developing systems for detecting thunderstorms. Lightning ionizes the air and generates a radio signal, which Watson-Watt could detect to map the positions of thunderstorms.

Possibly prompted by rumors that the Germans had produced a "death ray," in 1934 the Air Ministry asked Watson-Watt to investigate such a possibility. The Air Ministry had already offered 1000 pounds to anyone who could demonstrate a ray that could kill a sheep 100 yards away. Watson-Watt concluded that such a device was highly unlikely, but wrote a memo saying that he had turned his attention to "the difficult, but less unpromising, problem of radio-detection as opposed to radio-destruction." Watson-Watt and his assistant made some calculations and applied some of the same techniques he used in his atmospheric work.

In February 1935 Watson-Watt demonstrated to an Air Ministry committee the first practical radio system for detecting aircraft. The Air Ministry was impressed, and in April Watson-Watt received a patent for the system and funding for further development. Soon Watson-Watt was using pulsed radio waves to detect airplanes up to 80 miles away.

Shortly before World War II began, the British constructed a network of radar stations along the coast of England using Watson-Watts' design. These stations, known as Chain Home, successfully alerted the Royal Air Force to approaching enemy bombers, and helped defend Britain against the German Luftwaffe in the Battle of Britain.

The Chain Home system worked fairly well, but it required huge antennas, and used long wavelengths that limited ability to pinpoint enemy aircraft accurately. During the day, fighter pilots could see enemy bombers. But soon the Germans began nighttime bombing missions, so to help fighter pilots locate enemy aircraft at night, the British needed a shorter wavelength radar system that was compact enough to install in planes.

This became possible when British engineers Harry Boot and John Randall invented the cavity magnetron in early 1940. The magnetron generated about 400 hundred watts of power at wavelengths about 10 centimeters, enough to produce echoes from airplanes many miles away.

Britain didn't have the large-scale manufacturing capability to mass-produce the magnetron, so in 1940 a mission led by Henry Tizard secretly brought the magnetron to the United States and persuaded the US to help develop and produce the device. The MIT Radiation Laboratory, was set up and quickly became one of the largest wartime projects, employing about 4000 people. Researchers and workers there made mass-production versions of the magnetron and developed about 100 different radar systems.

Germany and Japan also invented their own radar systems, but those were in general less effective, and the Allies' radar superiority is sometimes credited with the victory in WWII.

After the war, many peaceful uses for radar technology were found. Today air traffic control depends on radar to keep commercial aircraft from colliding. Radar is essential for tracking the weather. The cavity magnetron is now used to cook food in microwave ovens. And many motorists have been caught speeding by police radar guns, including, reportedly, Sir Watson-Watt himself.

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PHYSICS AND TECHNOLOGY FOREFRONTS

Multiple Disciplines Converge in Embedded Wireless Sensor Networks

By Jennifer Ouellette

Imagine a world in which buildings can detect their own structural faults and respond to earthquake tremors in real time. Public health officials continuously monitor contamination levels in water supplies and can even trace contaminants back to their source. When bacterial levels in coastal waters get too high, surfers, swimmers and fishermen are alerted immediately. Every aspect of modern life would be monitored via wireless linkages.

This might strike some people as a futuristic scenario ripped from the pages of the latest science fiction novel, but it is becoming a technological reality. At the Center for Embedded Networked Systems (CENS), an interdisciplinary team of researchers from six California institutions combine microsensors, actuators, robotics, low-power electronics, and wireless network technology into compact, integrated packages for distributed monitoring and control.

These so-called embedded wireless sensor networks can be designed to monitor and collect information on everything from plankton colonies, endangered species, soil and air contaminants, traffic flow, medical patients, and buildings and bridges. They are yielding an unprecedented level of hard scientific data. And they can do so far more cheaply, with greater energy efficiency, than the instruments now in use, which are linked by wires and power lines. The emergence of such networks is due in part to the explosion in wireless-enabled consumer electronics, and the continued emphasis on miniaturization.

CENS Director Deborah Estrin strives to foster a multidisciplinary innovation model that seeks to create a tight "feedback loop" between users and innovators. For many users, the result is "a tremendous innovation in their ability to understand the physical processes they study."

The CENS collaboration involves researchers at the University of California, Los Angeles (UCLA), the University of Southern California (USC), the University of California, Riverside, CalTech, the University of California, Merced, and California State University at Los Angeles. The center's work involves everything from fundamental communication theory to embedded computing, networking, electrical engineering, sensor technology and statistics principles. For UCLA's William Kaiser, there is a clear physics aspect to the project. "We are making measurements, and we need to optimize the information return relative to all the different sources in our environment, so we're relying throughout on physics principles," he says.

CENS is developing systems that can be used to characterize natural phenomena in two primary environments: terrestrial ecosystems over a broad range of climate types in North America, Central America, and Australia; and aquatic systems, such as coastal marine environments, urban rivers, and streams.

Terrestrial Ecosystems

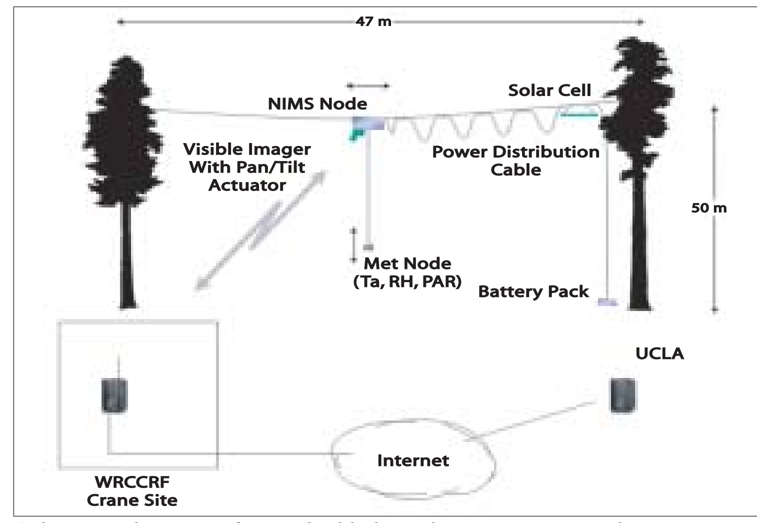
In California's San Jacinto Mountains, robotic arrays of sensors and cameras–dubbed "treebots" –move up and down cables attached to trees to actively monitor changes in temperature, humidity or sunlight. The treebots are individual nodes in a Networked Infomechanical System (NIMS), which combines robotics with multiple environmental sensors, including actuated imaging systems and a wireless network. The treebots are highly autonomous and can communicate with other devices. They have their own servers and can use wireless net links to send sample information and other measurement data back to the home laboratory, located in this case at UCLA.

Treebots are more flexible than fixed nodes. They can be raised and lowered as needed to collect data at different levels of the forest canopy. Full-motion cameras mounted on high observation towers track wildlife and changes in plant growth, while a "nestbox" collects time-lapsed images to document wildlife nesting activity. There is even a microclimate array to collect climate data above and below ground.

Because the robotic nodes are constantly changing location, the treebot system also boasts a capability Kaiser calls adaptive sensing. Adaptive sensing involves finding the right data at the right time, thanks to self-configuring systems that adapt to unpredictable environments where pre-configuration and manual intervention aren't possible. "Any time you put down a number of static nodes, they are in fixed locations, which limits the spatial resolution you can achieve," he says. "But with a robotic node that can move on command, you can get 3D precision resolution."

Taken together, the network will help scientists understand the subtle changes that take place over time in light, humidity and CO_2 levels, not to mention the growth of individual leaves and branches. Statistical techniques are vital to achieving this. "One needs to be able to characterize the incoming data stream from the sensors and use that to adaptively adjust the way in which a sensor operates, or where it moves to collect more data," says Kaiser.

Other new technologies that have been incorporated into the treebot's sensing network include a thermal mapping device developed by Kaiser's UCLA colleague, Phil Rundel. It maps the surface temperature of objects as the robotic system scans. Rundel has used the device to study, for example, the thermal properties of unique alpine plants that inhabit very high elevations, and must therefore withstand extreme temperature differences between the very cold atmosphere and the much warmer ground. Rundel has also developed a laser mapper, which enables the treebot to scan the forest and reconstruct the shape of objects in 3D.



Schematic diagram of an embedded wireless sensor network.

Aquatic Ecosystems

Richard Ambrose heads the public health program at UCLA and uses embedded wireless sensing networks to characterize urban streams. One area of interest is the problem of excessive algae. When too many nutrients get into the water, whether it's a river, lake, or pond, the result is excess algae.

Gaining detailed knowledge about the specifics of the relationship between excessive nutrients and too much algae is difficult in the real world because there are so many factors that influence how much algae grows and where it grows, including sunlight, which water substrates contain the highest concentrations of nutrients, and how fast the water flows. There's even a time factor, since algae can soak up nutrients like a sponge and store them for later.

Using NIMS, researchers can observe all the variations in flow and concentrations of contaminants within a stream. One of the more interesting findings is that concentration levels of nitrogen and phosphorus vary with the time of day the samples are collected. "NIMS gives us the possibility of collecting data on a temporal scale that we would never be able to get otherwise," says Ambrose. "We can track the dynamics of the nutrients so we can understand that relationship better."

Currently, his cable system spans the stream in cross sections moving in 2D, with sensors that can move across and along the stream. The ultimate goal is to have sensors that can also move down into the stream to take measurements at different depths to give a 3D picture rapidly.

CENS collaborator Tom Harmon at UC-Merced is using NIMS to better understand the origin of toxic material, algae, and bacteria in marine/coastal areas, using a system of fixed buoys and robotic boats that automatically move to take samples of the environment. The goal is to determine how environmental change –whether natural or induced by human activity–can lead to excessive growth of toxic bacteria or algae.

UCLA's David Caron is using a similar approach. His team has developed a version of the robot system that can operate underwater, scanning a stream cross-section to determine what kinds of contaminants are flowing past. But the system also precisely measures the flow in all directions, including eddies and other

P&T Forefronts continued on page 5

Sound Bytes

UCLA's Mark Hansen has never been the sort of statistician who stays inside what he calls the "physics box." In addition to his work with CENS developing statistical algorithms for embedded wireless sensing networks, he is an accomplished multimedia artist. And his science feeds directly into his art.

In the late 1990s, when Hansen was at Bell Labs, the company revived a program in art technology that originated in the 1960s, that teamed up engineers and scientists with New York City artists–among them Robert Rauschenberg and Andy Warhol. Thirty years later, Hansen hooked up with artist Ben Rubin and produced the "Listening Post" [www.earstudio.com]: a multimedia installation that is also an experiment in sonofication–the process of turning raw data into sound, instead of plotting it onto a graph.

Hansen and Rubin built a data stream using text from online bulletin boards and chat rooms, as well as tracking users' Web browsing activities. This data was then processed by a voice synthesizer to "score" the video portion of the installation: a long panel of 231 small text displays, each about the size of a candy bar.

The end result is a visual and aural representation of data flow that proffers snippets of connectiveness, random glimpses of people interacting in the virtual world at any given moment. "Whether we like it or not, the flow of data exists to regulate our movements through the world, our behaviors," says Hansen.

"The Listening Post" was featured on National Public Radio and won a 2003 Webby Award for Net Art. It will be up and running again at the San Jose Art Museum this summer, with the data stream expanded to include snippets from blogs, news sources, even Wikipedia. Hansen and Rubin are now working on delivering real-time data feeds to live actors, instead of using voice synthesizers and a grid of text displays–bringing the human element back into the technology.

zero gravity

The Lighter Side of Science

Find the Physicists

Editor's Note: The following story doesn't make a whole lot of sense, but it contains within it the names of 22 famous physicists (all dead), spelled either forward (14) or backward (8), ignoring spaces and punctuation. How many of them can you find? For those who need a little more help, we list the physicists alphabetically on page 7.

John Jacob Bausch and Henry Lomb, founders of the famous optics company Bausch and Lomb, were very competitive with one another, and one day Lomb bet he could catch more fish in a local pond than Bausch could. The loser would buy the winner some German pancakes, which they each loved to eat. Bausch said confidently, "I concur. I even will give you odds." But he was not satisfied with the quality of American fishing rods, and he therefore sent for the Bausch rod in Germany, from which country he had emigrated a few years before. Lomb, meanwhile, was a stickler regarding his diet, and asked his wife, Lila, to cook him up his favorite bean dish to get ready for the competition. "Not lima, honey" he told her, "I just want navy and pinto. You can't beat lovely beans."

Bausch and Lomb agreed that Lila, who despite being married to Lomb was known for her fairness, could be the judge of the competition. "I'm refereeing this," Lila said, "and I'll make sure it's fair and square." On the day of the competition, Lila set off for the pond, but her wagon was stuck in a rut. Her Ford was out of gas as well. [*Ed. Note: this is an anachronism, because Bausch and Lomb lived in the middle of the 19th century. Henry Ford's car idea was far in the future*]. With her wagon stuck and her car not working she was forced to go with plan C, known also as walking. She decided she would not wend her way through the meadow, but would take the main road instead. "Oh, my!" she exclaimed, "it's very far. A day's journey at least." That was an exaggeration, but when the heel broke on her right shoe, Lila got even more upset. Finally, though, she made it to the pond in the early afternoon.

On the bank of the pond she saw four hoboes, in an arbor near the water. They were planning to steal a canoe there. She said "Scram!" peremptorily, and the hoboes ran off. Soon Bausch and Lomb arrived, but the competition itself was something of an anticlimax. Well into the second hour, Lomb had caught nothing, and Bausch was reeling them in. In desperation, Lomb told his children, "tie more flies, please!", but nothing worked. Finally, Lomb conceded, and thus did Bausch win German pancakes.

Letters

Discovery of Superfluidity Clarified

There were a few errors in the article about the discovery of superfluidity in This Month in Physics History, *APS News*, January 2006.

Allen and Misener did indeed independently discover superfluidity in liquid He. However, they were working at the Royal Mond Laboratory in Cambridge University, not at the University of Toronto as the article states. The confusion probably arose because both Allen and Misener had been graduate students at the University of Toronto (which had a thriving program on liquid He and superconductors since 1923) just before they went to Cambridge. At Cambridge, Allen was like a "post-doc" while Misener was a PhD student. Misener later returned to the University of Toronto, while Allen became a professor at the University of St. Andrews in Scotland after WWII.

Also the Allen-Misener work measured flow through many parallel small-radius glass capillaries, not a single narrow glass tube, as stated in the article.

The fact that Allen was ignored in handing out the Nobel prize for the discovery of superfluidity is still a matter of controversy and mystery in the low temperature community. Kapitza only received the prize 40 years after the seminal discovery (not 30 years, as the article states), which is a sure indication of many backroom discussions. Kapitza's Nobel talk is unique in that not a single word is said about his low temperature work, for which he got the prize! It discusses his work on plasma physics.

I always enjoy reading the history column. Sorry to have to note a few errors!!

Allan Griffin
Toronto, Ontario

Numbers Off By Millions and Billions

In the February 2006 issue of *APS News*, you include a section "Physics News in 2005." This wonderful set of summaries of important advances and discoveries in the field is an excellent resource, both for keeping up with advances outside one's own specialty as well as communicating high-level results to the public.

There is, unfortunately, a fairly significant typographical error in one of these summaries. The discussion of "Room-Temperature Ice in Electric Fields," on page 9, incorrectly states that freezing took place in fields of "106 V/m," significantly lower than the predicted values of "109 V/m." The field strengths should read 10^6 V/m and 10^9 V/m, respectively, as can be found in the *Physical Review Letters* paper referenced in the summary (Choi et al., PRL 95, 085701 (2005)).

Erik Iverson
Oak Ridge, TN

Scientists Must Stand Together Against Intelligent Design

One can hardly disagree with Thomas Sheahen [letter to *APS News*, January 2006] that screaming, name calling, and comparing one's opponents to arch villains rarely advances the cause. I do, however, take issue with his suggestion that Intelligent Design is anything but old-hat Biblical Creationism wearing a new hat.

Intelligent Design implies an extraordinarily knowledgeable designer. Infinitely so? Can't say, but if it designed this whole universe it must be so smart it would seem infinitely so to us mortals. By similar reasoning it has to be extremely (infinitely?) powerful in order to carry out (create) its design in the physical world. Of course one now has to ask what made this designer–unless it exists outside of time (eternal).

So we now have an omniscient, omnipotent, eternal creator.

Ain't we seen this guy before?

It's not just the life sciences that are under attack. Creationism also opposes modern physics, especially cosmology and geophysics where they conflict with Biblical literalism. Even classical fluid mechanics is in trouble to the extent that it is inconsistent with the Great Flood and the parting of the Red Sea. We must therefore stand with our biologist colleagues.

Jonathan Allen
Titusville, NJ

INSIDE THE BELTWAY:
WASHINGTON ANALYSIS AND OPINION

The President's Pledge: America Will Compete!

By Michael S. Lubell, APS Director of Public Affairs

In politics, six months is an eternity. It's a well-worn adage. And it's usually accurate. President Bush's popularity may be tanking in the spring, and the public may be disgusted with Congress, but the 2006 election is still many months away. Anything can happen between now and then.

Much the same can be said about the future of the President's innovation agenda. The White House rolled out the American Competitiveness Initiative (ACI) in the President's State of the Union Address. Among its four principal components: a permanent R&D tax credit, large investments in science education, visa reforms, and a pledge to double the aggregate budgets of the DOE's Office of Science, the NSF and the NIST Core Programs over a 10-year period.

On February 6, the President made a down payment on his funding promise when he released his proposed budget for FY 2007. It contained a 9.3% increase for the total of the three agencies, 14% for DOE Science, 8% for NSF and 24% for NIST Core.

Pretty impressive, and in the eyes of many, decades overdue. But what will materialize six months from now is not easy to forecast. It's too far away. It's an eternity.

But if six months is an eternity, what is 10 years? Well, that's almost how long ago *U.S News and World Report* published David Gergen's editorial on the "7 Percent Solution." If you're too young to remember or too old to care, Gergen, an assistant to three former Presidents, took his cue from the late D. Allan Bromley (George H.W. Bush's science advisor), who had been advocating for a 10-year doubling of the federal

Inside the Beltway continued on page 6

Viewpoint...

What Exactly Is Michael Crichton's "Scientific Method"?

By James Hansen

Michael Crichton's latest fictional novel, *State of Fear*, designed to discredit concerns about global warming, purports to use the scientific method. The book is sprinkled with references to scientific papers, and Crichton intones in the introduction that his "footnotes are real." But does Crichton really use the scientific method? Or is it something closer to scientific fraud?

Several people have pointed out to me that Crichton takes aim at my 1988 congressional testimony and claims that I made predictions about global warming that turned out to be 300% too high. Is that right?

In my testimony in 1988, and in an attached scientific paper written with several colleagues at the Goddard Institute for Space Studies (GISS) and published later that year in the *Journal of Geophysical Research* (volume 93, pages 9341-9364), I described climate simulations made with the GISS climate model. We considered three scenarios for the future, labeled A, B and C, to bracket likely possibilities. Scenario A was described as "on the high side of reality," because it assumed rapid exponential growth of greenhouse gases and it assumed that there would be no large volcanoes (which inject small particles into the stratosphere and cool the Earth) during the next half century. Scenario C was described as "a more drastic curtailment of emissions than has generally been imagined," specifically greenhouse gases were assumed to stop increasing after 2000. The intermediate Scenario B was described as "the most plausible." Scenario B had continued growth of greenhouse gas emissions at a moderate rate and it sprinkled three large volcanoes in the 50-year period after 1988, one of them in the 1990s.

Not surprisingly, the real world has followed a course closest to that of Scenario B. The real world even had one large volcano in the 1990s, the eruption of Mount Pinatubo, which occurred in 1991, while Scenario B placed a volcano in 1995.

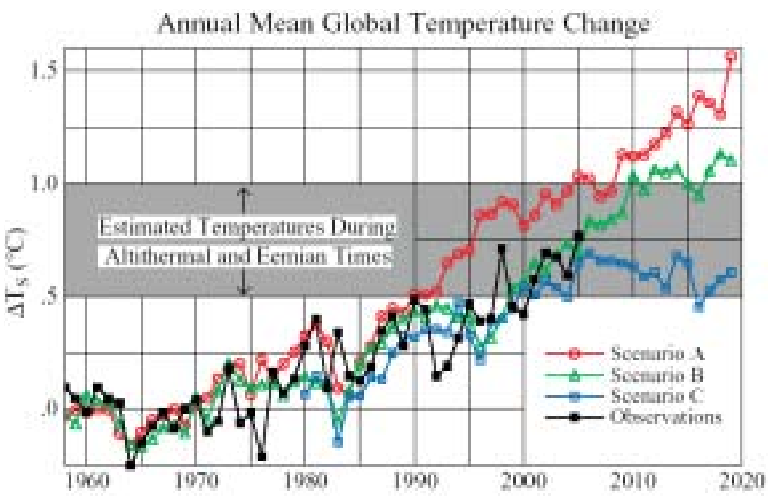


Figure 1. Annual mean global surface air temperature computed for scenarios A, B and C. Observational data are an update of the analysis of Hansen and Lebedeff [J. Geophys. Res., 92,13,345, 1987]. Shaded area is an estimate of the global temperature during the peak of the current interglacial period (the Altithermal, peaking about 6,000 to 10,000 years ago, when we estimate that global temperature was in the lower part of the shaded area) and the prior interglacial period (the Eemian period, about 120,000 years ago, when we estimate that global temperature probably peaked near the upper part of the shaded area). The temperature zero point is the 1951-1980 mean.

In my testimony to congress I showed one line graph with scenarios A, B, C and observed global temperature, which I update in Figure 1. However, all of the maps of simulated future temperature that I showed in my congressional testimony were for scenario B, which formed the basis for my testimony. No results were shown for the outlier scenarios A and C.

Back to Crichton: how did he conclude that I made an error of 300%? Apparently, rather than studying the scientific literature, as his footnotes would imply, his approach was to listen to "global warming skeptics." One of the skeptics, Pat Michaels, has taken the graph from our 1988 paper with simulated global temperatures for scenarios A, B and C, erased the results for scenarios B and C, and shown only the curve for scenario A in public presentations, pretending that it was my prediction for climate change. Is this treading close to scientific fraud? Crichton's approach is worse than that of Michaels. Crichton uncritically accepts Michaels' results, and then concludes that Hansen's prediction was in error "300%." Where does he get this conclusion?

Let's reproduce here the global temperature curves from my 1988 congressional testimony, without erasing the results for scenarios B and C. Figure 1 updates observations of global temperature using the same analysis of meteorological station data as in our 1988 paper, which removes or corrects station data from urban locations. Note that the observed warming would be slightly less in our analysis of observations if we combine ocean temperature measurements with the meteorological station data. However, differences among alternative analyses of the observational data are generally less than 0.1°C.

The observations, the black curve in Figure 1, show that the Earth is indeed getting warmer, as predicted. The observed temperature fluctuates a lot, because the real world is a "noisy," chaotic system, but there is a clear warming trend. Curiously, the scenario that we described as most realistic is so far turning out to be almost dead on the money. Such close agreement is fortuitous. For example, the model used in 1988 had a sensitivity of 4.2°C for doubled CO_2, but our best estimate for true climate sensitivity is closer to 3°C for doubled CO_2. Climate sensitivity is usually expressed as the equilibrium global warming expected to result from doubling the amount of CO_2 in the air. Empirical evidence from the Earth's history indicates that climate sensitivity is about 3°C, with an uncertainty of about 1°C. A climate model yields its own sensitivity, based on the best physics that the users can incorporate at any given time. (The 2005 GISS model sensitivity was 2.7°C. It is suspected that the sensitivity of the 2005 model may be slightly too small because of the sea ice formulation being too stable.)

There are various other uncertain factors that can make the warming larger or smaller (see our papers at http://pubs.giss.nasa.gov). But it is becoming clear that our prediction was in the right ballpark. So how did Crichton conclude that our prediction was in error 300%? Beats me. Crichton writes fiction and seems to make up things as he goes along. He doesn't seem to have the foggiest notion about the science that he writes about. Perhaps that is okay for a science fiction writer. (Discussion of Crichton's science fiction is provided on the blog www.realclimate.org/index.php?p=74.) However, I recently heard that, in considering the global warming issue, a US senator is treating words from Crichton as if they had scientific or practical validity, and that Crichton was invited to the White House for an extensive interview with the President. Houston, we have a problem!

James Hansen is director of NASA's Goddard Institute for Space Studies, and a longtime advocate of combating global warming and climate change. The above is adapted from comments posted on September 27, 2005. Figure 1 courtesy of Makiko Sato.

High-Energy Physicists Hear Mixed Message From Washington Science Policy Leaders

Photo Credit: Alan Chodos

Listening to a presentation at the HEPAP meeting are (l to r) : Presidential science advisor John Marburger; DOE Office of Science Associate Director for High-Energy Physics Robin Staffin; HEPAP Chair Melvyn Shochet; NSF Director Arden Bement (partially obscured); and NSF Physics Division Director Joseph Dehmer.

Members of the High-Energy Physics Advisory Panel (HEPAP) heard generally encouraging words about the prospects for physical science from three of Washington's scientific decision makers, but they also were given a cautionary outlook for the construction of the International Linear Collider (ILC) over the next decade and more.

HEPAP, currently chaired by Melvyn J. Shochet of the University of Chicago, advises both the DOE Office of Science and the NSF about high-energy physics. Both Office of Science Director Ray Orbach and NSF Director Arden Bement addressed the group, as did Presidential Science Advisor John Marburger when the panel met in Washington in early March.

Orbach called himself "a child of Sputnik", and described President Bush's state of the union speech, in which he unveiled the American Competitiveness Initiative (ACI), as "a comparable moment to Sputnik". But he worried that the 14% requested increase for the Office of Science would be a "sitting duck" in a year when most of the rest of US discretionary spending is being cut, and urged the physics community to support the request as it makes its way through Congress. Orbach said that if the request is enacted, DOE facilities will be able to operate at or near full capacity, and instead of 2200 people losing their funding, as happened last year, funding to 2600 PhDs and graduate students will be restored.

Commenting on the lessons learned from the Superconducting Super Collider, which was terminated by Congress in 1993, Orbach pointed to a decrease in the Office of Science budget in 1995, and said "if you kill a project in high-energy physics, the funding for condensed matter goes down. And I believe the converse is also true." Noting the importance of support from all parts of the physics community for the ILC, he said "I'd like to see the APS make a statement and get all the Divisions behind it." He also pointed out that the construction of the ITER controlled fusion facility, as an international project, was a model for how the ILC project should be managed.

Marburger traced the history leading up to the ACI, saying that the physical sciences had fallen behind while the NIH budget was doubling. "This administration was not negative toward the physical sciences," he said, "but had priorities that made it difficult to

High-Energy Physicists continued on page 6

APS Member Honored for Intelligence

APS member Dwight Williams has been elected one of the first Director of National Intelligence fellows.

The DNI Fellows Awards program recognizes and rewards outstanding technical achievement within the Intelligence Community.

Director of National Intelligence John Negroponte presented the first DNI Fellows Awards to nine members of the Intelligence Community at a ceremony in February. "These distinguished experts are the best of the best–professionals in whom we have enormous trust and confidence," said Negroponte, "As globalization spreads technology to the far corners of the globe, the Intelligence Community's S&T leaders must devise ways to maintain our competitive advantage."

A $200,000 research grant is awarded to each Fellow to perform government intelligence technology research.

DNI Fellows are nominated by the science and technology organizations of the Intelligence Community and selected annually by the Office of the Associate Director of National Intelligence for Science and Technology. They are chosen based upon their outstanding technical contributions, the expectation of significant technical advances based upon their track record of achievement, and the potential for the DNI fellowship to facilitate subsequent technical work and collaboration across the Intelligence Community.

Dwight Williams serves as the Principal Nuclear Physicist in the Defense Intelligence

APS Member Honored continued on page 6

Unit Officers Share Ideas

Photo credit: Ken Cole

Marilyn Gunner of CCNY, Chair-elect of the Division of Biological Physics, makes a point during the APS Unit Convocation in February. The unit convocation brings together leaders from APS divisions, topical groups, forums and sections to discuss topics of mutual interest, and to learn more about how the Society operates. This year, 76 participants, representing all but one of the 39 units, attended the convocation.

P & T FOREFRONTS CONTINUED FROM PAGE 3

circulations. This allows them to compute not only the concentration of the contaminant in the San Joaquin River, for example, but at what rate it is flowing downstream.

On the Horizon

The potential applications for such systems extend far beyond the study of complex ecosystems. DARPA is interested in using them to monitor battlefield conditions. Embedded sensing could also be incorporated into concrete bridges to monitor vibration, stress, changes in temperature, even cracking.

Attaching nodes to water or power meters in residential neighborhoods could make existing meter reading methods obsolete. Placing nodes along a sensor-equipped highway would enable police to better monitor traffic flow.

The next step, according to Estrin, involves more widespread proliferation of embedded wireless network systems among scientists–in every discipline. She cites NEON as one example of a continental multiscale sensor network. NEON is being designed to track changes in various environments, from urban and suburban areas to more rural and wild settings. She also hopes to combine this new observational capability with remote sensing and existing GIS-based modeling facilities. Another example of a distributed sensor-based observatory is Earthscope, which connects thousands of stations to map Earth's interior and study crust deformation, searching for clues to the planet's early evolution.

Ultimately, rampant proliferation should bring the center's innovation "feedback loop" full circle. The miniaturization and wireless trends in consumer electronics paved the way for developing prototype embedded sensing networks for scientific applications, but as they proliferate, more consumer-oriented urban sensing applications will emerge. Estrin foresees a day when individuals make use of acoustic, imaging, or personal-health-monitoring sensors, communicating with and through their already omnipresent cell phones: "That's when we'll start to see this proliferate out into non-scientific applications."

IMPACT FACTOR CONTINUED FROM PAGE 1

impact factor, but citations to those news articles may be included in the numerator, inflating the impact factor of journals that publish those types of articles.

Review articles, such as those published in *Reviews of Modern Physics*, are often much more highly cited than the average original research paper, so the impact factor of review journals can be quite high.

In some fields, there have been reports of journals that have raised their impact factors by such tactics as adding news articles, accepting papers preferentially that are likely to raise the journal's impact factor, or even asking authors to add citations to other articles in the journal.

APS journals have not been much affected by these types of problems, said Martin Blume, APS Editor-in-Chief. In fact, Blume says he makes a point of trying not to pay attention to the impact factor.

Blume and others are more concerned that in some cases hiring and tenure committees or funding agencies may use the impact factor inappropriately as a way to evaluate individual researchers. "There is no quantitative metric of excellence. High impact factor journal publication is not a measure of excellence of the individual," said Blume.

Ivan Schuller of UCSD says he likes to publish in the *Physical Review* journals, because he wants his work to be read by physicists. But some of his students feel that publishing in *Physical Review* instead of *Science* or *Nature*, which have higher impact factors, puts them at a disadvantage when applying for jobs. They believe some universities may simply look at the impact factors of journals they've published in, rather than carefully review the individual's work.

Paul Kwiat of the University of Illinois recently co-authored a paper on quantum computation that was published in *Nature*. But the impact factor, which Kwiat had never heard of, wasn't considered in the decision of where to publish.

"We chose *Nature* because we thought we had an item that might have some general public interest, while being novel science," Kwiat said. "I'm not sure I know any kind of quantitative 'impact factor', but surely scientists know that some journals are more prestigious than others, partly in view of the difficulty of getting published in them."

Some of the latest (2004) impact factors:

Physical Review A: 2.902
Physical Review B: 3.075
Physical Review C: 3.125
Physical Review D: 5.156
Physical Review E: 2.352
Phys Rev Letters: 7.218
Rev Mod Physics: 32.771
Science: 31.853
Nature: 32.182
More than half of all science journals counted by the ISI have an impact factor below 1.

BOY SCOUTS CONTINUED FROM PAGE 1

the history of nuclear science, modern atomic models, particle accelerators, radiation and its uses, nuclear energy, and careers related to nuclear science.

To earn the badge, scouts must show that they understand these topics. They must also complete several activities, choosing from a variety of options, including building models of atoms, constructing an electroscope or cloud chamber, testing irradiated foods and seeds, and building a model of a nuclear reactor.

The scouts may also visit a place where radiation is used, or visit a national lab or research group that studies nuclear science. This provides a perfect opportunity for nuclear physicists to be involved in outreach, said Matis. "Any physics lab or research group can be part of the requirements."

LARGEST APS PRIZE CONTINUED FROM PAGE 1

The selection committee consists of the President and two immediate past-Presidents of the APS, the previous recipient of the Prize, and a chairperson to be elected by the APS Council. A sixth, non-voting, member of the committee is George C. Valley, son of George E. Valley, Jr. and, like his father, a physicist. Further details on rules of eligibility and nomination procedures may be found on the APS web site at http://www.aps.org/praw/valley/index.cfm .

The two previous recipients of the prize were David Goldhaber-Gordon, currently at Stanford University, "for the discovery and elucidation of the physics of the Kondo Effect in Single Electron Transistors" and Ivo Souza, at UC Berkeley, "for fundamental advances in the theory of polarization, localization and electric fields in crystalline insulators" .

George E. Valley, Jr. received his PhD in physics from the University of Rochester in 1939. He was named a National Research Fellow in nuclear physics in 1940 and was Project Supervisor and senior staff member of the Radiation Laboratory at MIT from 1941 to 1945. He was on the faculty at MIT from 1946 to 1974, was one of the founders of MIT Lincoln Laboratory, and was Chief Scientist of the Air Force in 1957-58.

Gershenfeld Hopes To Spearhead a Fab-ulous Revolution

Neil Gershenfeld

In his lab at MIT, Neil Gershenfeld can build almost anything. The lab contains a few high-tech machines that together make it possible for individuals to design and build almost anything they can imagine. People have used the lab to make all kinds of weird gizmos to suit their personalities and needs–from a web browser for parrots to a dress that puffs up when other people approach too closely.

But the "fab lab", as Gershenfeld calls it, is not just a high-tech tool for making odd gadgets. He has set up similar labs in undeveloped areas around the world, where people with few resources can use the tools to build things they need to substantially improve their lives. Gershenfeld thinks that these fab labs will eventually allow regular people to make exactly what they want or need, rather than buying a mass-produced item at a store, a prospect he believes is as revolutionary as the personal computer.

Gershenfeld has always liked making stuff himself. As a child, he liked to build things and play with all sorts of gadgets. "Growing up I did a lot of tinkering," he says, "Taking stuff apart, though not necessarily putting it back together again." For a while he wanted to go to trade school, to learn hands-on skills like welding and auto mechanics, but he ended up following a college-prep program and then going to Swarthmore College.

Even while studying physics, Gershenfeld spent a lot of time in the machine shop at Swarthmore. After obtaining a PhD in applied physics from Cornell, Gershenfeld worked at Bell Labs, where he caused some trouble because he wanted to operate the machines himself, rather than just have the machinists build things for him. He's never liked the idea that machining was supposed to be done only by specialist machine operators. So it isn't surprising that he had the idea for personal fabrication.

The fab (for fabrication, or fabulous, whichever you prefer) labs, which cost about $20,000, contain high-tech tools such as a laser cutter to cut shapes out of a variety of materials, a sign cutter that makes flexible electrical connections and antennas, a milling machine for making circuit boards and precision parts, and tools for programming tiny high speed microcontrollers. With these tools, some basic materials, and a little training and creativity, one really can make almost anything.

Though the fab lab doesn't construct objects subatomic particle-by-subatomic particle, like the "Replicator" on *Star Trek*, Gershenfeld's research is heading in that direction. In fact, says Gershenfeld, who heads MIT's Center for Bits and Atoms, "There's a pretty solid road map to making a *Star Trek*-style molecular assembler."

Gershenfeld originally put together the fab lab machines for his own research. His work at the interdisciplinary Center for Bits and Atoms explores how the content of information relates to its physical representation. "We're just starting to see nature as information processing," he says, and the lab's goal is to "bring together the best features of the bits of new digital worlds with the atoms of the physical world. " The lab studies everything from atomic nuclei to global networks. Among other things, Gershenfeld's research led to the development of molecular logic used to implement the first complete quantum computation.

After setting up the fab lab machines, Gershenfeld found himself spending a lot of time teaching others to use them, so he decided to offer a course, which he called "How to Build (Almost) Anything." He expected to have a few advanced engineering students sign up. Instead, he was overwhelmed by about a hundred students, many with relatively non-technical backgrounds, clamoring to enroll.

They all had ideas for things they wanted to make. Many of them were quirky. For instance, one student made a "defensible dress" that was inspired by the porcupine's and blowfish's methods of defending their space by puffing up. Sensors in the dress detect when someone else gets too close to the wearer, and stiff wires then cause the dress to billow out, defending the wearer's personal space.

Another student, an artist with little electronics background, made a portable sack for screaming. When someone yells into the sack, the scream is silenced, so people nearby can't hear it, but it is also recorded, so the screamer can play it back at a more appropriate time.

Other fab lab students have made weird items such as an alarm clock that forces you to play a game to prove you're awake, and a web browser for parrots. "It's not about making things you need, but making things you want," says Gershenfeld about these rather eccentric projects. Personal Fabrication, as Gershenfeld calls it, is about making things for a "market of one." He envisions that someday soon the cost of a fab lab will come down, and people will use them routinely to build their own things, rather than just buy things that are available at Wal-Mart. Gershenfeld describes this revolutionary new business model in his recent book *Fab: The Coming Revolution on Your Desktop–from Personal Computers to Personal Fabrication*.

Gershenfeld realized that the labs could actually be most useful in some of the world's most undeveloped and impoverished places. Fab labs are now running in South Boston, Ghana, Costa Rica, India, Norway, and one is being built in South Africa. "They have exploded around the world. We're drowning in demand. Everywhere we go, we're inundated with people with compelling problems they're desperate to solve," says Gershenfeld. These places are very different from each other, and the people have unique problems, but Gershenfeld found that, in some ways, the people were remarkably similar. "The community figures we work with are all the same. They're not technical, but they have this tremendous sense of opportunity for technology. The ways people work seem to span across very different cultural backgrounds," says Gershenfeld.

In India, fab lab users made electronic monitoring devices to test milk for freshness and contamination. In northern Norway, a group of shepherds made a wireless radio network to track sheep. In the fab lab in Ghana, people are developing inexpensive ways to harness the abundant solar power, and are working on a machine to process cassava, a staple food in the region.

Children are often the most enthusiastic users of the fab labs, says Gershenfeld, who often brings his own kids, eight year-old twins Grace and Eli, to the lab at MIT. They've produced furniture for their teddy bears and dolls and a cardboard construction set they say is more fun than Legos. Now, when they want something–a new toy, perhaps–they always say, "Let's go to MIT," rather than dragging their dad to a toy store to buy something that someone else designed. These youngsters seem to have absorbed the idea of making things themselves, evidence that Gershenfeld's vision of personal manufacturing is already taking hold.

–Courtesy of Physics Central: www.physicscentral.com

INSIDE THE BELTWAY CONTINUED FROM PAGE 4

science budget as a matter of long-term economic necessity.

Gergen's no mathematical slouch, and he knew that it takes annual increments of 7 percent to reach the doubling goal over a decade. He also knew that "The 7 Percent Solution" had a lot more punch than "Doubling the Science Budget."

But neither Gergen's punch nor Bromley's clout had much impact on the Clinton White House or on the Republican Congress. Lobbying efforts focused on averting looming disasters. In that respect they succeeded.

But except for a brief up-tick in Clinton's final year in office, federal support for the physical sciences continued to stagnate–until last year when the floor virtually collapsed under the DOE science budget. National labs sent out lay-off notices; user facilities announced reductions in running time; and Brookhaven said that it would mothball the Relativistic Heavy Collider for a year. Unless its funding were restored in the next few years, insiders speculated that Brookhaven might be forced to close.

Such was the bleak physical science budget landscape as Christmas 2005 approached. But following a series of mid-December meetings between industrial CEO's and high-level Administration officials, including Vice President Cheney, OMB Director Josh Bolten, White House Chief of Staff Andrew Card and Presidential Senior Advisor Karl Rove, rumors began to circulate that President Bush was willing to make competitiveness a prime domestic policy issue. In a matter of a few weeks, innovation and competitiveness had gone from the work of policy wonks to draft language in the State of the Union Address.

Of course, in Washington, nothing other than sex and bribery moves at lightning speed. And the ACI was no exception. In December 2004, the Council on Competitiveness had published its report, *Innovate America*; in February 2005, the Task Force on the Future of American Innovation had issued its analysis, *Benchmarks of our Innovation Future*; that same month, the American Electronics Association had released its report, *Losing the Competitive Advantage;* in October 2005, the National Academies, in response to a request from Senators Lamar Alexander (R-TN) and Jeff Bingaman (D-NM), had rolled out a set of competitiveness policy recommendations in *Rising Above the Gathering Storm*; in November 2005, the House Democratic leadership had announced its Innovation Agenda; and in early December, at the request of Representative Frank Wolf (R-10th VA), the Commerce Department hosted *The National Summit on Competitiveness*. They all concluded that without aggressive federal action, America's number one ranking on the world's economic stage was unlikely to endure.

Over the past decade, there have been many heroes–inside and outside government–in the fight to make innovation and competitiveness Beltway buzzwords. But in the last four years, few have worked harder than Norman Augustine, retired CEO of Lockheed-Martin; Craig Barrett, Chairman of the Board of Intel; Burton Richter, former Director of SLAC and Chairman of the APS Physics Policy Committee; Senators Lamar Alexander, Jeff Bingaman and Pete V. Domenici (R-NM); and Representatives Frank Wolf, Sherwood Boehlert (R-24th NY), Judy Biggert (R-13th IL); Vern Ehlers (R-3rd MI), George Miller (D-7th CA), Anna Eshoo (D-14th CA) and Zoe Lofgren (D-16th CA).

It's hard to predict whether the goals of ACI will be met a decade from now, and even whether this year's down payment will materialize, once Congress has disposed with what the President has proposed. But without a doubt, were he still alive, Allan Bromley would be smiling broadly. In a real sense, the ACI began with him nearly a decade ago. And in Washington that's an eternity of eternities.

APS MEMBER HONORED CONTINUED FROM PAGE 5

Agency's Science and Technology Brain Trust within the Directorate for Measurements and Signatures Intelligence (MASINT) and Technical Collection. He earned his B.S. and M.S. degrees in Nuclear Engineering from North Carolina State University and his Ph.D. in Nuclear Engineering from the University of Maryland.

He said he felt honored to receive the DNI Fellows award. "I was actually kind of humbled by it," he said.

HIGH-ENERGY PHYSICISTS CONTINUED FROM PAGE 5

fill that hole." He added, "the ACI improves conditions for many, if not all, areas of physical science."

But Marburger stressed that neither high-energy physics nor space science are among the areas explicitly covered by the ACI. "The priority and thrust is toward Basic Energy Sciences and other areas related to competitiveness. The ACI is neutral toward particle and nuclear physics."

Marburger said it is dangerous to try to sell high-energy physics on the basis of its technological spinoffs. "Intellectual excitement drives the field," he said. "We have a responsibility to share the excitement of the field with the people who are helping to fund it. Our sponsors are the people of the world."

Bement characterized the value of high-energy physics as threefold: transformational science, technological impact, and the production of highly trained scientists who then enter diverse fields. He noted that $15 million would be added to the high-energy physics budget in the NSF research and related activities account, which he said would become significant over time as the budget compounded. He mentioned the RSVP experiment at Brookhaven, which had been planned to look for rare symmetry violating processes, but which was canceled last year "with great regret because of a complex set of reasons." On the positive side, Bement cited NSF's continuing involvement in the prospect of constructing a deep underground laboratory.

APRIL MEETING CONTINUED FROM PAGE 1

collide. (Sessions H5, L1, E1, Q6)

Radiation Markers. Physicists continue to find creative and useful applications for naturally and artificially created radiation. Vincente Guiseppe of the University of Maine will explain how radon-222, a naturally occurring radioactive gas dissolved in groundwater, can provide information on groundwater mixing and flow (B8.4). Taking advantage of the fact that fission energy reactors emit large numbers of antineutrinos, Nathaniel Bowden of Sandia National Laboratory and his colleagues will explain how these antiparticles might be useful for measuring the reactor's power and plutonium inventory through the reactor's fuel cycle (Paper B8.3).

Cosmic Rays and Biodiveristy. The fossil record shows that Earth's biodiversity fluctuates on an approximately 62-million-year cycle. Until now, there has been no satisfactory explanation for this biodiversity oscillation. University of Kansas researchers Mikhail Medvedev and Adrian Melott show that this cycle can be explained by a change in the flux of cosmic rays reaching Earth as the solar system moves through the galactic plane. This is due to differences in shielding by galactic magnetic fields, and to variations in cosmic ray production and propagation in the galactic interstellar medium. Cosmic rays can influence cloud formation and atmospheric chemistry, and thus affect climate. In addition, energetic cosmic rays produce showers of energetic particles that can damage organisms' DNA. (paper H7.1)

How Round is a Pulsar? Pulsars are some of the most spherical objects in the sky. Generally, however, physicists could only measure the shapes of the stars indirectly, by watching the rate that a pulsar's rotation slows. Data from LIGO (Laser Interferometer Gravitational Wave Observatory) has now placed limits on the shape of pulsars, including the one at the heart of the Crab nebula, through attempts to directly detect gravitational waves coming from the stars. Matthew Pitkin of the University of Glasgow, on behalf of the LIGO Scientific Collaboration, will present the analysis of the most recent and most sensitive LIGO data collected so far, and discuss the limits that the current and forthcoming LIGO data puts on pulsar shapes (Paper C7.2).

Funding Research in Poor Countries. International scientific collaboration and research programs have a largely unrealized potential to promote innovation and economic development in poor countries. As session C4 will show, governmental and public/private programs are reaching out to a wider range of nations and world regions than before. Arden Bement, director of the National Science Foundation, will talk about NSF's international outreach through a variety of initiatives in Africa and elsewhere. At session E4, officials from UNESCO, the World Bank, and NSF's International Science and Engineering Division will discuss burgeoning efforts to develop science, technology, and education programs for reducing poverty in developing nations. (Session C4)

Sakharov in the Gray Zones. The battle for protecting the human rights of scientists did not end with Andrei Sakharov and the former Soviet Union–it is still going on today. Session L6 will explore programs to support and provide safe haven for scholars persecuted for their speech, ethnicity, gender, and citizenship. Yuri Orlov, who is the first recipient of the APS Sakharov Prize, helped establish Human Rights Watch and was one of the early defenders of Sakharov. He will describe "difficult areas of human rights activity in which human rights defenders cannot reach a consensus on how to proceed, and even on how to define the problem." An Iranian physicist sentenced to 10 years of prison for advocating democracy and openness, Hadi Hadizadeh, now at Ohio University, will describe the closed-door trials that he and fellow scholars experienced in Iran. (Session L6)

Astrophysics in the Laboratory. Plasma physicists have produced in a laboratory some of the extreme conditions and fascinating phenomena observed in the sun and in space. Plasmas and magnetic fields in space often form loops, which merge, twist and reconnect, releasing energy and jets of particles. This magnetic reconnection is believed to underlie many solar phenomena, but scientists don't have a complete understanding of how it works, and the details can be hard to study in space. In an experiment at Swarthmore College, Michael Brown, along with a group of undergraduate researchers, generates and merges loops of extremely hot gas suspended on magnetic fields. These loops have many properties of the much larger loops observed on the surface of the sun, including temperatures up to 1 million degrees, strong magnetic fields, and high velocities. Brown and colleagues have used hundreds of tiny magnetic detectors to map out the entire complex 3-dimensional structure of loops in the process of intertwining and reconnecting. Brown will compare this structure, which had never been mapped out before, to similar structures in reconnecting magnetic fields in the magnetosphere. In their newest measurement, the Swarthmore researchers used Doppler spectroscopy to measure high-velocity (40 km/s), bi-directional jets coming out of a reconnection event. Brown will report on his observations and compare them to observations in a solar context (paper L16.4).

Why Aristotle Took so Long to Die. Aristotle's view of physics and cosmology reigned for many centuries as the definitive model of physical reality among the philosophical thinkers of Islam and Christendom, even after Copernicus and Galileo came on the scene. Dennis Danielson (University of British Columbia) considers why this was and suggests how, by attempting to see things from Aristotle's point of view, we might be better able to "avoid getting stuck in our own orthodoxies" when it comes to untangling nature's mysteries. (paper B5.1)

Cosmic Evolution. Speakers at a Monday afternoon session will present some of the latest and most compelling evidence of how the universe, Earth and life have evolved. Joel Primack (University of California, Santa Cruz) is the co-author (with Nancy Ellen Abrams) of *The View From the Center of the Universe: Discovering Our Extraordinary Place in the Cosmos*. Primack will review key observations that support modern cosmology, describe some symbolic ways of understanding the modern cosmos, and discuss some possible implications of a cosmic perspective for our 21st century worldview. Penn State's James Kasting will discuss climate and life on early Earth. Duane Jeffrey, a professor of integrative biology at Brigham Young University, will talk about the evolution of biological diversity. (Session Q5)

Cool Roofs Save Money. White roofs with a high reflectivity or "albedo" have a long history of keeping buildings cool, especially in the Mediterranean, according to Arthur Rosenfeld of the California Energy Commission. Closer to home, so-called "cool roofs" have been shown to reduce A/C demand in California by as much as 10%, and to slow the formation of ozone. Rosenfeld will report on his recent investigation into the positive environmental impacts of widespread deployment of cool roof technology. Among other benefits, "cooling the planet" with such technology could save hundreds of billions of dollars annually worldwide. (Paper W5.2)

Lessons from Katrina. Coastal and riverine flooding and hurricane-driven storms have long plagued US residents who live or work near shorelines. The devastation wrought last year by Hurricane Katrina has brought the problem to national attention. Gerald Galloway of the University of Maryland will review the development of the US program for providing structural protection, discuss the effectiveness of levees, dams, floodways, and storm barriers, and explore what new approaches might be taken to be better prepared for such disasters, based on post-Katrina planning. (Paper W5.3)

Reaching for the Stars. In 1925, a little-known female astronomer named Cecilia Payne-Gaposchkin published a monograph on the composition of the stars and universe that was hailed as "the most brilliant PhD thesis ever written in astronomy" by one renowned colleague. It combined observations of stellar spectra with the then-new atomic theories in physics. Yet like many other early women in astronomy, today she has been largely forgotten. Her story is among those featured at a session honoring pioneering women in astronomy. The early 19th century astronomer Henrietta Leavitt will also be featured, and Jill Tarter of the SETI Institute will wrap things up with her personal experiences in a male-dominated field. (Session J5)

Distinguished Traveling Lecturer Program in Laser Science

The Division of Laser Sciences (DLS) of APS announces its lecture program in Laser Science, and invites applications from schools to host a lecturer in 2006/2007. Lecturers will visit selected academic institutions for two days, during which time they will give a public lecture open to the entire academic community and meet informally with students and faculty. They may also give guest lectures in classes related to Laser Science. The purpose of the program is to bring distinguished scientists to colleges and universities in order to convey the excitement of Laser Science to undergraduate and graduate students.

The DLS will cover the travel expenses and honorarium of the lecturer. The host institution will be responsible only for the local expenses of the lecturer and for advertising the public lecture. Awards to host institutions will be made by the selection committee after consulting with the lecturers. Priority will be given to those institutions that do not have extensive resources for similar programs.

Applications should be sent to the DTL committee Chair Rainer Grobe (grobe@ilstu.edu) and to the DLS Secretary-Treasurer John Fourkas (fourkas@umd.edu). The deadline for application for visits in Fall 2006 is April 30.

Detailed information about the program and the application procedure is available on the DLS-DTL home page: http://physics.sdsu.edu/~anderson/DTL/

Lecturers for the 2006-2007 Academic Year:

- Lee W. Casperson, University of North Carolina.
- Eric Cornell, University of Colorado.
- Jim Kafka, Spectra Physics.
- Marsha Lester, University of Pennsylvania.
- Christopher Monroe, University of Michigan.
- Luis A. Orozco, University of Maryland.
- Carlos Stroud, University of Rochester.
- Ron Walsworth, Harvard University.

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

Onsager and the theory of hydrodynamic turbulence
Gregory L. Eyink and Katepalli R. Sreenivasan

Besides Osager's well-known contributions to physics and chemistry, he had a life-long interest and made ground-breaking discoveries in the subject of hydrodynamic turbulence. His 1949 paper stimulated considerable later work, but it is in his private letters and unpublished notes that some of the most original ideas appeared. In at least four cases, the theories were developed and published only decades later by others.

M. Hildred Blewett Scholarship for Women Physicists

This scholarship has been established to enable women to return to physics research careers after having had to interrupt those careers for family reasons. The scholarship consists of an award of up to $45,000. The applicant must currently be a legal resident or resident alien of the US or Canada. She must be currently in Canada or the US and must have an affiliation with a research-active educational institution or national lab. She must have completed work toward a PhD.

Applications are due June 1, 2006. Announcement of the award is expected to be made by August 1, 2006.

Details and online application can be found at http://www.aps.org/educ/cswp/blewett/index.cfm

Contact: Sue Otwell in the APS office at blewett@aps.org

(See Zero Gravity on page 3):

Ampere	Dirac	Maxwell	Rutherford
Bethe	Faraday	Meitner	Schrodinger
Bohr	Fermi	Newton	Schwinger
Born	Galileo	Noether	Volta
Carnot	Hamilton	Ohm	
Curie	Henry (twice)	Planck	

The Back Page

When Worldviews Collide: Science and Religion Face Off Again

By Lawrence M. Krauss

Religion and science are in collision again today, as they have been periodically in the past. In Afghanistan in 2001, the Taliban blew up the monumental Buddha statues at Bamiyan. They destroyed them because their religion forbade the reproduction of human faces and bodies. The Taliban had nothing specific against Buddhism; they wanted to destroy *all* statues. This was a clear example of religion attacking science–in this case, archaeology–inasmuch as these sculptures were amazing specimens of antiquity. What motivated this attack? In a word, *fear*.

Similar collisions between science and religion, based on fear, have taken place in the United States. Former House Majority Leader Tom DeLay–who has, amazingly, a degree in biology–once argued that the Columbine school shootings happened "because our school systems teach our children that they are nothing but glorified apes who have evolutionized out of some primordial mud." That's in the *Congressional Record*. Meanwhile, public policy regarding Intelligent Design (ID) has been defined by people like President George W. Bush. Talking about evolution versus ID, Bush recently declared that "Both sides ought to be properly taught so people can understand what the debate is about." The sentence assumes that there are two "sides" and that there is a debate. There isn't.

The ID conflict unfolds against a background of desperate problems in education. Our public schools are not teaching science effectively. As a society, we should be spending our time and energy trying to teach science better in the classrooms, not worse. The argument over evolution versus ID is a huge waste of time. Having to focus our energies on this attack on science keeps us from finding better ways to teach how remarkable science is in illuminating various aspects of our universe.

The Real Target

ID doesn't amount to much more than simply *being opposed to evolution*. But evolution is a straw man. What people are challenging is science itself, and the methods by which it investigates the universe. People who oppose evolution are really trying to take a stand against science and rationality as such. This is why I, a physicist, got involved in the public policy issue.

Years ago, my state of Ohio was one of the first to experience a concerted attack on science standards. A local group called Science Excellence for All Ohioans–associated with televangelist James Dobson–accused in its literature: "Science standards use a little-known rule to censor the evidence of design. The rule, which is usually unstated, is often referred to as methodological naturalism." We have a different name for it where I come from. It's called the scientific method.

Advocates of creationism and ID ultimately stand opposed to the

Photo credit: http://www.phys.cwru.edu/~krauss/

Lawrence Krauss (right) with Captain Kirk (aka William Shatner) in the galley of the Starship Enterprise

scientific method, because the scientific method is based on the assumption that natural effects have natural causes and that human beings can try to understand those causes. That's incompatible with their particular theological view of reality–and that is the heart of the problem. (Of course, science is not inherently atheistic. The existence of God simply isn't a scientifically testable proposition.)

In 2002, the Ohio Board of Education was developing a new science curriculum, and there was a statewide controversy over whether to include ID. Stephen Meyer, a vice president of the pro-ID Discovery Institute, made a bold rhetorical move that turned out to be the first appearance of a clever new theme in ID's marketing campaign: teaching the controversy.

Everyone expected Meyer to get up and say, "We want ID to be taught in schools." Instead he declared, "You know what? We're not dogmatic. We want to compromise. Let's just teach the controversy." Meyer implied that there is a controversy, which there isn't, and that there are grounds for compromise, which is also not true.

When the Board of Education finished the new science standards, we saw how effective Meyer's teach-the-controversy strategy had been. Tacked on at the very end of the science standards was a phrase that required students to learn "how scientists continue to investigate and critically analyze aspects of evolutionary theory."

There's nothing inherently wrong with that statement, but it was in the wrong place. It should appear at the beginning of the science curriculum and say something like, "Students should learn how scientists are continuing to investigate and critically analyze all scientific theories." After all, that's the way science works. Putting the statement so late in the document, where it pertained only to the science standards concerning evolution, had the effect of making evolution seem suspect.

Not surprisingly, instead of producing a lesson plan that showed how students were critically analyzing evolutionary theory, it produced a lesson plan *critical* of evolutionary theory. It was so badly flawed that the president of the National Academy of Sciences protested, as did many other individuals and groups. The proposed curriculum passed.

Dishonest and Unfair

The marketing campaign for ID in this country has been well run and strategically ingenious. It's designed to exploit revered American values, including: open-mindedness ("We can't have this closed, dogmatic view of evolution."); honesty ("Let's talk about the fact that there are some people who don't believe in evolution."); and fairness ("We should just allow different people to express their views in classrooms.") It's not enough for defenders of evolution to talk about the science. I think the argument we have to present is that the ID strategy is in fact dishonest and unfair.

The dishonesty of ID lies in its proponents pointing to a controversy when there really is no controversy. A friend of mine did an informal survey of more than 10 million articles in major science journals during the past twelve years. Searching for the key word *evolution* pulled up 115,000 articles, most pertaining to biological evolution. Searching for *Intelligent Design* yielded 88 articles. All but 11 of those were in engineering journals, where, of course, we hope there is discussion of intelligent design. Of the 11, eight were critical of the scientific basis for ID theory and the remaining three turned out to be articles in conference proceedings, not peer-reviewed research journals.

The ID strategy is also unfair in a very particular way. Consider how real-world science gets done. Suppose you have a novel scientific claim. You do some research on it. You then submit an article to journals. The journals send it out to idiots called peer reviewers, and those idiots tell you why you're wrong, and then you have to fight with them and tell them why they're idiots, and it goes on and on. If you're lucky, you get published. What happens next? If your work is interesting, other people will begin to look at it and do follow-up research. If it's really interesting, you'll build a scientific consensus, which may take ten, 20, 30, or 40 years. Only then does your work get mentioned in high-school textbooks.

ID advocates want to skip all the intermediate steps. They want to take their theory straight into high school textbooks. *And that's not fair*. ID advocates are unwilling to play by the same rules as scientists. If they believe ID is a scientific theory, they should welcome the requirement that they go through all the steps that other scientists have to go through before their work makes it way into textbooks.

We face a vast problem in the public understanding of science. Consider some depressing statistics. In a June 2005 Harris Poll, 54% of respondents said they disbelieved in evolution. Only 38% accepted it. Asked what they do believe about human origins, only 22% said human beings evolved from earlier species. In contrast, 64% said human beings were created directly by God, and 10% said they believed in ID. Asked what should be taught in public schools, a mere *12%* of respondents said that only evolution should be taught. Twice as many, 23%, thought only creationism should be taught. Most of the rest, 55% in fact, thought creationism, evolution, and ID should be taught–on grounds of fairness, of course.

Conventional American intuitions about fairness are simply out of place in genuine scientific debate. Science itself is not fair–and that very fact may be science's greatest legacy. In science, not all ideas are treated equally. In most scientific controversies, one side is simply wrong. Science's power lies precisely in its ability to prove false things to be false. If certain contentions do not hold up with experiment, we can just stop talking about them.

Many people suggest that because the majority of adults in this country apparently don't believe in evolution, we should "teach the controversy". But *the purpose of education* is *not to validate ignorance; it's to overcome it*. If we're doing a crummy job of teaching science in America–and we are–then we need to do a better job in teaching many different kinds of science, including evolutionary biology. Far from watering it down or teaching a nonexistent controversy, we need to teach it better.

In December, the effort to install ID in science classrooms received a major blow, as Judge John Jones III ruled that a short anti-evolution statement read by school administrators to students in Dover, Pennsylvania, accompanied by a recommendation to read a creationist text called "Pandas and People", was unconstitutional, violating the separation of church and state. Judge Jones's 139-page ruling, available on the internet, is a masterpiece of scholarship, examining not merely the legal aspects of the Dover case, but the history of ID and its precursors and the nature of science, including evolutionary biology. As Judge Jones stated:

"Both defendants and many of the leading proponents of ID make a bedrock assumption which is utterly false. Their presupposition is that evolutionary theory is antithetical to the existence of a supreme being and to religion in general. Repeatedly in this trial, Plaintiffs' scientific experts testified that the theory of evolution represents good science, is overwhelmingly accepted by the scientific community, and that it in no way conflicts with, nor does it deny, the existence of a divine creator… ID's backers have sought to avoid the scientific scrutiny which we have now determined that it cannot withstand by advocating that the *controversy*, but not ID itself, should be taught in science class. This tactic is at best disingenuous.…the fact that a scientific theory cannot yet render an explanation on every point should not be used as a pretext to thrust an untestable alternative hypothesis grounded in religion into the science classroom or to misrepresent well-established scientific propositions…"

As a result of this decision, we were recently able to convince the Ohio State School Board to revise their science standards, and remove the offending lesson plan. This success, and others like it around the country, suggest the disingenuous effort to introduce ID as a scientific theory in schools may have peaked. However, if history is any guide, the efforts of those whose religious convictions are inconsistent with scientific knowledge will "evolve" once again.

Why should we care so much about textbook stickers, a few sentences read before class, or whatever the next ID initiative may turn out to be? For some, it's an issue of church/state separation, but that's not my bottom line. To me, the crucial point is that, whenever teachers are made to soft-pedal evolution or teach a controversy that isn't there, *we are forcing teachers to lie*. The minute we force teachers to lie in one place, we make it easier to force them to lie in others. I view lying and misinformation–not religion–as the greatest threat to our democracy.

The universe as it really is is a profoundly remarkable place. Science education should awaken American students to that fact. We also need to get the point across that science is not a threat to a moral world. Quite the contrary, science has an ethos based on honesty, open-mindedness, creativity, egalitarianism, and full disclosure. If those things were realized as thoroughly in the rest of the world as they already are in science, the world would be a better place.

*Lawrence Krauss is a theoretical physicist at Case Western University and a best-selling author and lecturer. His most recent book is **Hiding in the Mirror**: **The Mysterious Allure of Extra Dimensions**. The above was condensed and updated from a longer article in the April/May 2006 issue of **Free Inquiry**, the magazine of the Council for Secular Humanism, www.secularhumanism.org.*

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.